Final Sub-Slab Sampling and Building Mitigation Work Plan

East Hennepin Avenue Study Area
Minneapolis, Minnesota

Prepared for
General Mills, Inc.

February 2014

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1.0 Background and Objectives

1.1 Background

General Mills is in the process of conducting a vapor intrusion investigation associated with historic disposal practices at the General Mills/Henkel Corp. Superfund Site (the Site) located in the southeastern portion of the property at 2010 East Hennepin Avenue in Minneapolis, Minnesota. Historic disposal practices at the Site from the late 1940s to the 1960s impacted shallow groundwater in the mainly residential neighborhood south of the Site with volatile organic compounds (VOCs), primarily trichloroethylene (TCE). The concentrations of trichloroethylene (TCE) in the shallow groundwater led to the assessment of the potential for vapors migrating from groundwater impacted with TCE upward into the soil.

The vapor intrusion investigation was initiated in late 2011 at the direction of the Minnesota Pollution Control Agency (MPCA), the lead regulatory agency for the Site. Investigation work included an evaluation of site conditions from a vapor intrusion perspective and the collection of groundwater and soil gas samples from locations at the 2010 East Hennepin Avenue property and in the City of Minneapolis right-of-way along neighborhood streets and alleys.

TCE was detected in soil gas samples collected at eight feet below the ground surface (bgs) at concentrations exceeding 10 times the MPCA's Residential Interim Intrusion Screening Value (10X Residential ISV) from several right-of-way locations during the investigation. General Mills, under the direction of the MPCA and in accordance with MPCA's September 2008 *Risk-Based Guidance for the Vapor Intrusion Pathway* (MPCA, 2008) and the MPCA's August 2010 *Vapor Intrusion Technical Support Document* (MPCA, 2010), will now conduct sub-slab sampling and provide vapor mitigation systems, if appropriate, to occupied buildings identified in the area shown on Figure 1-1 (East Hennepin Avenue Study Area or Study Area). The Study Area boundaries are based on TCE concentrations greater than 10 times the MPCA's Residential ISV (10X ISV), or 20 micrograms per cubic meter ($\mu g/m^3$), at eight feet bgs as measured during previous investigations in the public right-of-way.

1.2 Objectives

The overall objective of this Work Plan is to outline and provide detail on collecting sub-slab soil gas samples beneath occupied buildings within the Study Area to make determinations on whether mitigation systems are needed to prevent potential vapor intrusion. This process involves property access coordination, sub-slab sampling, and mitigation system construction. The prescribed, step-wise approach described in this document will allow for project efficiency and informed property owners and stakeholders during this process. The general project approach, stakeholder communications, and continuing evaluation of the Work Plan are described in the following sections.

1.2.1 General Project Approach

A general overview of the process for obtaining building access, collecting sub-slab samples, and mitigating properties in the Study Area is shown on the figures in Appendix A. There may be deviations from this process for unique situations (e.g., access restrictions, non-traditional basement construction, large commercial buildings, etc.) as described further in other sections of this document. Work will be conducted consistent with MPCA guidance (MPCA, 2008; MPCA, 2010).

Access to buildings located within the Study Area must be obtained from property owners, and potentially coordinated with occupants/tenants, as described in Section 2 to collect sub-slab samples and install mitigation systems, if appropriate based on the results of the sub-slab sampling. The purpose of conducting sub-slab sampling is to measure the TCE concentration in the soil vapor beneath the lowest floor of the building. The details of sub-slab soil vapor sampling in a building are described in Section 3. Knowing the concentration of TCE beneath the floor slab will allow for the evaluation of the vapor intrusion risk on a building-specific basis. The evaluation of sub-slab sampling results and how the results will inform a decision as to the need to install a mitigation system is described in Section 4. If the TCE concentration in sub-slab vapor exceeds MPCA screening criteria, a mitigation system will be installed assuming the building owner provides access for system installation. The purpose of installing and operating a mitigation system is to create a negative pressure gradient beneath the floor slab in a building at risk for vapor intrusion. The negative pressure gradient (i.e., lower pressure beneath the floor than above) serves to interrupt the vapor intrusion pathway and prevents vapors from entering the building. The building mitigation process is described in Section 5. Project schedule and reporting is described in Section 6 and document references are in Section 7. A monitoring and maintenance plan for mitigation will be submitted separately.

1.2.2 Stakeholder Communications

The project involves up to 200 properties in the Study Area. The numbers of properties to be sampled will depend in part on sampling results as the project progresses. General Mills is committed to working cooperatively with the MPCA, the Minnesota Department of Health (MDH) and other stakeholder groups in the Study Area, including residents and the nearby community as the project is implemented.

1.2.3 Work Plan Flexibility and Re-evaluation

Due to the data-driven nature of the project and the accelerated schedule, General Mills expects that the scope of work may be adjusted as the project progresses. General Mills and MPCA will continually evaluate the extent to which the sampling program is warranted, based on data gathered. This Work Plan is written to address residential properties; however, it is also applicable to commercial properties, although they are not explicitly referenced. Approximately 5 percent of the total parcels in the Study Area are considered commercial properties. The applicable screening values for TCE at residential and commercial properties are 10 times the MPCA's residential and commercial ISVs or 20 $\mu g/m^3$ and 60 $\mu g/m^3$, respectively.

2.0 Property Access Coordination

Barr Engineering Company (Barr), on behalf of General Mills, will make good faith efforts to obtain access to properties from building owners in the Study Area. Entry into buildings will be coordinated with owners and, as needed, occupants or property managers, within the Study Area shown on Figure 1-1 to conduct sub-slab sampling and, if appropriate based on sampling results, install building mitigation systems.

2.1 General Study Area Property Information

According to Hennepin County's property information, as of November 1, 2013, 195 parcels are located within the Study Area. According to a preliminary review of property information obtained from Hennepin County and limited reconnaissance and aerial photography review, the 195 parcels within the Study Area consist of the following:

- 141 single-family homes
- 36 multi-family buildings/apartment buildings
- 5 commercial/industrial buildings
- 2 multi-use buildings (residential and commercial/industrial)
- 11 vacant parcels

It is anticipated that many of the residential building occupants are renters attending or associated with the University of Minnesota, which is located just south of the Study Area.

2.2 Obtaining Access Agreements

Access to collect sub-slab samples and access to install a mitigation system, if necessary, will be obtained through the use of separate access agreements for sampling and, where appropriate, for mitigation.

2.2.1 Access for Sampling

To collect sub-slab samples from an occupied building, the property owner must sign an access agreement for a General Mills representative to enter the building, install one or more sampling ports, and collect one or two sets of soil gas samples. The sampling access agreement template is in Appendix B.

The initial process for obtaining a signed sampling access agreement includes the following:

- On November 6, 2013, the MPCA mailed a notice letter to each property within the Study Area, and to each property in a mailing area located adjacent to the Study Area. The letter described the vapor study and encouraged all residents in the Study Area to provide access for sampling. Barr's contact information to schedule sampling was provided in the letter.
- Sampling access agreements also were available at the November 12, 2013, community meetings hosted by the MPCA and MDH.
- The sampling access agreement is posted on MPCA's project website.

Following the community meetings on November 12, 2013, additional General Mills efforts to obtain signed sampling access agreements either have or are anticipated to include the following:

- Continuing to provide sampling access agreements to Study Area property owners who contact Barr.
- Working to contact property owners and building occupants individually via an additional mailing to properties in the Study Area and/or door knocking in the Study Area to obtain signed access agreements and contact information for property owners, building management personal, etc. Door-to-door efforts will be conducted by teams of two Barr staff members.
- Working to contact property owners and occupants in the Study Area via telephone and email to discuss access and entry for sampling once contact information is known. This will also be conducted by Barr.
- Requesting assistance from stakeholder groups (e.g., MDH, City of Minneapolis, neighborhood associations, etc.) to obtain access. General Mills and Barr will coordinate this effort.
- Where needed following these efforts, the MPCA or Barr may send follow-up notification letters with the sampling access agreement attached.

Where practical and to the extent access is provided, sampling efforts will be prioritized to obtain sampling access from areas where previous investigations in the public right-of-way have indicated the potential for higher TCE concentrations in soil gas and those areas closest to the Site.

A minimum of three good-faith efforts (U.S. mail, email, phone call with voice mail message, door knocking with fact sheet and access agreement template left behind, etc.) will be made by Barr to obtain access and entry to each specific property. Barr will refer the following categories of properties to the MPCA:

- Property owner cannot be reached after three good-faith efforts to have a sampling access agreement signed as described above;
- Property owner declines to sign a sampling access agreement; and
- Property owner or occupant does not coordinate entry for sampling after three good faith attempts.

If neither Barr nor MPCA are able to obtain a sampling access agreement or to gain entry for sampling if a sampling access agreement has been signed, sampling will not occur on the property.

2.2.2 Mitigation System Installation Access

If sub-slab sampling results indicate that a building mitigation system is appropriate, the property owner will be asked to sign a mitigation system access agreement to authorize system installation. The mitigation system installation access agreement template is in Appendix B.

It is anticipated that obtaining mitigation system access agreements will be simpler than obtaining the sampling access agreement for the property, as the property owner will have already provided a signed sampling access agreement. Nevertheless, to the extent necessary, Barr will try to obtain access for mitigation system installation by using a combination of mail, email and telephone contacts as appropriate. Similarly, properties where Barr cannot establish access will be referred to the MPCA. If both Barr and the MPCA are unable to obtain a mitigation system installation access agreement or entry, a mitigation system will not be installed on the property.

2.3 Scheduling and Coordination

Sample collection and mitigation system installation will be scheduled and coordinated with property owners and/or occupants once signed access agreements are obtained. A summary of the property owner/occupant coordination is shown on Figure 2-1.

2.4 Records

As described in this section, Barr will maintain records to track specific contact information and project implementation at properties located within the Study Area.

2.4.1 Structure of Recordkeeping

Property information for each of the parcels in the Study Area was obtained from Hennepin County and used as the starting point for building the records.

The following property-specific information will be recorded as the project is implemented:

- Contact information for owners and/or occupants
- Contacts with and attempts to contact owners and/or occupants (e.g., phone calls, door visits, emails, etc.)
- Sampling access agreements
- Building-specific information provided by owners and/or occupants (e.g., basement, radon mitigation system currently installed/operational, etc.) and building information obtained by Barr or the mitigation contractor in constructing the mitigation system.
- Sampling port installation and sampling date(s)
- Sample analytical results and laboratory reports
- Mitigation system installation access agreements
- Mitigation system installation completion date
- Mitigation system diagnostic results
- Sampling port removal date

The records will be used to provide status updates to the MPCA on a regular basis as the project is implemented as described further in Section 6.2.

2.4.2 Privacy and Confidentiality

Each property within the Study Area will be assigned a unique, random numeric 4-digit (1000 to 9999) identifier to correlate each property to the project in a confidential manner for the public record. This unique identifier will be included on sampling chains-of-custody and used to track sampling results and to track mitigation system installations. All properties within the Study Area will be assigned a unique identifier whether or not the property owner has signed a sampling access agreement and/or a mitigation system installation access agreement. Due to the confidential nature of the project, only authorized parties implementing the project including the MPCA, General Mills, and Barr, will have access to the unique numeric identifier assigned to each property.

3.0 Scope of Sub-Slab Sampling

The purpose of collecting sub-slab soil vapor samples is to provide data that accurately represents conditions beneath the lowest floors of the occupied buildings located within the Study Area identified in Figure 1-1.

3.1 Interior Building Inspection

Prior to collecting a sub-slab sample, but during the sub-slab sampling event, Barr will perform a visual survey in the basement (or lowest level) of each building (residential, commercial and recreational) to collect information about building use, construction, floor condition, occupancy, potential vapor entry locations, and other features that can influence the potential for vapor intrusion risk. This is consistent with MPCA guidance (MPCA, 2010). The information recorded during the building survey will include consideration of the information in the Building Survey Form in Appendix C.

If a radon mitigation system is present in the building, Barr will describe the system as set forth in Part 1 of the Building Survey Form. A sub-slab soil vapor sample will be collected and a diagnostic test of the existing system will be performed. The system may need to be upgraded to meet the performance requirements for systems that are constructed under this Work Plan. This work will be carried out by Home Safety Solutions (HSS) or Standard Water Control Systems (Standard Water) and McGough Construction (McGough) during a subsequent visit to the building.

If the building survey shows that the basement has a dirt floor, sub-slab sampling will not be possible. In this case, the situation will be evaluated and either a membrane will be placed over the floor, a concrete slab will be constructed, or indoor air sampling will be performed. If a membrane is placed or if a new concrete floor is constructed, sub-slab sampling will proceed as described in this section of the Work Plan.

3.1.1 Building Footprint Less Than 1,000 Square Feet

Barr will collect one sub-slab soil vapor sample using a sampling port (vapor pin) for every 1,000 square feet of building footprint or for every section of the building that is separated by footings or with foundations at different levels. This is consistent with MPCA guidance (MPCA, 2010). The size of the building footprint will be approximated based on the dimensions of the basement (or lowest level) floor. Barr anticipates that most buildings in the Study Area in Figure 1-1 will have a building footprint less than 1,000 square feet and therefore that one sub-slab soil vapor sample will be collected from each building unless sections of the basement floor are separated by footings or have floors at different levels.

3.1.2 Building Footprint Greater Than 1,000 Square Feet

For buildings with foundation footprints greater than 1,000 square feet, Barr will collect one sub-slab soil vapor sample for every 1,000 square feet or for every section of a building that may be separated by footings or foundations at different levels. This is consistent with MPCA guidance (MPCA, 2010). For very large buildings with foundation footprints greater than 5,000 square feet, Barr will collect a minimum of five sub-slab samples from locations evenly distributed throughout the building footprint as described in MPCA guidance (MPCA, 2010).

3.2 Quality Assurance and Data Quality Objectives

The overall quality assurance (QA) objective for this work is to develop and implement procedures for sub-slab sampling, sample custody, laboratory analysis, and reporting that will support decisions made for subsequent sub-slab soil vapor sampling and the installation of mitigation systems. Data quality objectives (DQOs) for meeting the overall QA objective for the work are summarized in the Quality Assurance Project Plan (QAPP) (Barr, 2014).

3.3 Monitoring Point Construction

Based on access provided by the property owner, Barr will select the location for the sub-slab soil vapor monitoring point(s) and place at least one vapor monitoring point in each occupied building. A schematic of a sub-slab soil vapor monitoring point is shown in Figure 3-1. Barr will coordinate monitoring point construction activities with the building property owner and/or their representative (e.g. property manager, tenant). Barr anticipates that the location of the monitoring point will be near the approximate center of the concrete floor slab and that the location will be adjusted based on the presence of obstructions, utilities, or other hindrances. When possible, Barr will select the monitoring point location to be in an area with an unfinished floor (i.e., bare concrete with no tile, carpet, or other coverings) and not in areas where disturbances may occur to potentially hazardous materials such as asbestos containing materials (ACM) or lead based paint. Barr will document the sample location with photographs and by measuring from nearby walls, stairs, support beams or other permanent structures in the building. These measurements will be noted on the Building Survey Form.

Barr will conduct a visual interior utility screen prior to installing the monitoring points to minimize the risk of damage to utilities buried under the floor. In situations where a visual screening is insufficient, a private utility locator will be used to be sure sampling locations are not directly above floor utilities. Barr will install the monitoring point in general conformance with Barr Standard Operating Procedure (SOP) *Installation and Extraction of the Vapor Pin™* (Appendix D). Barr will complete leak testing at each monitoring point using potable water as described in Appendix D. After the monitoring point passes the leak test, a sub-slab soil vapor sample will be collected following the procedures described in Section 3.4.

3.4 Sampling Procedure

A Barr team of two will collect sub-slab soil vapor samples using the methods described in the Barr SOP titled *Air Sample Collection from a Sub-Slab Soil Vapor Monitoring Point* (Appendix E). Barr will document the quality control measures (e.g., vacuum testing of the manifold and leak testing) on the Field Sampling Quality Control Checklist (Appendix E). Barr will collect sub-slab soil vapor samples in laboratory-supplied, individually-certified 1-liter Summa canisters and submit the samples to Pace Analytical Services, Inc. (Pace) of Minneapolis, Minnesota or to ALS Environmental (ALS) in Simi Valley, California, for analysis. A chain of custody will accompany the sub-slab soil vapor samples to the laboratory to document proper handling of the sample. Barr understands that approximately 10% of the properties in which sub-slab sampling is performed will be field audited by the MPCA's oversight contractor.

If an existing radon mitigation system is present in the building, Barr will temporarily turn off the radon mitigation system. After a short period (10 to 30 minutes), Barr will collect a sub-slab soil vapor sample. Barr will then re-start the radon mitigation system and perform the diagnostic testing as indicated in Section 5.

3.5 Analytical Methods

Pace or ALS will analyze the sub-slab soil vapor samples using EPA Compendium Method TO-15 (TO-15). Pace or ALS will conduct the TO-15 analysis and report the result for TCE at or below their maximum reporting limit of 1.1 micrograms per cubic meter ($\mu g/m^3$) for an undiluted sample.

Barr understands that approximately 10% of the sub-slab soil vapor samples will be split with the MPCA's oversight contractor. These split samples will be analyzed by Pace or ALS and the oversight contractor for the Minnesota Soil Gas List compounds. The procedure to collect the split samples is discussed in Appendix E.

Pace's and ALS's SOP for the TO-15 analysis including quality assurance and quality control procedures are presented in the QAPP for this project (Barr, 2013; Barr, 2014).

3.6 Sampling Point Removal and Restoration

After sub-slab soil vapor sampling is complete in the building, Barr will remove the sub-slab soil vapor monitoring point(s) and seal the opening(s) in the floor. The borehole used to place the sampling point will be filled with fast-setting vinyl cement grout until the top of the grout is smooth and level with the surrounding floor slab. If a sub-slab soil vapor monitoring point is advanced in a location that cannot be restored with vinyl cement grout (e.g., through a wood floor, carpet, tile, etc.), arrangements will be made with McGough to repair the monitoring point location to the satisfaction of the homeowner.

4.0 Evaluation of Sampling Results

Results from the sub-slab sampling will be used to inform property-specific decisions (i.e., no further action, re-sampling, or installing a mitigation system) and will also determine when sampling is complete and when sampling at an adjacent property is unnecessary.

As described in the QAPP, sampling results will be reported to Barr with a 1 to 2-day turn around. The laboratory QA/QC data furnished with the initial laboratory report will be reviewed to determine that the data is fit for the intended purpose. The property specific decisions described in Section 4.1 and the sampling progression decisions described in Section 4.2 will be made based on that data. More thorough laboratory QA/QC information (e.g., contract lab program data packages on 10% of the samples) will be validated as it is received from the laboratory. Systemic problems identified with the data, including false negatives and false positives relative to the threshold values, will be evaluated and addressed at the time they are discovered.

4.1 Property-Specific Actions

The sampling and building mitigation decision process for residential buildings (single-family, multi-family, apartments) is shown in Figure A-1 (Appendix A). As shown in Figure A-1, the first step in the process is to assess the condition of the basement floor slab and to identify a sampling location or locations as described in Section 3.1 of this Work Plan.

Basements with dirt floors may require either placing a membrane or concrete floor prior to implementing sub-slab sampling, or as an alternative, conducting indoor air sampling in the basement to determine if the TCE concentration exceeds 2 $\mu g/m^3$. These situations will be discussed with the MPCA.

After installing the sampling port through the floor, a sample of the air below the floor will be collected and analyzed for TCE. As shown in Figure A-2 (Appendix A):

- If the TCE concentration in the first sample is equal to or greater than 20 $\mu g/m^3$, a mitigation system will be offered to the property owner. The process for installing the mitigation system is described in Section 5.0 of this Work Plan.
- If the TCE concentration in the first sample is 2 $\mu g/m^3$ or less, no further work at the property will be required and an appointment will be made with the property owner to remove the sampling port, as described in Section 3.6 of this Work Plan

- If the TCE concentration in the first sample is less than 20 µg/m^3 but greater than 2 µg/m^3, a second sample will be collected from the sampling port and analyzed for TCE, as described in Section 3.0 of this Work Plan. Collection efforts for the second sample will take place seven to thirty days after the first sample. If the TCE concentration from the second sample is equal to or greater than 20 µg/m^3, a mitigation system will be offered for installation in the building following the process described in Section 5.0 of this Work Plan. If the TCE concentration in the second sample is less than 20 µg/m^3, no further work at the property will be required and an appointment will be made with the property owner to remove the sampling port as described in Section 3.6 of this Work Plan.

The above decision process and threshold values will apply to all residential buildings. The same process will be followed for commercial and industrial buildings; however, the industrial Intrusion Screening Values rather than the residential screening values will be used as the threshold values in the process. The industrial ISV for TCE is 6 µg/m^3, so the 10xISV threshold used in this project to determine the decision to install a mitigation system will be 60 µg/m^3 for commercial and industrial buildings.

4.1.1 Transmittal of Sampling Results to MPCA

Sampling results for each building will be provided to the MPCA following Barr's QA/QC of the results.

4.1.2 Transmittal of Sampling Results to Property Owners

Sampling results will be shared and explained to each property owner concurrently with transmitting the results to the MPCA.

- A results table will be prepared including the TCE concentration measured in the sample, the screening value, and the laboratory reporting limit with a simple explanation of each and a cover letter with a simple explanation of the results. This information will be sent via the mail along with calling the property owner. If the property owner cannot be reached via phone after the third attempt, the mailed sampling results and cover letter will be the sole form of communicating the results to the owner.
- One of the following three sampling result cover letter templates will be used, based on the evaluation of results described above (template cover letters are in Appendix F):
  - Option 1: sub-slab sampling result is below threshold values and the sampling port can be removed

- Option 2: sub-slab sampling result is above threshold value and a mitigation system installation access agreement is needed
- Option 3: sub-slab sampling result is between 2 and 20 $\mu g/m^3$ and resampling is required; a general time window will be provided for the resampling

- For properties that have 20 $\mu g/m^3$ or greater TCE in the sub-slab sample, Barr will attempt to contact property owners via telephone to confirm receipt of results and attempt to coordinate an appointment for a mitigation system design meeting and obtain a mitigation system access agreement.

4.2 Sampling Process Progression

Allowing for flexibility to conduct individual prioritized sampling locations as may be identified by MDH, the initial sampling strategy is to begin in the following areas:

- On the east side of the Study Area where there is less definition on the limits of soil gas impacts,

- Near the areas with the highest concentrations in the right-of-way (DP- 019 and DP-024)

- At the separate western portion of the Study Area near the Van Cleve Park Recreation Center

The process for the progression of sampling is shown in Figure A-4. It is recognized that the timing of the receipt of sampling access agreements may make this process difficult to follow, at least initially.

The essence of the process shown in Figure A-4 is that the edge of the sampling area will be reached when properties not eligible for mitigation systems establish a buffer from mitigation-eligible properties or until the sub-slab sampling reaches the edges of the groundwater plume. When this occurs, discussions will be held with the MPCA to determine if sub-slab sampling can be discontinued at properties beyond the established buffer. Consequently, with the sub-slab sampling described in Section 3.0, the edges of the area eligible for mitigation systems will systematically be defined. Properties that do not provide access will not be considered as requiring or not requiring mitigation in this process.

5.0 Scope of Building Mitigation

If the evaluation of the sub-slab sampling results, as described in Section 4, indicates a concentration of TCE beneath the slab that exceeds the screening criteria, a vapor intrusion mitigation system will be offered to the property owner. The building mitigation system construction process will include coordinating with the property owner to perform a visual inspection of the building interior and discuss a mitigation system type suitable for their building, the most appropriate mitigation system routing, mitigation system construction, and mitigation system operational diagnostic testing. The steps for performing the building mitigation are shown schematically in Figure A-3. McGough, the general contractor, and HSS or Standard Water, the mitigation contractors, all under contract to General Mills, will coordinate with the property owner, construct the mitigation system, conduct diagnostic testing and report the results to Barr. Barr, also on behalf of General Mills, will provide oversight of the mitigation system construction and contractors. The relationship between the various contractors that will be used in the mitigation phase of the work is shown in Figure 5-1.

5.1 Mitigation System Construction

The most common and cost-effective soil vapor intrusion mitigation strategy involves installing a system that is identical to a typical radon mitigation system. These mitigation systems are referred to as sub-slab depressurization (SSD) systems and are considered the most effective vapor intrusion mitigation strategy for existing or new buildings (MPCA, 2010). An SSD vapor intrusion mitigation system will be installed in the buildings where sampling results demonstrate that mitigation is appropriate. Certain unique circumstances may require different or additional mitigation measures that are discussed in Section 5.1.2.3. All mitigation systems will, at a minimum, comply with the American Society for Testing and Materials (ASTM) E2121-13 Standard Practice for Installing Radon Mitigation System in Existing Low-Rise Residential Buildings (ASTM, 2013).

A typical residential SSD system consists of one or more suction points extending through the slab floor. Each suction point is fitted with a pipe with the annulus between the floor and the pipe sealed. The pipe is generally routed through the upper floors of the building and fitted with a fan in the attic. In special cases, the pipe may be routed to the outside of the building and up the outside wall to above the roof. In this case, the fan and piping will be enclosed within an insulated, possibly heated, pipe chase to prevent freezing in cold weather. The fan provides suction that serves to depressurize the soil layer beneath the slab floor and directs soil vapor to the atmosphere.

5.1.1 Preparation

To prepare for mitigation system installation, the building will be inspected and photographed to document the pre-installation conditions. This initial inspection is referred to as the mitigation design meeting. The basement inspection conducted during sub-slab sampling will also be referenced. A pre-mitigation system construction checklist will be completed by the mitigation contractor during the mitigation design meeting to record the observed building construction, discuss the plan for the layout of the mitigation system (e.g., where will the suction point(s) be located, where will the piping be routed, etc.), and record the property owner-agreed layout (subject to field installation changes) and date for installation of the mitigation system. Building design and construction aspects that will be considered include the number of floors, multi- or single-family residence, additions, crawl spaces, floor and wall construction and integrity, likely footings, floor protuberances, utilities, and materials that may need special handling and disposal (e.g. asbestos tiles or shingles, insulation, likely lead-based painted surfaces, etc.).

Most residential homes will receive a standard SSD system without building-specific designs or pre-mitigation diagnostic tests, relying on the mitigation contractor's experience. The approach will be to install a standard system and modify it as necessary based on the results of post-mitigation system construction diagnostic testing. Where visual inspection reveals obvious building aspects that would impact the effectiveness of a standard SSD system, a further evaluation will be performed to develop a suitable design.

During the mitigation design meeting, the property owner will be asked to sign a mitigation system access agreement. Property owners will need to sign the access agreement prior to scheduling the mitigation system construction. The mitigation system access agreement template is in Appendix B.

5.1.2 Mitigation System Construction

Prior to installing the SSD system, building leaks identified in the basement inspection will be sealed. Common locations where leaks and openings can occur include: floor cracks, floor sumps, around floor drains, floor or wall joints, pipe or wiring penetrations, and crawl spaces. Potential or likely vapor entry points will be sealed with caulk or expanding foam, damaged concrete slabs will be repaired to the extent practicable, exposed earth or pits will be covered and sealed, and air-tight sump covers will be placed on existing sumps. This is consistent with MPCA guidance (MPCA, 2010). The details regarding how a typical SSD system will be constructed are described in Appendix G. The typical SSD system will consist of PVC piping and fittings, an inline tubular fan, and a manometer to show that the mitigation system is operating properly with the piping, fan, and manometer located inside the building. For a building with an outdoor piping route, the piping and fan will be placed outside in an insulated and possibly heated pipe chase and the manometer will be placed inside the building.

5.1.2.1 Single Extraction Point System

One suction point for every 1,000 square feet is generally sufficient for a SSD system to be effective in residential buildings having one continuous slab and when sub-slab communication is good (USEPA, 1993). A typical layout for a single extraction point system is shown in Appendix G.

5.1.2.2 Multi-Extraction Point System

Larger buildings, sections of a building separated by footings or with foundations at different levels, or buildings with wet or low permeability sub-slab soils may require multiple extraction points and higher-powered fans to be effective at depressurizing the sub-slab zone. This could include commercial and industrial buildings or multi-unit residential buildings and apartment complexes. Layouts for a multi-extraction point system will be determined with the mitigation contractor on a building-by-building basis. A typical layout for a multi-extraction point system is shown in Appendix G.

Multi-extraction point systems may also include suction field extension measurements prior to installation of the mitigation system. The field extension measurements involve generating a suction field under the slab to measure the suction field induced at test holes located at various distances from the suction point. Commonly, this pre-mitigation suction field is generated using an industrial vacuum cleaner or an adjustable speed fan attached to a 3- or 4-inch diameter PVC pipe mounted on a portable test stand. Results of the suction field extension testing will be used to determine the number of suction pits in the building mitigation system and will be performed primarily at buildings with footprints greater than 1,000 square feet.

5.1.2.3 Other Variations for Unique Construction/Building Use

There are a number of building conditions that may require a somewhat different approach to achieve sub-slab depressurization. These building conditions include the presence of an existing radon system, a dirt floor in the basement, limestone foundation/walls, a crawl space, a sump with drain tile, and multiple additions or foundations.

If a building has an existing radon system, diagnostic testing will be conducted in the sub-slab sampling phase of the project to ensure that the system is operating so as to meet the diagnostic testing requirements of this Work Plan. The system may require modifications or upgrades to meet the performance requirements set forth in Section 5.2.1.1.

The presence of a dirt floor in the basement or a crawl space requires a different mitigation strategy. If a building has a dirt floor and is not an unoccupied crawl space, a barrier that allows the operation of a SSD system (concrete slab, synthetic membrane, etc.) will be placed, if it is practicable to do so, and a SSD system will be installed. This is not expected to occur often in the Study Area and will be a significant construction project if it occurs.

If a building has an unoccupied crawl space, a sub-membrane depressurization (SMD) system will be installed in that crawl space. A SMD system is similar to a SSD system; however, since there is no slab present, a synthetic membrane is placed and sealed to the foundation or walls. The zone beneath the membrane is depressurized with a vent pipe and fan just like a SSD system. The use of SMD systems will be limited to spaces that are never occupied. The MPCA will be contacted prior to installing a SMD system in areas where occupancy may occur.

The presence of a sump and associated drain tile system also requires a somewhat different mitigation strategy. A sump and drain tile system presents a short circuiting potential. The approach that will be used in buildings with a sump and drain tile will be to seal the sump cover and depressurize the drain tile system by connecting the suction line in close proximity to the drain tile system. This is commonly referred to as a drain-tile-depressurization (DTD) system and is reportedly the second most used mitigation technology (USEPA, 1993). In a building where a sump and drain tile system is present, a DTD will be installed; however, since the DTD system willnot meet the diagnostic testing requirements in Section 5.2, an SSD system will be installed in addition to the DTD system. The same diagnostic testing used for SSD systems, described in Section 5.2 and Appendix H, will be used to demonstrate the effectiveness of the DTD/SSD system.

In some cases, particularly buildings with multiple additions and foundation types, it may be necessary to employ a combination of the systems described above. These unique situations will be dealt with on a case-by-case basis and will be based on the experience of the mitigation contractors.

5.1.3 Permits and Inspections

5.1.3.1 Contractor Certification

Since an SSD or SMD system is the same as a radon system, the mitigation systems for this project will be installed by a mitigation contractor that has received voluntary certification through the National Radon Proficiency Program (NRPP).

5.1.3.2 Electrical

Electrical permits will likely be required at locations where mitigation systems are installed. Electrical work will be performed by a Minnesota-licensed electrician that meets all licensing and/or permitting requirements of Hennepin County and/or the City of Minneapolis. This work will be coordinated through the general contractor.

5.1.3.3 Other Permits

There may be other project specific permits required by the City of Minneapolis. Certain types of finishing work may require a building permit or another type of permit. Building permits may be required for work such as constructing concrete slabs, modifying plumbing, or other major finishing work. All contractors that work on the construction of the mitigation systems will meet licensing and/or permitting requirements of Hennepin County and/or the City of Minneapolis.

5.2 Mitigation System Diagnostics

Mitigation system diagnostics are tests that will be performed to show that the mitigation system is functioning properly and is meeting the performance criteria described in this Work Plan.

5.2.1 Diagnostic Objectives

5.2.1.1 Performance

An SSD system prevents vapor intrusion into a building by lowering the air pressure in the soil directly beneath the lowest building floor slab relative to the indoor air pressure (MPCA, 2010). The performance of SSD, SMD, and DTD/SSD systems can be assessed by measuring the magnitude and extent of the low pressure zone created by the installed system. If the extent of the low pressure zone extends over or beyond the building footprint and if the magnitude of the low pressure zone exceeds the ambient pressure differential created by barometric pressure variations, wind, HVAC operation, etc., then the system will be sufficient to prevent vapor intrusion.

To measure the extent of the low pressure zone, monitoring points will be installed in three locations; one location will be at least 3 feet from the suction point and two locations will be at least 10 feet from the suction point or as far from the suction point as reasonably possible. If there is evidence of a building feature that may inhibit the propagation of a low pressure zone (e.g. interior building footings, multiple slabs, slabs at different elevations, etc.) monitoring points will be installed in locations that will allow for an assessment of these features.

The magnitude of the low pressure zone will be assessed at the monitoring points by measuring the differential pressure between indoor and sub-slab air. Differential pressure measurements will be made with a digital micro-manometer. The pressure differential between sub-slab and indoor air that will be achieved by the SSD, SMD, or DTD/SSD system will range from 0.012 to 0.02 inches of water which is equivalent to 3 to 5 Pascals (MPCA, 2010).

To assess the magnitude of the low pressure zone created by an SSD, SMD, or DTD/SSD system, the diagnostic testing will be performed in a reasonable "worst case scenario." Building appliances that rely on a natural draft for make-up air (i.e. appliances that take in air from inside the building instead of having a supply line for make-up air from outside the building) can lower the indoor air pressure. Natural draft appliances include older non-high efficiency furnaces and boilers, bathroom fans, stove or range hoods, and other building ventilation fans. In addition, the "stack effect," created by natural draft appliances, especially in the winter, can also lower the indoor air pressure. To assure that the SSD or DTD system is capable of creating a sufficient pressure differential, diagnostic testing will be performed with all windows, doors, and other building entrances closed, and while all natural draft appliances and bathroom and kitchen fans are operating.

5.2.1.2 Data Quality Objectives

In order for diagnostic testing to demonstrate the effectiveness of an SSD or DTD system, the data collected during testing must be sufficiently precise, accurate, reproducible, and representative. The necessary precision and accuracy will be attained by selecting a micro-manometer with a resolution of at least 0.001 inches of water or less and an accuracy reading of +/-10% or less. The representativeness of the data will be evaluated by comparing the vacuum measurements from the two monitoring points. If the two measurements are within two orders of magnitude (the expected spatial variation presented by Johnson, AEHS 2012), the measurements will be considered representative. Reproducibility will be tested by taking duplicate vacuum measurements at 10% of the locations. If the measurements are within 10% of the original reading, the measurements will be considered reproducible.

5.2.2 Diagnostic Procedures

Detailed diagnostic procedures including equipment, methods, field data forms, and checklists are described in Appendix H.

5.2.3 Backdrafting

The mitigation systems discussed in this Work Plan (SSD, SMD, and DTD/SSD) are active soil depressurization (ASD) systems. By design, an ASD system creates a pressure differential that can draw indoor air out of the building. In some instances this flow can be significant enough to cause the exhaust from combustion appliances (including carbon monoxide) to flow into the basement. Although mitigation system installers encounter ASD-induced backdrafting only infrequently, the consequences of backdrafting can be severe.

To protect against unexpected backdrafting, the mitigation contractor will complete a backdraft test prior to and after installation of an ASD system or when inspecting an existing mitigation system. The mitigation contractor will use smoke to assess backdrafting of exhaust gases from natural draft appliances. Smoke that does not enter the chimney from a natural draft appliance is deemed to have failed the backdraft test and the building will be further evaluated. Smoke that enters the chimney is deemed to have passed the backdraft test and is indicative of the building appliances operating in a safe manner.

The mitigation contractor will also install a carbon monoxide monitor in the basement outside of a bedroom or near the manometer for the mitigation system in accordance with Minneapolis code.

5.3 Documentation of Installation and Diagnostics

The installation of the mitigation systems and associated diagnostic testing will be performed by a mitigation contractor. The mitigation contractor will be responsible for documenting the installation and the diagnostic testing. Barr will oversee the installation of the mitigation system and the diagnostic testing and record measurements from the diagnostic testing. Installation and diagnostic testing records will be furnished to Barr by the mitigation contractor within 3 days following each installation. Installation records will be maintained by Barr.

5.3.1 Documents and Forms

Diagnostic testing forms and checklists are attached in the diagnostic testing SOP in Appendix H.

5.3.2 Photographic Documentation

The area or system installation and the diagnostic testing will be photographed prior to, during, and after completion of the installation and diagnostic work.

5.3.3 Information Provided to Property Owner

The mitigation system installation contractor will provide a verbal description of the system operation and maintenance to the property owner. The property owner will be left with a placard placed next to the manometer that will monitor the mitigation system that visually depicts the manometer configuration if it is operating improperly and provides a number to call a mitigation contractor if the system is not operating properly. The property owner will also be furnished with a binder of material relative to the constructed system including a fact sheet describing in general how the SSD, SMD, or DTD/SSD system is constructed, fan warranty, etc.

6.0 Reporting and Schedule

6.1 Schedule

Barr began implementing the Work Plan immediately upon MPCA approval of the sub-slab sampling portion of the Work Plan (Section 3.0). Assuming 200 buildings undergo sub-slab sampling, it is expected that completion of the sampling and mitigation system installation activities described in this Work Plan will take several months. This schedule relies heavily on the cooperation and responsiveness of the individual property owners. If GMI encounters difficulties in securing access to one or more properties, it will inform MPCA and request assistance.

6.2 Progress Reporting

While sampling and mitigation system installation activities are underway, Barr will prepare weekly progress reports and submit them to MPCA. The weekly progress reports will contain narrative, tables, and figures as needed to detail the work activities completed to date, work activities completed during the previous week, work activities scheduled to be completed during the week the report is prepared, copies of analytical data received during the previous week, and a discussion of any problems encountered during the week. It is anticipated that the weekly reports may include numbers of properties for the reporting week and an accumulated total for the following categories of milestones:

- Signed sampling access agreements received
- Properties with sampling ports installed and first samples collected
- Properties with second samples collected
- Properties with no mitigation required
- Properties with mitigation required
- Signed mitigation access agreements received
- Properties with mitigation systems installed
- Properties with sampling ports removed
- Properties with special issues by category (e.g., businesses, occupied buildings with no basement floors or with a crawl space, businesses with existing radon systems, etc.) and the status of the properties in each category
- Properties referred to MPCA for access assistance
- Properties on access or mitigation refused list

6.3 Implementation Report

At the conclusion of implementation of the Work Plan, Barr will submit an Implementation Report to the MPCA summarizing the work completed for the project including the status of each property in the mitigated area, including copies of the mitigation system plan for each building that had a mitigation system installed, and all laboratory data collected for the project organized by 4-digit property identifier. The report will be submitted to the MPCA within 120 days of receipt of the final analytical results or the final mitigation system installation.

7.0 References

American Society for Testing and Materials (ASTM), 2013. *ASTM E2121-13 Standard Practice for Installing Radon Mitigation System in Existing Low-Rise Residential Buildings.* 2013.

Barr Engineering Co. (Barr), 2013. Draft Quality Assurance Project Plan, Sub-Slab Sampling, East Hennepin Avenue Study Area. November 2013.

Barr, 2014. QAPP Addendum 1.0 – Sub-Slab Sampling, East Hennepin Avenue Study Area, Minneapolis, MN (EPA ID# MND051441731, MPCA Site ID# SR3). January 2014.

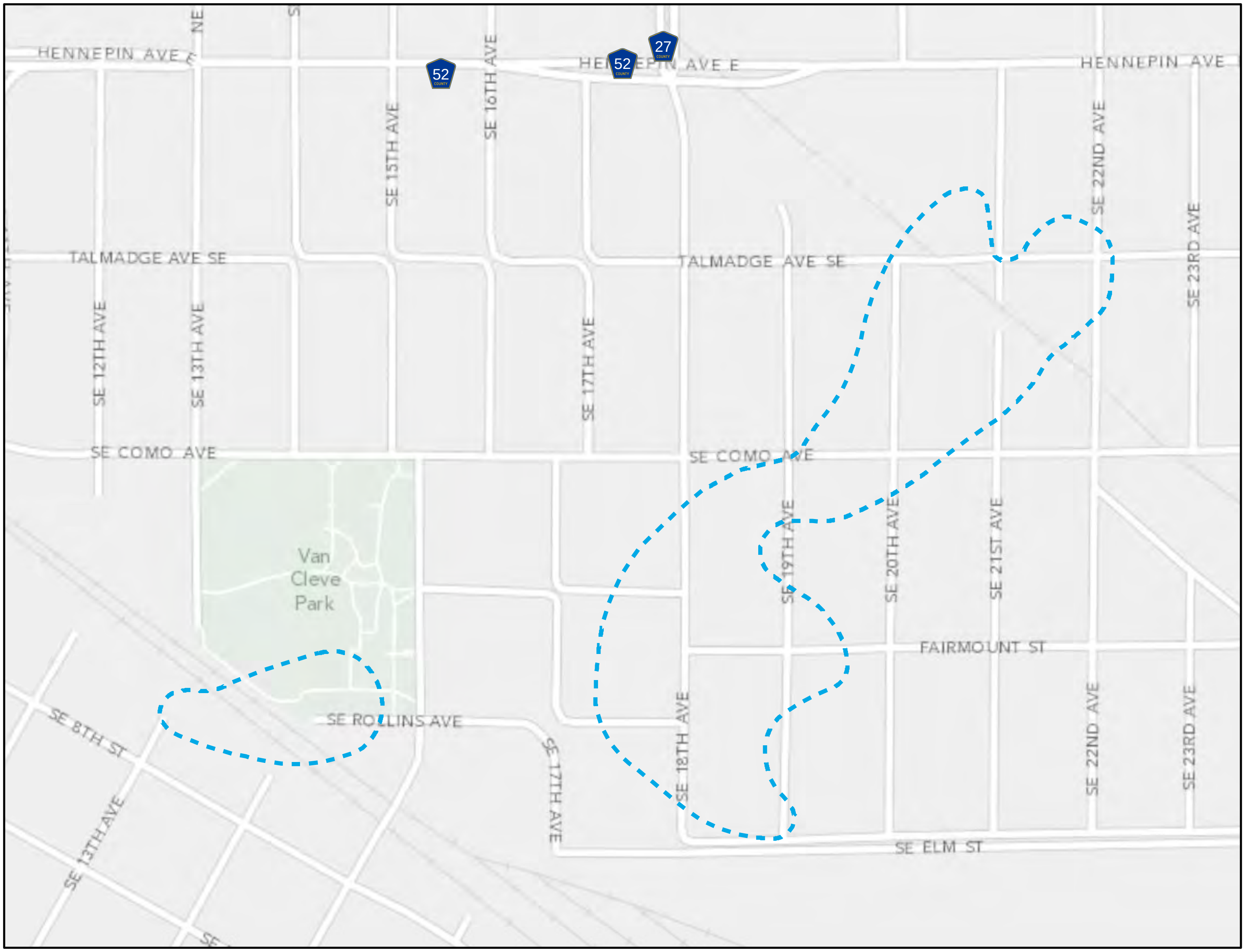
Minnesota Pollution Control Agency (MPCA), 2010. *Vapor Intrusion Technical Support Document.* August 2010.

MPCA, 2008. *Risk-Based Guidance for the Vapor Intrusion Pathway*. September 2008.

New Jersey Department of Environmental Protection (NJDEP), 2013. *Vapor Intrusion Technical Guidance*. March 2013.

United States Environmental Protection Agency (USEPA), 1993. *Radon Reduction Techniques for Existing Detached Houses, Technical Guidance (Third Edition) for Active Soil Depressurization Systems.* October 1993.

Figures



Potential Study Area

530 0 530

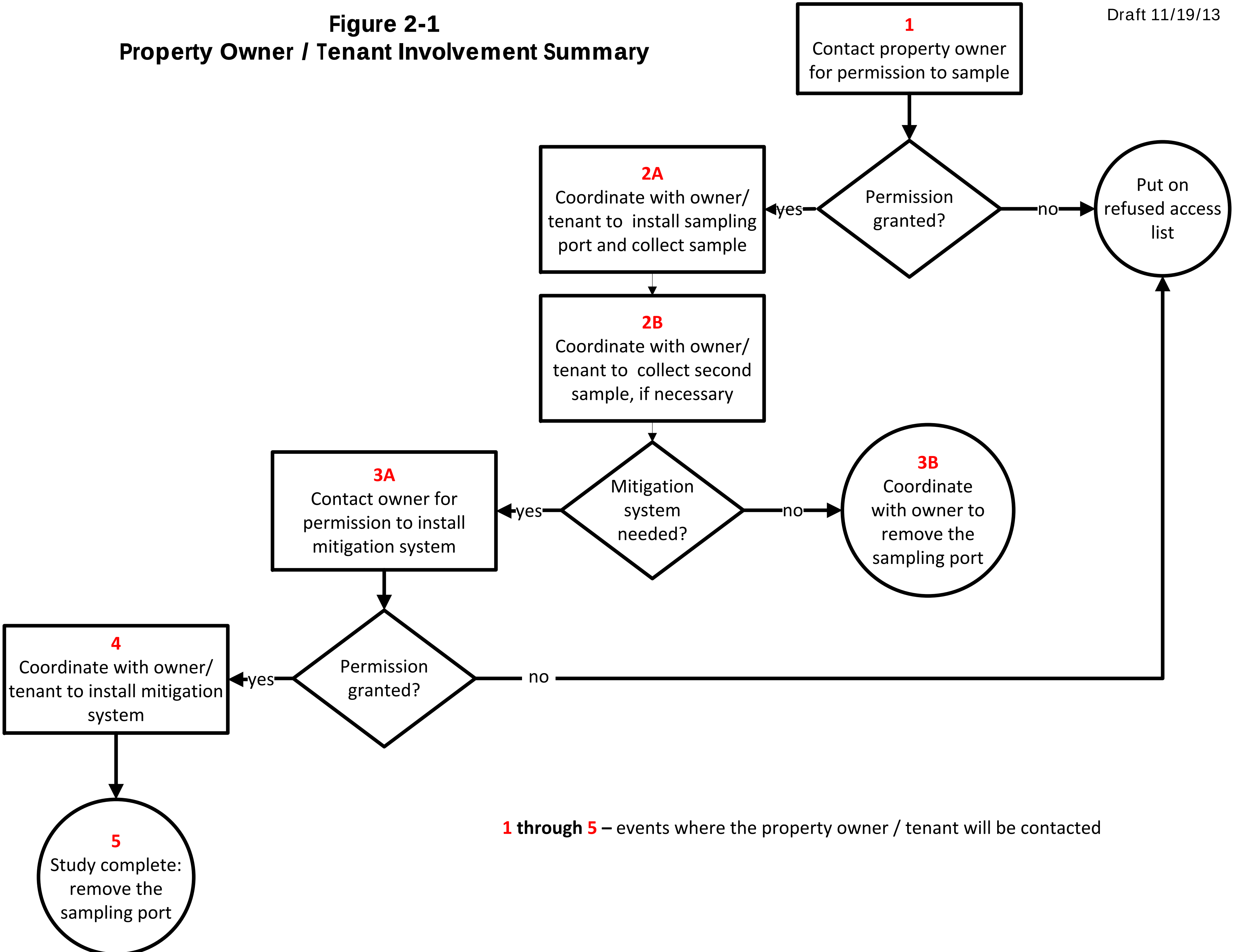
Feet

Figure 1-1

EAST HENNEPIN AVENUE
STUDY AREA
Minneapolis, Minnesota

Draft 11/19/13

Figure 2-1
Property Owner / Tenant Involvement Summary



1 through 5 – events where the property owner / tenant will be contacted

\\barr.com\projects\Mpls\23 MN\27\2327169\WorkFiles\Vapor Intrusion\Mitigation Project\2 Work Plans\Sub-Slab Sampling & Mitigation Work Plan\Final Figures + Appendices\Figures\Fig 2-1Property Owner Tenant Involvement.vsd

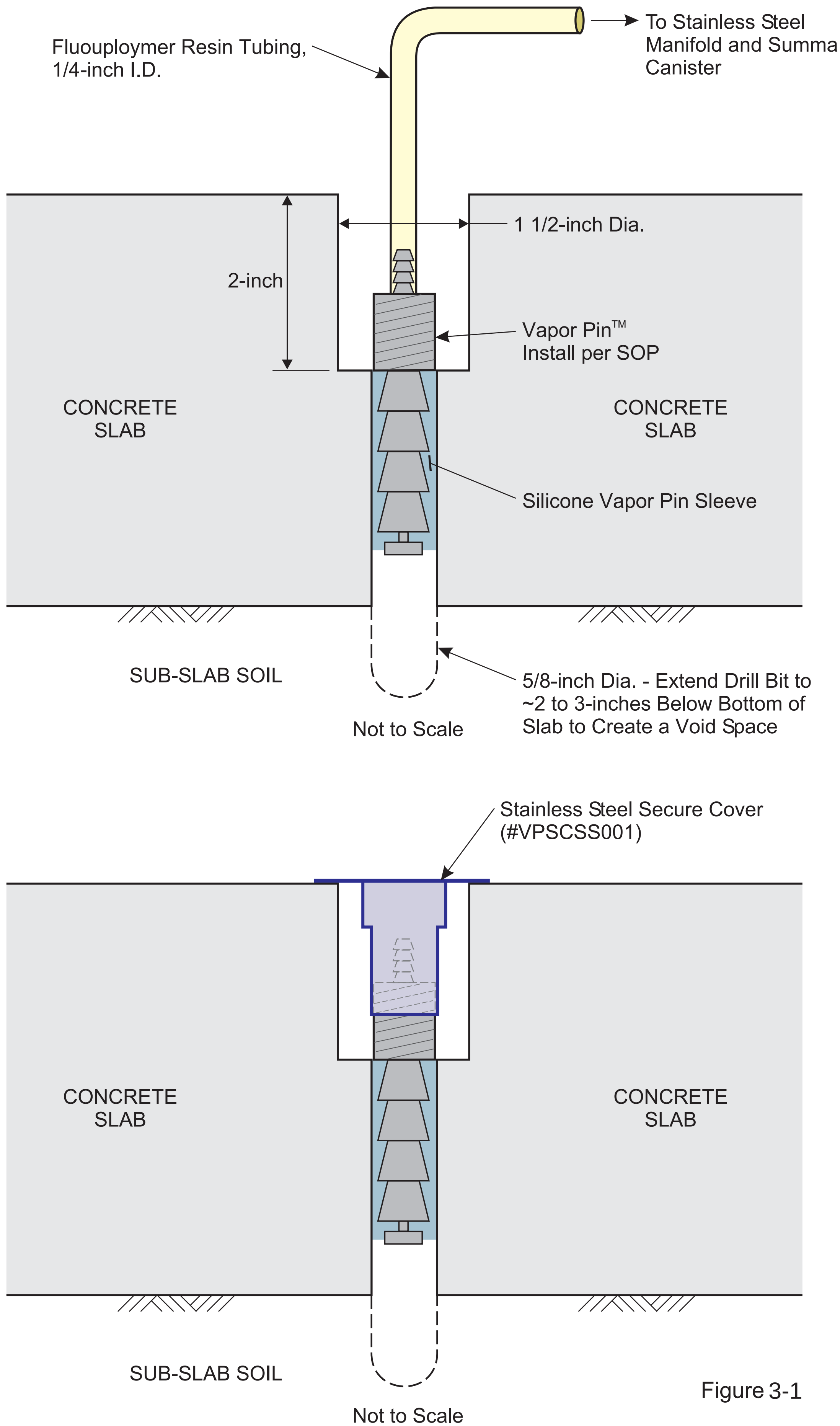
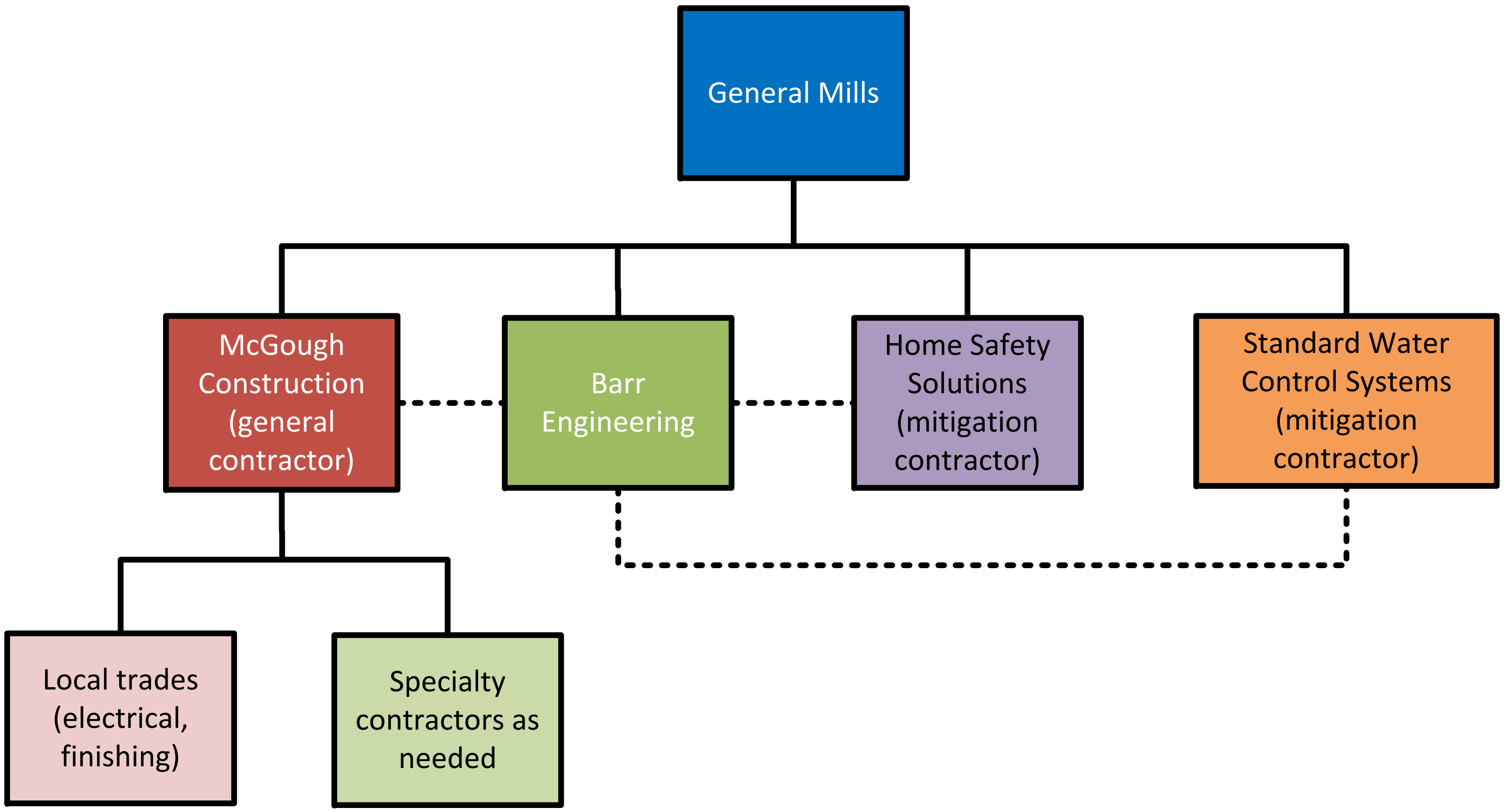


Figure 3-1

SUB-SLAB SOIL VAPOR
MONITORING POINT SCHEMATIC

Figure 5-1
Mitigation Contractor Relationships



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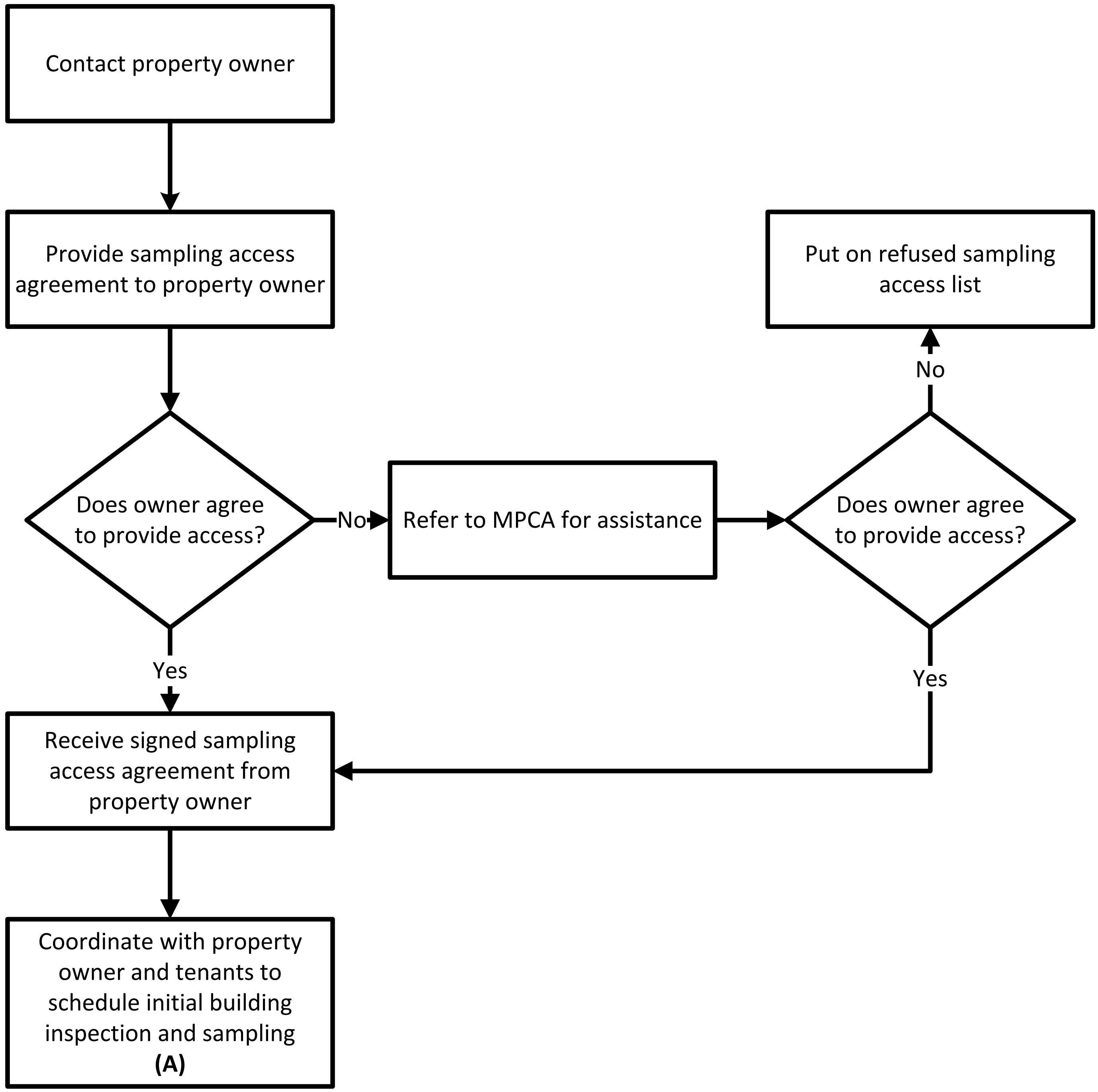
Appendices

Appendix A

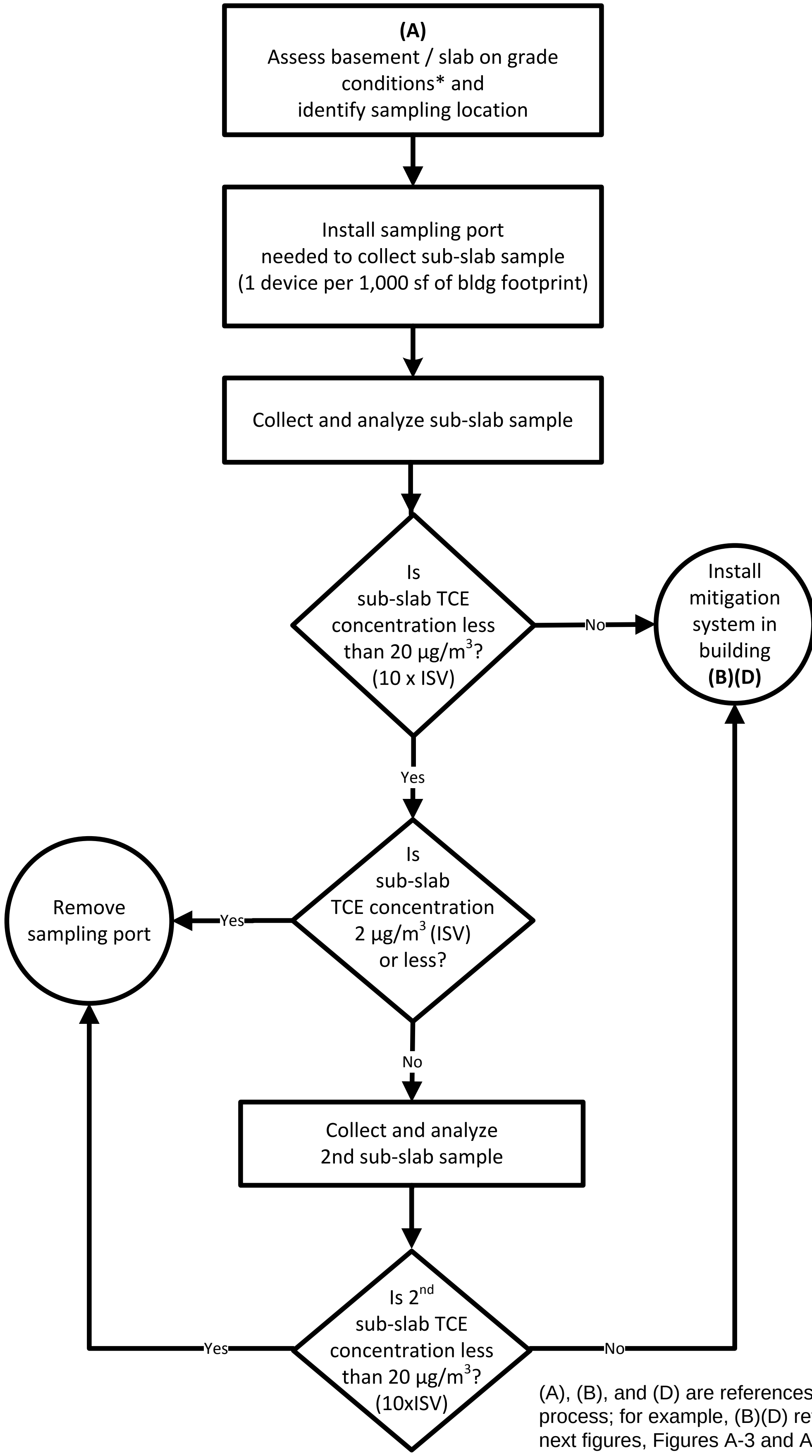
General Project Approach

Figure A-1
Pre-Sampling Process



(A), (B), and (D) are references to steps in the process; for example, (A) refers to the top of the next figure, Figure A-2.

Figure A-2
Sampling and Building Mitigation Decision Process

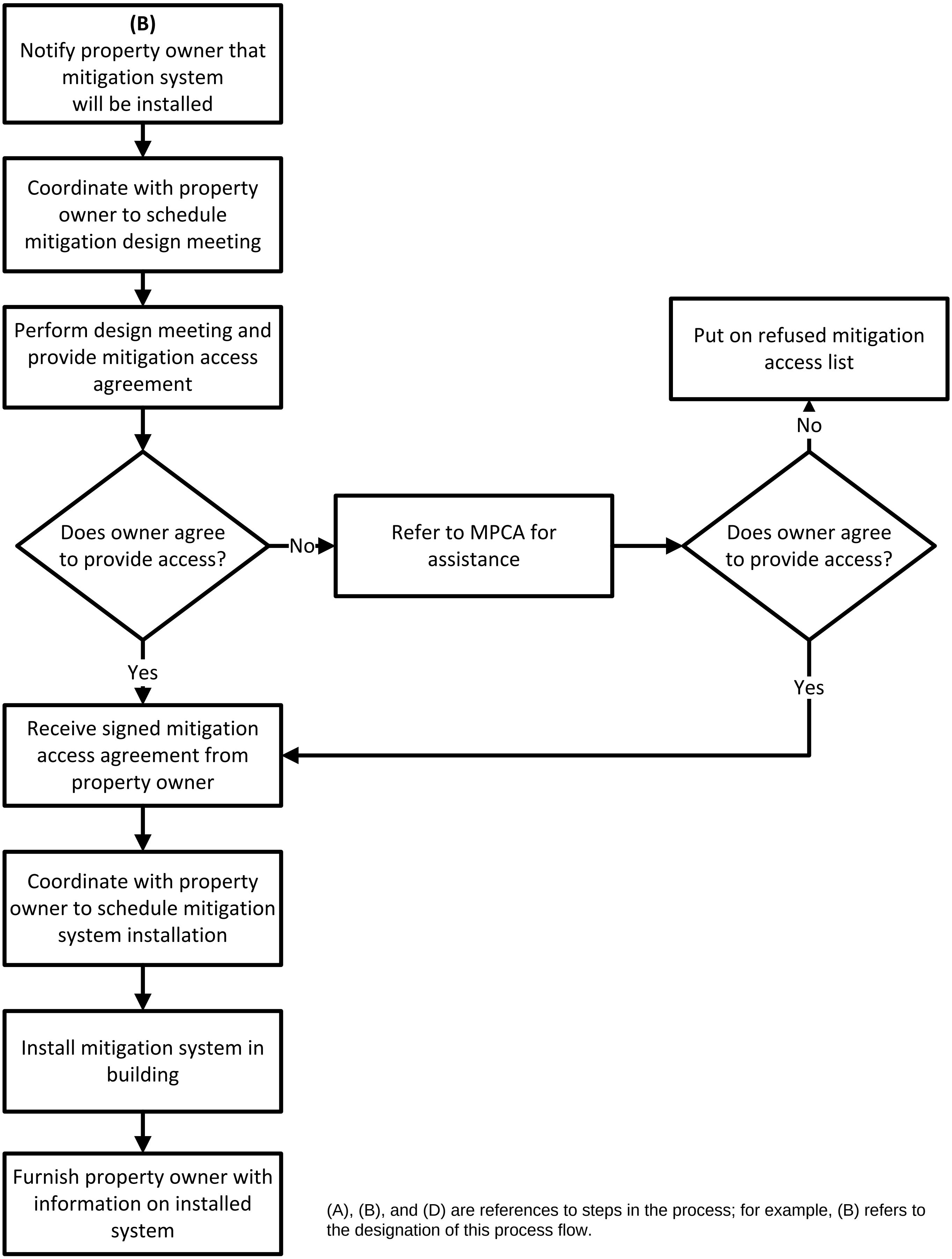


(A), (B), and (D) are references to steps in the process; for example, (B)(D) refers to the top of the next figures, Figures A-3 and A-4, respectively.

* Basements with dirt floors will be a special case requiring either placing a membrane or concrete floor prior to implementing the next step in the decision process or indoor air sampling in the basement.

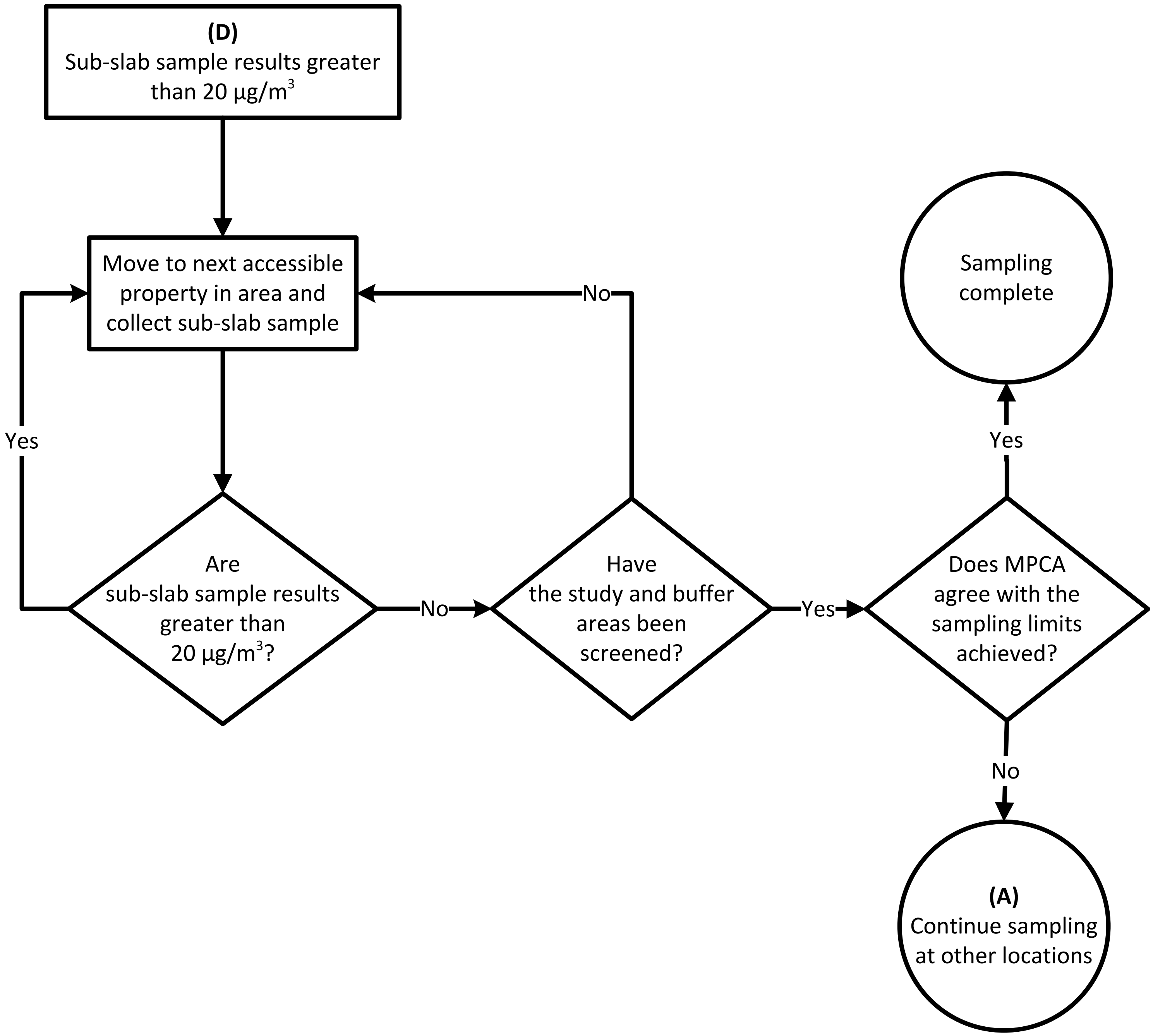
\\barr.com\projects\Mpls\23 MN\27\2327169\WorkFiles\Vapor Intrusion\Mitigation Project\2 Work Plans\Sub-Slab Samp & Mitigation\App A - Decision Trees 2014 02 07 v2.vsd

Figure A-3
Building Mitigation Process



(A), (B), and (D) are references to steps in the process; for example, (B) refers to the designation of this process flow.

Figure A-4
Sampling Progression Process



(A), (B), and (D) are references to steps in the process; for example, (D) refers to the designation of this process flow.

Appendix B

Access Agreement Templates

Soil Vapor Sampling Study - Access Agreement

This section to be completed by OWNER OR TENANT of property to be sampled:

NAME: ____

ADDRESS: ____

CITY: ________________ STATE: ________________ ZIP: ________________

PH. (Day): ______________ PH. (Evening): ______________ EMAIL: ______________

PLEASE CHECK: HOMEOWNER ❑ TENANT ❑

PREFERRED TIME OF DAY TO CONTACT:

____

IF TENANT, PROVIDE NAME, ADDRESS AND PHONE NUMBER OF HOMEOWNER:

____

____

This section to be completed by OWNER of property to be sampled:

Check the box below as applicable:

❑ It is my desire to have vapor sampling conducted in the soil beneath my home. I understand that in order to collect samples, those contractors necessary to perform these functions will have to enter my property for the purpose of identifying the appropriate sampling location in the basement of lowest level of my home. In addition, I agree to assist the sampling team in answering a few questions about my home. I understand Barr Engineering, acting on behalf of General Mills, will restore my property to its original condition to the extent possible following completion of its sampling activity. I have read the materials made available regarding the soil vapor sampling study. By signing below, I hereby authorize Barr Engineering and their representatives the right to access my property for the purpose of performing their respective tasks.

❑ I have been offered to have the soil beneath my home sampled for soil vapor and have reviewed the materials made available regarding the soil vapor sampling study and **DECLINE** to have my property sampled.

______________________________ ________________

Property Owner Signature **Date**

Please complete this form with the information requested above and return it to the attention of:

Sara Gaffin at Barr Engineering
4700 West 77th Street, Suite 200
Minneapolis, MN 55435
phone: 952-832-2935 fax: 952-832-2601 email: easthennepin@barr.com

Ventilation System Program Access Agreement

This section to be completed by OWNER or TENANT of property eligible to receive ventilation system:

NAME: ____________________

ADDRESS: ____________________

CITY: ____________ STATE: ____________ ZIP: ____________

PHONE (Day): ________ (Evening): ________ EMAIL: ____________

PREFERRED TIME OF DAY FOR CONTACT PURPOSES:____________

PLEASE CHECK: HOMEOWNER ____________ TENANT ____________

IF TENANT, PROVIDE NAME, ADDRESS AND PHONE NUMBER OF HOMEOWNER:

____

This section to be completed by property OWNER:

Check one box:

☐ It is my desire to have a ventilation system installed in my home/building. I understand that in order to allow the system to be installed, contractors retained by General Mills to perform these functions will have to enter my property for the purpose of installing the ventilation system. I have read the materials provided regarding installation of the system. I understand General Mills' contractors will restore my property to its original condition to the extent possible following completion of their work. By signing below, I hereby authorize those contractors and their representatives the right to access my property for the purpose of performing their respective tasks.

☐ I have been offered installation of a ventilation system and reviewed the materials provided regarding installation of the system, and **DECLINE** to have a ventilation system installed in my home/building.

____________________ ____________

Property Owner Signature **Date**

Please complete this form with the information requested above and return it to:

Sara Gaffin at Barr Engineering
4700 West 77th Street, Suite 200
Minneapolis, MN 55435
phone: 952-842-3505 fax: 952-832-2601 email: easthennepin@barr.com

Appendix C

Interior Building Survey Form

Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, MN 55155-4194

Vapor Intrusion Interior Building Survey Form

Remediation Program

Doc Type: Site Inspection Information

Part 1: Physical Building Inspection

Preparer's name: ______________________ Date/Time prepared: ______________________

Affiliation: ______________________ Phone number: ______________________

1. Occupant information

Occupant name(s): ______________________ Interviewed: ☐ Yes ☐ No

Mailing address: ______________________

City: ______________________ State: __________ Zip code: __________

Phone: __________ Fax: __________ E-mail: ______________________

Number of occupants at this location: ______ Age range of occupants: ______________________

2. Owner/Landlord information (Check if same as occupant: ☐)

Occupant name(s): ______________________ Interviewed: ☐ Yes ☐ No

Mailing address: ______________________

City: ______________________ State: __________ Zip code: __________

Home phone: ______________________ Office phone: ______________________

3. Building type (Check appropriate response)

☐ Residential ☐ Industrial ☐ School ☐ Church ☐ Commercial/Multi-use

☐ Other (specify): ______________________

If the property is residential, what type? (Check appropriate response)

☐ Ranch rambler ☐ Raised rambler ☐ Townhouses/Condos ☐ Duplex ☐ Modular ☐ 2-Family

☐ Split level ☐ Contemporary ☐ Apartment house ☐ Cape cod ☐ Log home ☐ 3-Family

☐ Colonial ☐ Mobile home ☐ Other (specify): ______________________

4. Building description

If the property is commercial or industrial, describe the business use(s):

____

____

____

Indicate the number of floors and general use of each floor of the building beginning with lowest level:

____

____

____

If there are multiple residential units, indicate how many units: ______ When was building constructed: __________

Type of insulation used in building: ______________________ Elevators or lifts: ☐ Yes ☐ No

Basement/Lowest level depth below grade: ______________________ (feet)

Observed basement characteristics (Check all that apply)

Is basement/lowest level occupied:	☐ Full time	☐ Occasionally	☐ Almost never		
Basement type:	☐ Full	☐ Crawlspace	☐ Slab	☐ Other:	
Floor materials:	☐ Concrete	☐ Dirt	☐ Stone	☐ Other:	
Floor covering:	☐ Uncovered	☐ Covered	☐ Covered with:		
Concrete floor:	☐ Unsealed	☐ Sealed	☐ Sealed with:		
Foundation walls:	☐ Poured	☐ Block	☐ Stone	☐ Other:	
Basement finished:	☐ Unfinished	☐ Finished	☐ Partially finished		
Basement wetness:	☐ Wet	☐ Damp	☐ Seldom	☐ Moldy	
Sump pump present:	☐ Yes ☐ No	If yes, was water present: ☐ Yes ☐ No			

Indicate sources of water supply sources (i.e., drinking, irrigation, etc.) and type of sewage disposal
(Check all that apply)

Water supply:	☐ Public water	☐ Drilled well	☐ Driven well	☐ Dug well
Sewage disposal:	☐ Public sewer	☐ Septic tank	☐ Leach field	☐ Dry well:

5. Heating, venting, air conditioning, or other building controls (Check all that apply)

Type of heating system(s) used in this building (Check all that apply)

☐ Hot air circulation ☐ Space heaters ☐ Electric baseboard ☐ In-floor heating ☐ Heat pump

☐ Steam radiation ☐ Wood stove ☐ Hot water baseboard ☐ Radiant floor ☐ Outdoor wood boiler

☐ Other (specify): ____________________ **Primary type:** ____________________

Primary type of fuel used (Check appropriate response)

☐ Natural gas ☐ Fuel oil ☐ Kerosene ☐ Electric ☐ Propane

☐ Solar ☐ Wood ☐ Coal

If hot water tank present, indicate fuel source: ____________________

Boiler/furnace is located in:	☐ Basement	☐ Outdoors	☐ Main floor	☐ Other:	
Type of air conditioning:	☐ Central air	☐ Window units	☐ Open windows	☐ No mechanical system	

Are there air distribution ducts present: ☐ Yes ☐ No

Describe the supply and cold air return ductwork and its condition where visible, including whether there is a cold air return and the tightness of duct joints. Indicate the locations on the floor plan diagram.

____

____

____

Describe the type of mechanical ventilation systems used within or for the building (e.g., air-to-air exchangers, HVAC, etc.). Indicate whether the interior spaces of the building use separate ventilation systems and/or controls. Provide information on any existing building mitigation system (e.g., radon mitigation, passive venting systems, etc.). If available, provide information on air exchange rates for any existing mechanical ventilation systems currently in use.

____

____

____

____

____

6. Grid plans

Use grid plans to describe floor plans, locate potential soil vapor entry points (e.g., cracks, utility ports, drains); and if applicable, identify sample locations (sub-slab, indoor air, outdoor air sampling).

Floor plan for basement or lowest level:

Floor above lowest level:

Outdoor grid plot (Include if outdoor ambient air samples collected):

Insert sketch (or attach separate document) of the area outside the building and locate outdoor air sample locations.
If applicable, provide information on spill locations, potential air contamination sources, locations of wells, septic system, etc., and PID meter readings. Indicate wind direction and speed during sampling.

Part 2: Indoor Air Quality Survey

Complete if indoor air sampling is conducted (use grids in Part 1 for labeling sampling locations).

Factors that may influence indoor air quality:

Is there an attached garage: ☐ Yes ☐ No

Are petroleum-powered machines or vehicles stored in the garage (e.g., lawn mower, ATV, car): ☐ Yes ☐ No Please specify: ____________

Has the building ever had a fire: ☐ Yes ☐ No When: ____________

Is a kerosene or unvented gas space heater present: ☐ Yes ☐ No Where & type: ____________

Is there smoking in the building: ☐ Yes ☐ No How frequently: ____________

Have cleaning products been used recently: ☐ Yes ☐ No When & type: ____________

Have cosmetic products been used recently: ☐ Yes ☐ No When & type: ____________

Has painting/staining been done in the last 6 months: ☐ Yes ☐ No Where & when: ____________

Has any remodeling or construction occurred in the last 6 months: ☐ Yes ☐ No Where & when: ____________

Is there new carpet, drapes, or other textiles: ☐ Yes ☐ No Where & when: ____________

Have air fresheners been used recently: ☐ Yes ☐ No When & type: ____________

Is there a clothes dryer: ☐ Yes ☐ No If yes, is it vented outside: ____________

Are there odors in the building: ☐ Yes ☐ No If yes, please describe: ____________

Do any of the building occupants use solvents at work: ☐ Yes ☐ No

If yes, what types of solvents are used: ____________

Do any of the building occupants regularly use or work at a dry-cleaning service: ☐ Yes ☐ No

If yes, indicate approximately how frequent: ____________

Product inventory form (Add additional rows if needed)

Make and model of field instrument used: ____________

List specific products identified in the building that have the potential to affect indoor air quality:

Location	Product description*	Comments	Instrument readings if taken and units

* Describe the condition of the product containers as Unopened (UO), Used (U), or Deteriorated (D).
Include photographs of product containers as appropriate to document products and ingredients.

Appendix D

Installation and Extraction of the Vapor Pin SOP

Standard Operating Procedure
Installation and Extraction of the Vapor Pin™

May 20, 2011

Scope:

This standard operating procedure describes the installation and extraction of the Vapor Pin™[1] for use in sub-slab soil-gas sampling.

Purpose:

The purpose of this procedure is to assure good quality control in field operations and uniformity between field personnel in the use of the Vapor Pin™ for the collection of sub-slab soil-gas samples.

Equipment Needed:

- Assembled Vapor Pin™ [Vapor Pin™ and silicone sleeve (Figure 1)];
- Hammer drill;
- 5/8-inch diameter hammer bit (Hilti™ TE-YX 5/8" x 22" #00206514 or equivalent);
- 1½-inch diameter hammer bit (Hilti™ TE-YX 1½" x 23" #00293032 or equivalent) for flush mount applications;
- ¾-inch diameter bottle brush;
- Wet/dry vacuum with HEPA filter (optional);
- Vapor Pin™ installation/extraction tool;
- Dead blow hammer;
- Vapor Pin™ flush mount cover, as necessary;
- Vapor Pin™ protective cap; and
- VOC-free hole patching material (hydraulic cement) and putty knife or trowel.

[1]Cox-Colvin & Associates, Inc., designed and developed the Vapor Pin™; a patent is pending.

Figure 1. Assembled Vapor Pin™.

Installation Procedure:

1) Check for buried obstacles (pipes, electrical lines, etc.) prior to proceeding.

2) Set up wet/dry vacuum to collect drill cuttings.

3) If a flush mount installation is required, drill a 1½-inch diameter hole at least 1¾-inches into the slab.

4) Drill a 5/8-inch diameter hole through the slab and approximately 1-inch into the underlying soil to form a void.

5) Remove the drill bit, brush the hole with the bottle brush, and remove the loose cuttings with the vacuum.

6) Place the lower end of Vapor Pin™ assembly into the drilled hole. Place the small hole located in the handle of the extraction/installation tool over the Vapor Pin™ to protect the barb fitting and cap, and tap the Vapor Pin™ into place using a

dead blow hammer (Figure 2). Make sure the extraction/installation tool is aligned parallel to the Vapor Pin™ to avoid damaging the barb fitting.

Figure 2. Installing the Vapor Pin™.

For flush mount installations, unscrew the threaded coupling from the installation/extraction handle and use the hole in the end of the tool to assist with the installation (Figure 3).

Figure 3. Flush-mount installation.

During installation, the silicone sleeve will form a slight bulge between the slab and the Vapor Pin™ shoulder. Place the protective cap on Vapor Pin™ to prevent vapor loss prior to sampling (Figure 4).

Figure 4. Installed Vapor Pin™.

7) For flush mount installations, cover the Vapor Pin™ with a flush mount cover.

8) Allow 20 minutes or more (consult applicable guidance for your situation) for the sub-slab soil-gas conditions to equilibrate prior to sampling.

9) Remove protective cap and connect sample tubing to the barb fitting of the Vapor Pin™ (Figure 5).

Figure 5. Vapor Pin™ sample connection.

10) Conduct leak tests [(e.g., real-time monitoring of oxygen levels on extracted sub-slab soil gas, or placement of a water

dam around the Vapor Pin™) Figure 6]. Consult your local guidance for possible tests.

Figure 6. Water dam used for leak detection.

11) Collect sub-slab soil gas sample. When finished sampling, replace the protective cap and flush mount cover until the next sampling event. If the sampling is complete, extract the Vapor Pin™.

Extraction Procedure:

1) Remove the protective cap, and thread the installation/extraction tool onto the barrel of the Vapor Pin™ (Figure 7). Continue

Figure 7. Removing the Vapor Pin™.

turning the tool to assist in extraction, then pull the Vapor Pin™ from the hole (Figure 8).

Figure 8. Extracted Vapor Pin™.

2) Fill the void with hydraulic cement and smooth with the trowel or putty knife.

3) Prior to reuse, remove the silicone sleeve and discard. Decontaminate the Vapor Pin™ in a hot water and Alconox® wash, then heat in an oven to a temperature of 130° C.

The Vapor Pin™ to designed be used repeatedly; however, replacement parts and supplies will be required periodically. These parts are available on-line at www.CoxColvin.com.

Replacement Parts:

Vapor Pin™ Kit Case - VPC001
Vapor Pins™ - VPIN0522
Silicone Sleeves - VPTS077
Installation/Extraction Tool - VPIE023
Protective Caps - VPPC010
Flush Mount Covers - VPFM050
Water Dam - VPWD004
Brush - VPB026

Standard Operating Procedure
Use of the Vapor Pin™ Drilling Guide and Secure Cover

July 16, 2012

Scope:

This standard operating procedure (SOP) describes the methodology to use the Vapor Pin™ Drilling Guide and Secure Cover to install and secure a Vapor Pin™ in a flush mount configuration.

Purpose:

The purpose of this SOP is to detail the methodology for installing a Vapor Pin™ and Secure Cover in a flush mount configuration. The flush mount configuration reduces the risk of damage to the Vapor Pin™ by foot and vehicular traffic, keeps dust and debris from falling into the flush mount hole, and reduces the opportunity for tampering. This SOP is an optional process performed in conjunction with the SOP entitled "Installation and Extraction of the Vapor Pin™". However, portions of this SOP should be performed prior to installing the Vapor Pin™.

Equipment Needed:

- Vapor Pin™ Secure Cover (Figure 1);
- Vapor Pin™ Drilling Guide (Figure 2);
- Hammer drill;
- 1½-inch diameter hammer bit (Hilti™ TE-YX 1½" x 23" #00293032 or equivalent);
- 5/8-inch diameter hammer bit (Hilti™ TE-YX 5/8" x 22" #00226514 or equivalent);
- assembled Vapor Pin™;
- #14 spanner wrench;
- Wet/Dry vacuum with HEPA filter (optional); and
- personal protective equipment (PPE).

Figure 1. Vapor Pin™ Secure Cover.

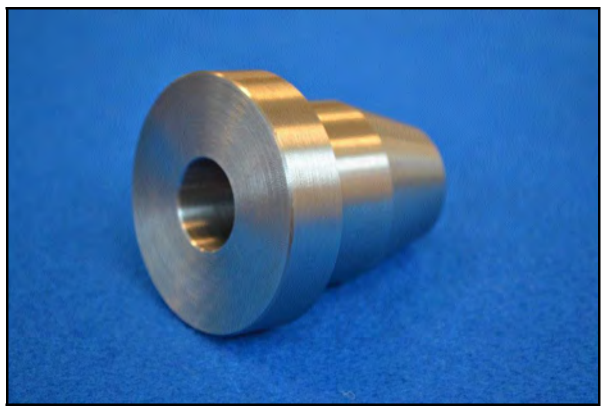


Figure 2. Vapor Pin™ Drilling Guide.

Installation Procedure:

1) Check for buried obstacles (pipes, electrical lines, etc.) prior to proceeding.

2) Set up wet/dry vacuum to collect drill cuttings.

3) While wearing PPE, drill a 1½-inch diameter hole into the concrete slab to a

depth of approximately 1 3/4 inches. Pre-marking the desired depth on the drill bit with tape will assist in this process.

4) Remove cuttings from the hole and place the Drilling Guide in the hole with the conical end down (Figure 3). The hole is sufficiently deep if the flange of the Drilling Guide lies flush with the surface of the slab. Deepen the hole as necessary, but avoid drilling more than 2 inches into the slab, as the threads on the Secure Cover may not engage properly with the threads on the Vapor Pin™.

Figure 3. Installing the Drilling Guide.

5) When the 1½-inch diameter hole is drilled to the proper depth, replace the drill bit with a $^5/_8$-inch diameter bit, insert the bit through the Drilling Guide (Figure 4), and drill through the slab. The Drilling Guide will help to center the hole for the Vapor Pin™, and keep the hole perpendicular to the slab.

6) Remove the bit and drilling guide, clean the hole, and install the Vapor Pin™ in accordance with the SOP "Installation and Extraction of the Vapor Pin™.

Figure 4. Using the Drilling Guide.

7) Screw the Secure Cover onto the Vapor Pin™ and tighten using a #14 spanner wrench by rotating it clockwise (Figure 5). Rotate the cover counter clockwise to remove it for subsequent access.

Figure 5. Tightening the Secured Cover.

Limitations:

On slabs less than 3 inches thick, it may be difficult to obtain a good seal in a flush mount configuration with the Vapor Pin™.

Appendix E

Air Sample Collection from a Sub-Slab Soil Vapor Monitoring Point SOP

PROJECT SPECIFIC
STANDARD OPERATING PROCEDURE –
EAST HENNEPIN AVENUE STUDY AREA

Air Sample Collection from a Sub-Slab Soil Vapor Monitoring Point

Revision 1

November 6, 2013

Approved By:

______________________	______________________	________
Print QA Manager(s) Signature		Date
______________________	______________________	________
Print Field Technician(s) Signature		Date

Barr Engineering Company
4700 West 77th Street • Minneapolis, MN 55435-4803
Phone: 952-832-2600 • Fax: 952-832-2601 • www.barr.com

Minneapolis, MN • Hibbing, MN • Duluth, MN • Ann Arbor, MI • Jefferson City, MO • Bismarck, ND • Calgary, AB, Canada

Annual Review of the SOP has been performed and the SOP still reflects current practice.

Initials: ______________ Date: ______________

Initials: ______________ Date: ______________

Initials: ______________ Date: ______________

Initials: ______________ Date: ______________

Initials: ______________ Date: ______________

Standard Operating Procedures for the
Air Sample Collection from a Sub-Slab Soil Vapor Monitoring Point

Purpose

To describe the procedure for collecting an active air sample for laboratory analysis using Summa canisters from sub-slab soil vapor monitoring points.

Applicability

The procedure applies to collection of an air sample in a Summa canister from a sub-slab soil vapor monitoring point. The term "Summa" Canister is a generalized trademark that refers to electropolished, passivated stainless steel vacuum sampling devices, such as TO canisters, SilcoCans, MiniCans, etc., which are cleaned, evacuated, and used to collect whole-air samples for laboratory analysis.

Equipment

a) Summa canister with a Swagelok or Entech male quick connect fitting (provided by laboratory).

b) 7 micron particulate filter (provided by laboratory)

c) Pressure Gauge (provided by laboratory)

d) Flow controlling device (provided by the laboratory)

e) Entech male and female quick connect fittings

f) Small diameter Teflon tubing with a Swagelok compression fitting/nut on one end

g) Surgical grade silicone tubing

h) Small diameter Swagelok plug valve and associated ferrules, nuts and fittings

i) 9/16-inch wrench

j) Surgical grade graduated syringe with female Luer lock type connection, 60 mL

k) Surgical grade Luer lock valve

l) Cable tie

m) Photo-Ionization Detector (PID) equipped with a 10.6 eV bulb

n) Chain of custody, and dedicated field logbook and/or sampling forms as required

References

Cox-Colvin & Associates, Inc., Standard Operating Procedure Installation and Extraction of the Vapor Pin™. May 20, 2011

Cox-Colvin & Associates, Inc., Standard Operating Procedure Use of the Vapor Pin™ Drilling Guide and Secure Cover. July 16, 2012

Air Toxics Ltd, Guide to Air Sampling and Analysis, Canisters and Tedlar Bags Fifth Edition

Responsibilities

The Field Technician(s) are responsible for collection of the air sample using a Summa canister.

Procedure

The following procedure includes purging a sub-slab soil vapor monitoring point, conducting a vacuum based leak test on the sampling train, and collecting a sub-slab soil vapor sample in a Summa canister.

Purging requirements may vary based on site conditions or project requirements, but will be a minimum of two times the volume of the sub-slab soil vapor monitoring point and the associated tubing and sampling train.

If the construction of the sub-slab soil vapor monitoring point included the use of a Vapor Pin™ device then attachment to the sub-slab soil vapor monitoring points shall be completed in general accordance with Standard Operating Procedure Installation and Extraction of the Vapor Pin™ and/or Standard Operating Procedure Use of the Vapor Pin™ Drilling Guide and Secure Cover. This method in general will incorporate the use of disposable small diameter PTFE (Teflon) tubing, a Swagelok plug valve, and the pressure gauge assembly supplied by the analytical laboratory. Brass or stainless steel Swagelok valves and/or fittings may also be used.

The sub-slab soil vapor monitoring point will be installed. The Teflon tubing is attached to the sub-slab soil vapor monitoring point. A single or a series of brass or stainless steel Swagelok valves and fittings is utilized to minimize the sub-slab soil vapor source's exposure to ambient atmosphere. The Teflon source tubing is then connected to the single or series of brass or stainless steel Swagelok valves and fittings. After connection of the source Teflon tubing, proceed with operational procedures described below.

The Teflon tubing will be discarded upon completion of sample collection. The sampling train will be submitted to the laboratory for decontamination following internal laboratory standard operating procedures for decontaminating Summa canisters.

1. Performing the Vacuum Based Leak Test

[Note: In this standard operating procedure if Vapor Pins™ are used, vacuum based leak testing should be performed in conjunction with water based leak testing described in Standard Operating Procedure Installation and Extraction of the Vapor Pin™ The analytical testing laboratories may supply the particulate filter, flow controlling device, vacuum gauge, and Teflon tubing with compression fitting as one assembly (Flow Control Assembly). In

addition, the Summa canisters may be fitted with a quick connect which will connect to the Sample Assembly. Alternate configurations may need to be assembled for collection of Summa canister data and/or successful sample collection.]

a. Connect the Luer lock valve to the male Swagelok threaded end of the Entech quick connect fitting (or other fitting as appropriate) with a short section of Teflon tubing fit inside surgical grade silicone tubing. Secure the silicon tubing to both fittings with a cable tie.
b. Connect the Luer lock valve to the syringe to complete the assembly (Purge Assembly).
c. Disconnect the laboratory supplied Teflon tubing (if present) from the Flow Control Assembly and insert the Swagelok plug valve between the tubing and particulate filter. Tighten the fittings on either side of the valve by turning approximately 1/8 turn past finger tight.

d. Connect one end of a short section (approximately 1 foot) of new Teflon tubing to the hose barb fitting of the sub-slab soil vapor monitoring point. Connect the other end to the Flow Control Assembly

e. Connect the male quick connect fitting (or other fitting as appropriate) on the Purge Assembly to the female quick connect fitting (or other fitting as appropriate) on the Flow Control Assembly.
f. Close the Swagelok plug valve(s).
g. Engage the Purge Assembly and draw back the syringe plunger until the pressure gauge indicates a vacuum of approximately 20-25 inches of Hg has developed in the sampling train.
h. While maintaining the syringe plunger position, quickly close the Luer lock valve and disconnect the Entech quick connect fitting (or other fitting as appropriate).
i. Although the vacuum in the sampling train may drop slightly while disconnecting the Entech quick connect fitting (or other fitting as appropriate), the vacuum should remain stable for a minimum of five minutes. If the vacuum, as indicated by the pressure gauge, drops then there is a leak in the sampling train.
j. If a leak is detected, tighten all fittings in the sampling train and repeat steps f through j.

2. Purging the Monitoring Point

a. Connect all portions of the sampling train by following steps a through e in Part 1.

b. Connect the male quick connect fitting (or other fitting as appropriate) on the Purge Assembly to the female quick connect fitting (or other fitting as appropriate) on the Flow Control Assembly.

c. While the Luer lock valve and Swagelok plug valve(s) are in the open position, slowly draw back the syringe plunger until the syringe plunger's indicator is to the 60 mL mark. Be sure to maintain the vacuum in the sampling train under 10 inches of Hg, as indicated by the pressure gauge, while drawing back the syringe plunger.

d. Close the Luer lock valve.

e. Disconnect the Luer lock valve from the syringe and purge the syringe contents to the atmosphere and away from other personnel.

f. Reconnect the Luer lock valve to the syringe and repeat steps f through h until the desired purge volume has been removed.

3. Summa canister sample collection

a. After leak testing is complete and with the Entech quick connect (or other fitting as appropriate) disconnected, open the Swagelok plug valve connected to the Teflon source tubing to relieve the vacuum in the sampling train. If a Flow Control Assembly is used, record the unique identifier number assigned by the laboratory (if present) on the chain of custody form and in/on the dedicated field book or sampling form.
b. Close the Swagelok plug valve.
c. Connect the Summa canister to the Entech quick connect fitting (or other fitting as appropriate). Once connected the pressure gauge should indicate the initial vacuum in the Summa canister.
d. Record the initial vacuum on the chain of custody form and in/on a dedicated field logbook or sampling form.
e. When ready, open the Swagelok plug valve to begin sample collection. Record the "start" time when the Swagelok plug valve was opened.
f. Monitor the vacuum in the Summa canister by watching and periodically tapping the pressure gauge in case of a "sticky" pressure indicator needle.
g. When the pressure gauge indicates that there is approximately three inches of Hg of vacuum in the Summa canister close the Swagelok plug valve.
h. Record the "stop" time and "final" vacuum on the chain of custody form and in/on a dedicated field book or sampling form.
i. Disconnect the Entech quick connect fitting (or other fitting as appropriate).
j. Disconnect the Teflon tubing from the Swagelok plug valve and quickly insert the tip of the PID.
k. Record the highest reading on the PID over a 30 second screening period.
l. Transfer the sample time (i.e. the stop time), the PID reading, the sample ID and the date to the Summa canister tag.

Sample Care and Documentation

1. Summa canister sample

The Environmental Technician should record on the Summa canister tag and in/on a dedicated field logbook or sampling form: the unique serial number of the Summa canister, the sample name, the time of sample collection, gauge pressure prior to collection, and gauge pressure following collection. The start and stop time of sample collection should also be recorded if using a flow controlling device. This information should also be reflected on the chain of custody when shipping samples to the laboratory.

Interferences/Discussion for Summa canister

Samples collected in a Summa canister should be shipped or stored at ambient temperature and kept out of direct sunlight.

2. Sample Storage

The Summa canisters must be stored at ambient temperature until receipt at the laboratory. All samples will be kept secured to prevent tampering. If samples are left in a vehicle or field office for temporary storage, the area will be locked and secured. The samples may be packaged into cardboard boxes and must be delivered to the laboratory via hand or overnight delivery courier in accordance with all Federal, State and Local shipping regulations.

3. Documentation

The Environmental Technician should record the following on the Summa canister tag, dedicated field logbook or sampling form, and chain of custody form as required:

Summa canisters:

1. unique serial number or identifier of the Summa canister
2. unique serial number or identifier of the vacuum gauge and particulate filter
3. unique serial number or identifier of the flow controlling devise
4. date and time of sample collection
5. gauge pressure prior to collection
6. gauge pressure following collection
7. sample identification
8. start and stop time of sample collection if using a flow controlling devise
9. name of sample technician

Attachments

Attachment 1: Chain of Custody Form
Attachment 2: Custody Seal – if applicable
Attachment 3: Field Sampling Quality Control Check List

Attachment 1
Chain of Custody Form

Pace Analytical
www.pacelabs.com

AIR: CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed accurately.

Page: of

Section A Required Client Information:		Section B Required Project Information:	Section C Invoice Information:
Company:		Report To:	Attention:
Address:		Copy To:	Company Name:
			Address:
Email To:		Purchase Order No.:	Pace Quote Reference:
Phone:	Fax:	Project Name:	Pace Project Manager/Sales Rep.
Requested Due Date/TAT:		Project Number:	Pace Profile #:

Program

☐ UST ☐ Superfund ☐ Emissions ☐ Clean Air Act

☐ Voluntary Clean Up ☐ Dry Clean ☐ RCRA ☐ Other____

Location of Sampling by State ______

Reporting Units: ug/m³__ mg/m³__ PPBV__ PPMV__ Other__

Report Level II.__ III.__ IV.__ Other____

ITEM #	*Section D Required Client Information: AIR SAMPLE ID (Sample IDs MUST BE UNIQUE)	Valid Media Codes: MEDIA / CODE — Sampling Bag SB; 1 Liter Summa Can 1LC; 6 Liter Summa Can 6LC; Low Volume Puff LVP; High Volume Puff HVP; Other PM10	MEDIA CODE	PID Reading (Client only)	COLLECTED: COMPOSITE START DATE	COMPOSITE START TIME	COMPOSITE END DATE	COMPOSITE END TIME	Initial Field reading (Inches of Hg)	Final Field reading (Inches of Hg)	Summa Can Number	Flow Control Number	Method: PM10, 3C Fixed Gas (%), TO-3, TO-3M (Methane), TO-4 (PCBs), TO-13 (PAH), TO-14, TO-15, TO15 Short List*	Pace Lab ID
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														

Comments :

RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME	SAMPLE CONDITIONS: Temp in °C	Received on Ice	Custody Sealed Cooler	Samples Intact
							Y/N	Y/N	Y/N
							Y/N	Y/N	Y/N
							Y/N	Y/N	Y/N
							Y/N	Y/N	Y/N

SAMPLER NAME AND SIGNATURE

PRINT Name of SAMPLER:

SIGNATURE of SAMPLER: DATE Signed (MM / DD / YY):

1700 Elm Street SE, Suite 200, Minneapolis, MN 55414

FC046Rev.01, 03Feb2010

Attachment 2

Custody Seal – if applicable

Custody Seal

Date________________________ Project______________________________________

Signature __________________________________Container#________ of________

Attachment 3
Field Sampling Quality Control Check List

☐ Sub-slab soil vapor monitoring point purging was completed.

Volume purged:_______________

☐ Vacuum based leak testing was performed. Vacuum:_________ Duration:__________

☐ Water based leak testing was performed.

☐ Initial summa canister vacuum was greater than 25 in. of Hg. Initial vacuum:________

☐ PID screening was performed. Reading:____________

☐ Sample information was added to the chain of custody form.

Appendix F

Template Cover Letter Examples

[Date]

[Recipient name]
[Address]
[City, State Zip]

Re: Sub-Slab Sampling Results at [*Sampled Property Address*]

Dear *[Property Owner]*:

Thank you for participating in the soil vapor study in your neighborhood. We sampled the sub-slab air (beneath your basement floor) on *[sampling date]*. As you know, the study is testing for the presence of trichloroethylene (TCE) vapor in the soil beneath homes.

The Minnesota Pollution Control Agency (MPCA) has approved General Mills' plan to offer a mitigation system if TCE in sub-slab samples is measured at or above 20 micrograms per cubic meter of air (20 ug/m^3). A summary table with your home's test results as reported by the laboratory (Pace Analytical Services, Inc.) is shown below and enclosed with this letter, and your result is above this level.

Address Project Unique ID Sample Date	*[Property address]* *[Unique ID]* *[Sampling date]*
Trichloroethylene (TCE)	**[*Sample result*] ug/m3**

We will be contacting you in the next few days to offer to install a vapor ventilation system in your home **at no cost to you**.

Vapor ventilation systems are a proven solution to the issue of potential soil vapor intrusion in residential settings. The system itself is identical to the radon mitigation systems installed in many Twin Cities area houses, and offers the added benefit of addressing naturally-occurring radon, if present, as well.

To help explain the ventilation system installation you will receive, we have enclosed:

- A fact sheet about vapor ventilation, with answers to many of the most commonly asked questions about the ventilation systems and how they are installed.

- An access agreement authorizing us to contact you to discuss and schedule installation of a mitigation system at your property.

If you have questions about vapor ventilation systems or the access agreement, please call Barr Engineering at 952-842-3505. We can schedule a time with you for a pre-installation visit with the contractor who will install the system in your home. **Following the pre-installation visit and once we receive your signed access agreement, Barr Engineering will work with you to schedule a time for the installation of the system.**

If you have concerns regarding health risks, contact Emily Hansen, M.P.H. at the Minnesota Department of Health at 651-201-4602. In addition, General Mills has arranged for Dr. Stephen Foster, Ph.D., a national expert in health risk assessment and TCE toxicology, to be available to talk with you by phone at 952-842-3737.

You may also contact any of the resources below:

For questions relating to:	Contact:	Phone:	Email:
Soil vapor samples	Barr Engineering	952-842-3505	easthennepin@barr.com
Study Area project	Hans Neve, MPCA	651-757-2608	hans.neve@state.mn.us

Thank you again for your cooperation in this study.

Sincerely,

Sara Ramsden, P.E.
Barr Engineering – Project Manager

[*Property Coordinator Name*]
Barr Engineering – Property Coordinator

cc: Ed Olson, Minnesota Pollution Control Agency

[Date]

[Recipient name]
[Address]
[City, State Zip]

Re: Sub-Slab Sampling Results at [*Sampled Property Address*]

Dear *[Property Owner]*:

Thank you for participating in the soil vapor study in your neighborhood. We sampled the sub-slab air (beneath your basement floor) on *[sampling date]*. As you know, the study is testing for the presence of trichloroethylene (TCE) vapor in the soil beneath homes.

The Minnesota Pollution Control Agency (MPCA) has approved General Mills' plan to offer a mitigation system if TCE in sub-slab samples is measured at or above 20 micrograms per cubic meter of air (20 ug/m^3).

A summary table with your home's test results as reported by the laboratory (Pace Analytical Services, Inc.) is shown below and enclosed with this letter. Because your home tested at a level below 2 micrograms per cubic meter, no further testing is required. There is no potential for vapor intrusion, and no mitigation is required.

Address Project Unique ID Sample Date	*[Property address]* *[Unique ID]* *[Sampling date]*
Trichloroethylene (TCE)	**[*Sample result*] ug/m3**

We will be contacting you in the next few days to remove the sampling port. We will permanently seal the hole in which the port was placed – and your role in the study will be complete.

Should you have any additional questions, please call:

For questions relating to:	Contact	Phone	Email
Study Area project	Hans Neve, MPCA	651-757-2608	hans.neve@state.mn.us
Health	Emily Hansen, MDH	651-201-4602	
Sampling	Barr Engineering	952-842-3505	easthennepin@barr.com

Thank you again for your cooperation. Your willingness to assist has provided important data that is essential for completing this study.

Sincerely,

Sara Ramsden, P.E.
Barr Engineering – Project Manager

[*Property Coordinator Name*]
Barr Engineering – Property Coordinator

cc: Ed Olson, Minnesota Pollution Control Agency

[Date]

[Recipient name]
[Address]
[City, State Zip]

Re: Sub-Slab Sampling Results at [*Sampled Property Address*]

Dear *[Property Owner]*:

Thank you for participating in the soil vapor study in your neighborhood. We sampled the sub-slab air (beneath your basement floor) on *[sampling date]*. As you know, the study is testing for the presence of trichloroethylene (TCE) vapor in the soil beneath homes.

The Minnesota Pollution Control Agency (MPCA) has approved General Mills' plan to offer a mitigation system if TCE in sub-slab samples is measured at or above 20 micrograms per cubic meter of air (20 ug/m^3).

A summary table with your home's test results as reported by the laboratory (Pace Analytical Services, Inc.) is shown below and enclosed with this letter. Your result is below this level. However, MPCA has approved General Mills' plan to collect a second sample from homes testing below 20 micrograms per cubic meter, but above 2 micrograms per cubic meter, to confirm the initial reading.

Address Project Unique ID Sample Date	*[Property address]* *[Unique ID]* *[Sampling date]*
Trichloroethylene (TCE)	**[*Sample result*] ug/m3**

We will be contacting you in the next few days to arrange for a second sub-slab air sample beneath your home **at no cost to you**. This second sample is either taken from the existing port already installed and used for the first sample or a new port will be installed. If the second sample is also below 20 micrograms per cubic meter, we will remove the sampling port and permanently seal the port space. Your role in the study would then be complete.

If you prefer, you may contact Barr Engineering at 952-842-3505, to arrange a convenient time to complete the second sample. If not, we will call you to arrange a time that works with your schedule.

Should you have any additional questions, please call:

For questions relating to:	Contact	Phone	Email
Study Area project	Hans Neve, MPCA	651-757-2608	hans.neve@state.mn.us
Health	Emily Hansen, MDH	651-201-4602	
Sampling	Barr Engineering	952-842-3505	easthennepin@barr.com

Thank you again for your cooperation in this study.

Sincerely,

Sara Ramsden, P.E.
Barr Engineering – Project Manager

[*Property Coordinator Name*]
Barr Engineering – Property Coordinator

cc: Ed Olson, Minnesota Pollution Control Agency

[Date]

[Recipient name]
[Address]
[City, State Zip]

Re: Sub-Slab Sampling Results at [*Sampled Property Address*]

Dear *[Property Owner]*:

Thank you for participating in the soil vapor study in your neighborhood. We sampled the sub-slab air (beneath your basement floor) on *[sampling date]*. As you know, the study is testing for the presence of trichloroethylene (TCE) vapor in the soil beneath homes.

The Minnesota Pollution Control Agency (MPCA) has approved General Mills' plan to offer a mitigation system if TCE in sub-slab samples is measured at or above 20 micrograms per cubic meter of air (20 ug/m^3).

A summary table with your home's test results as reported by the laboratory (Pace Analytical Services, Inc.) is shown below and enclosed with this letter. Your first sample was below 20 micrograms per cubic meter of air, and a second sample was taken at a later date. Your second sample, however, was above 20 micrograms per cubic meter.

Address Project Unique ID Sample Date	[*Property address]* [*Unique ID]* [*Sampling date]*
Trichloroethylene (TCE)	**[*Sample result*] ug/m3**

As a result, we will be contacting you in the next few days to offer to install a vapor ventilation system in your home **at no cost to you**.

Vapor ventilation systems are a proven solution to the issue of potential soil vapor intrusion in residential settings. The system itself is identical to the radon mitigation systems installed in many Twin Cities area houses, and offers the added benefit of addressing naturally-occurring radon, if present, as well.

To help explain the ventilation system installation you will receive, we have enclosed:

- A fact sheet about vapor ventilation, with answers to many of the most commonly asked questions about the ventilation systems and how they are installed.

- An access agreement authorizing us to contact you to discuss and schedule installation of a mitigation system at your property.

If you have questions about vapor ventilation systems or the access agreement, please call Barr Engineering at 952-842-3505. We can schedule a time with you for a pre-installation visit with the contractor who will install the system in your home. **Following the pre-installation visit and once we receive your signed access agreement, Barr Engineering will work with you to schedule a time for the installation of the system.**

If you have concerns regarding health risks, contact Emily Hansen, M.P.H. at the Minnesota Department of Health at 651-201-4602. In addition, General Mills has arranged for Dr. Stephen Foster, Ph.D., a national expert in health risk assessment and TCE toxicology, to be available to talk with you by phone at 952-842-3737.

You may also contact any of the resources below:

For questions relating to:	Contact:	Phone:	Email:
Soil vapor samples	Barr Engineering	952-842-3505	easthennepin@barr.com
Study Area project	Hans Neve, MPCA	651-757-2608	hans.neve@state.mn.us

Thank you again for your cooperation in this study.

Sincerely,

Sara Ramsden, P.E.
Barr Engineering – Project Manager

[*Property Coordinator Name*]
Barr Engineering – Property Coordinator

cc: Ed Olson, Minnesota Pollution Control Agency

[Date]

[Recipient name]
[Address]
[City, State Zip]

Re: Sub-Slab Sampling Results at [*Sampled Property Address*]

Dear *[Property Owner]*:

Thank you for participating in the soil vapor study in your neighborhood. We sampled the sub-slab air (beneath your basement floor) on *[sampling date]*. As you know, the study is testing for the presence of trichloroethylene (TCE) vapor in the soil beneath homes.

The Minnesota Pollution Control Agency (MPCA) has approved General Mills' plan to offer a mitigation system if TCE in sub-slab samples is measured at or above 20 micrograms per cubic meter of air (20 ug/m^3).

A summary table with your home's test results as reported by the laboratory (Pace Analytical Services, Inc.) is shown below. Your first sample was below 20 micrograms per cubic meter of air, and a second sample was taken at a later date. Your second sample was also below 20 micrograms per cubic meter.

Address Project Unique ID Sample Date	*[Property address]* *[Unique ID]* *[Sampling date]*
Trichloroethylene (TCE)	**[*Sample result*] ug/m3**

As a result, no further testing is required. There is no potential for vapor intrusion, and no mitigation is required.

We will be contacting you in the next few days to remove the sampling port. We will permanently seal the hole in which the port was placed – and your role in the study will be complete.

Should you have any additional questions, please call:

For questions relating to:	Contact	Phone	Email
Study Area project	Hans Neve, MPCA	651-757-2608	hans.neve@state.mn.us
Health	Emily Hansen, MDH	651-201-4602	
Sampling	Barr Engineering	952-842-3505	easthennepin@barr.com

Thank you again for your cooperation. Your willingness to assist has provided important data that is essential for completing this study.

Sincerely,

Sara Ramsden, P.E.
Barr Engineering – Project Manager

[*Property Coordinator Name*]
Barr Engineering – Property Coordinator

cc: Ed Olson, Minnesota Pollution Control Agency

[Date]

[Recipient name]
[Address]
[City, State Zip]

Re: Sub-Slab Sampling Results at [*Sampled Property Address*]

Dear *[Property Owner]*:

Thank you for participating in the soil vapor study in your neighborhood. We sampled the sub-slab air (beneath your basement floor) on *[sampling date]*. As you know, the study is testing for the presence of trichloroethylene (TCE) vapor in the soil beneath homes.

The Minnesota Pollution Control Agency (MPCA) has approved General Mills' plan to offer a mitigation system if TCE in sub-slab samples is measured at or above 20 micrograms per cubic meter of air (20 ug/m^3). A summary table with your home's test results as reported by the laboratory (Pace Analytical Services, Inc.) is shown below and enclosed with this letter, and your result is above this level.

Address Project Unique ID Sample Date	*[Property address]* *[Unique ID]* *[Sampling date]*
Trichloroethylene (TCE)	**[*Sample result*] ug/m3**

We will be contacting you in the next few days to offer to install a vapor ventilation system in your home **at no cost to you**.

Please note that, as part of its standard oversight process, the MPCA retained its own contractor to take samples in a small percentage of homes in the study area. Your home was chosen by MPCA for that additional sample, so you will also receive a separate laboratory report from MPCA. There will likely be some variation in laboratory results and this is normal. The determination of whether to offer installation of a ventilation system has been based on the data as a whole.

Vapor ventilation systems are a proven solution to the issue of potential soil vapor intrusion in residential settings. The system itself is identical to the radon mitigation systems installed in many Twin Cities area houses, and offers the added benefit of addressing naturally-occurring radon, if present, as well.

To help explain the ventilation system installation you will receive, we have enclosed:

- A fact sheet about vapor ventilation, with answers to many of the most commonly asked questions about the ventilation systems and how they are installed.
- An access agreement authorizing us to contact you to discuss and schedule installation of a mitigation system at your property.

If you have questions about vapor ventilation systems or the access agreement, please call Barr Engineering at 952-842-3505. We can schedule a time with you for a pre-installation visit with the contractor who will install the system in your home. **Following the pre-installation visit and once we receive your signed access agreement, Barr Engineering will work with you to schedule a time for the installation of the system.**

If you have concerns regarding health risks, contact Emily Hansen, M.P.H. at the Minnesota Department of Health at 651-201-4602. In addition, General Mills has arranged for Dr. Stephen Foster, Ph.D., a national expert in health risk assessment and TCE toxicology, to be available to talk with you by phone at 952-842-3737.

You may also contact any of the resources below:

For questions relating to:	Contact:	Phone:	Email:
Soil vapor samples	Barr Engineering	952-842-3505	easthennepin@barr.com
Study Area project	Hans Neve, MPCA	651-757-2608	hans.neve@state.mn.us

Thank you again for your cooperation in this study.

Sincerely,

Sara Ramsden, P.E.
Barr Engineering – Project Manager

[*Property Coordinator Name*]
Barr Engineering – Property Coordinator

cc: Ed Olson, Minnesota Pollution Control Agency

[Date]

[Recipient name]
[Address]
[City, State Zip]

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The Minnesota Pollution Control Agency (MPCA) has approved General Mills' plan to offer a mitigation system if TCE in sub-slab samples is measured at or above 20 micrograms per cubic meter of air (20 ug/m^3).

A summary table with your home's test results as reported by the laboratory (Pace Analytical Services, Inc.) is shown below and enclosed with this letter. Your first sample was below 20 micrograms per cubic meter of air, and a second sample was taken at a later date. Your second sample, however, was above 20 micrograms per cubic meter.

Address Project Unique ID Sample Date	*[Property address]* *[Unique ID]* *[Sampling date]*
Trichloroethylene (TCE)	**[*Sample result*] ug/m3**

As a result, we will be contacting you in the next few days to offer to install a vapor ventilation system in your home **at no cost to you**.

Please note that, as part of its standard oversight process, the MPCA retained its own contractor to take samples in a small percentage of homes in the study area. Your home was chosen by MPCA for that additional sample, so you will also receive a separate laboratory report from MPCA. There will likely be some variation in laboratory results and this is normal. The determination of whether to offer installation of a ventilation system has been based on the data as a whole.

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Sara Ramsden, P.E.
Barr Engineering – Project Manager

[*Property Coordinator Name*]
Barr Engineering – Property Coordinator

cc: Ed Olson, Minnesota Pollution Control Agency

Appendix G

Mitigation System Drawings

VAPOR INTRUSION MITIGATION SYSTEM

PART 1 - GENERAL

1.1 SCOPE

A. This Section covers the requirements for the installation and performance of a Vapor Intrusion Mitigation System (System). The purpose of the System will be to prevent migration of vapors from the sub-surface into overlying buildings by lowering the air pressure in the soils directly below the building relative to the air pressure inside the building.

The System may be any of the variations, or combinations of the following variations defined in ASTM E2121 – 13 *Standard Practice for Installing Radon Mitigation Systems in Existing Low-Rise Residential Buildings*: sub-slab depressurization (SSD), drain tile depressurization (DTD), and sub-membrane depressurization (SMD).

B. CONTRACTOR shall supply all labor, materials, equipment and services required for the proper installation of the System as described herein and shown on the Plans.

C. The installation and performance of the System shall meet ASTM E2121 – 13 *Standard Practice for Installing Radon Mitigation Systems in Existing Low-Rise Residential Buildings,* and the diagnostics described in the Work Plan for this project, and shall generally conform to USEPA's technical guidance document, "*Radon Reduction Techniques for Existing Detached Houses"* .

1.2 REFERENCES

A. American Society for Testing and Materials E2121 – 13, Standard Practice for Installing Radon Mitigation Systems in Existing Low-Rise Residential Buildings.

B. USEPA - *Radon Reduction Techniques for Existing Detached Houses – Technical Guidance (Third Edition) for Active Soil Depressurization Systems*. EPA/625/R-93/011. October 1993.

C. Barr Engineering Company, *Sub-Slab Sampling and Building Mitigation Work Plan, East Hennepin Avenue Study Are.* November 2013.

1.3 SUBMITTALS

A. Manufacturers product specification sheets listing the materials to be supplied for the sealing materials and compounds, pipe, fittings, membrane material, and vent fan.

B. Diagnostic testing results in the format shown in the Work Plan for the project.

1.4 Quality Assurance

A. CONTRACTOR shall ensure that the vacuum produced by the System is sufficient in strength and distribution beneath the building floor by performing the diagnostic testing defined in the Work Plan for the project.

B. CONTRACTOR shall allow ENGINEER to be present and observe System planning, construction, and diagnostic testing.

C. CONTRACTOR shall ensure that any sections of Vent Riser located outside the building envelope are sufficiently insulated to prevent the formation of condensation inside the pipe when ambient outdoor temperatures are below 32 degrees Fahrenheit.

D. CONTRACTOR shall ensure that in SMD-type Systems the barrier membrane is overlapped and taped at least one foot in the event that more than one continuous sheet of membrane is required to completely cover earthen areas. CONTRACTOR shall ensure that the membrane is butted up and sealed with Butyl Seal tape along the foundation walls, and with Vapor Bond Tape around, pipes, conduits and other penetrations through the vapor barrier.

E. CONTRACTOR shall ensure that any sections of PVC pipe exposed to UV radiation are either properly rated for UV exposure or are coated with a UV resistant coating.

PART 2 – PRODUCTS

2.1 Materials

A. PVC Pipe and Fittings

a. The PVC Riser Pipe and Vent Stack shall conform to the following: Schedule 40 PVC piping, elbows, end caps, and couplings

B. Vapor Barrier Membrane

a. Raven Industries Vapor Block 15 – 15 mil thickness
b. Vapor Bond Tape
c. Raven Industries Vapor Bond Tape
d. Butyl Seal Tape
e. Raven Industries Butyl Seal Tape

C. Inline Fan

a. Fantech HP Series or equal

PART 3 - EXECUTION

3.1 PROTECTION AND TAMPER-PROOFING

CONTRACTOR shall provide a lockable waterproof protective enclosure for vent fans and electrical components that are located outside.

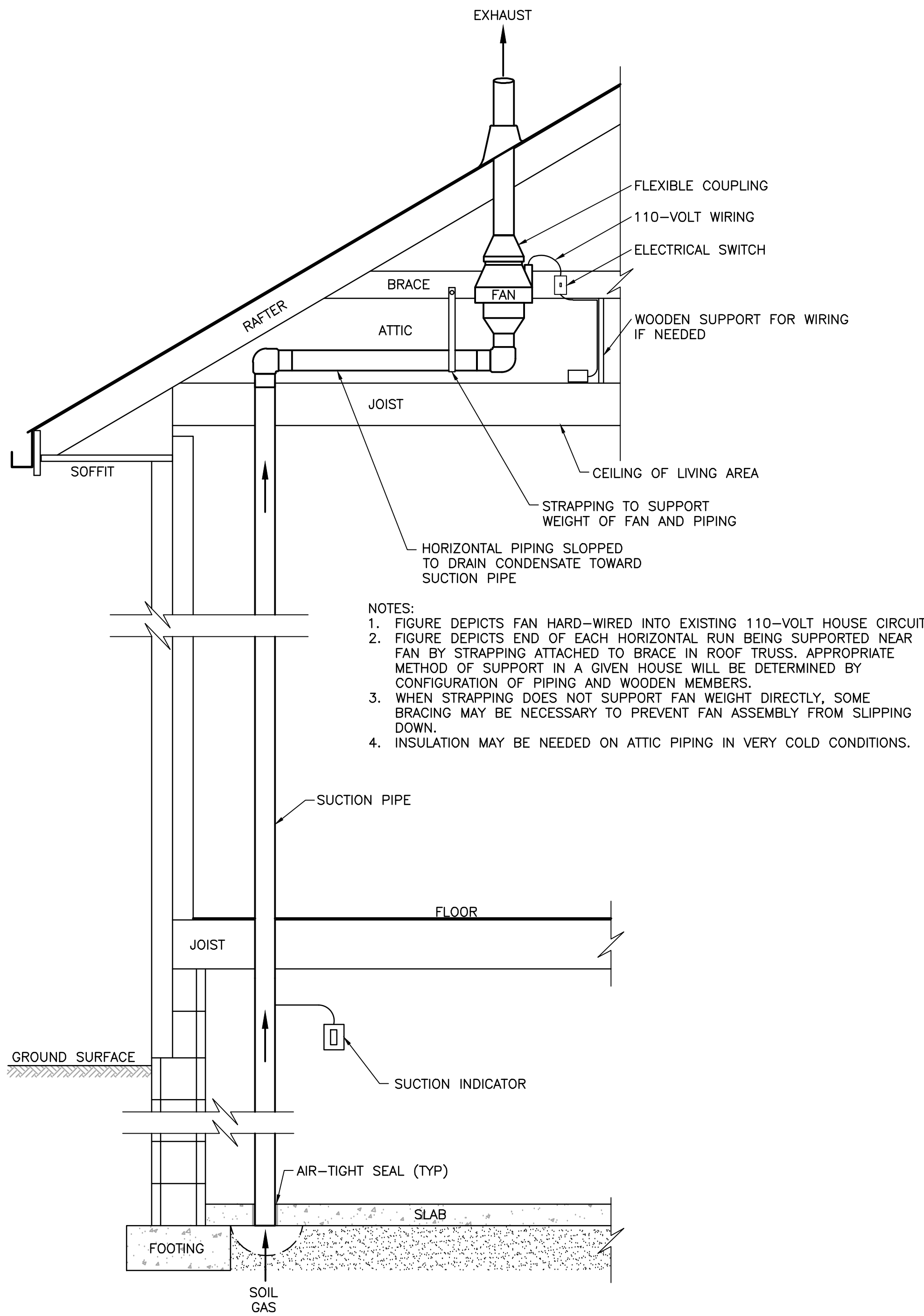
3.2 SUCTION PIT CONSTRUCTION

CONTRACTOR shall excavate a suction pit below the slab where the Vent Riser penetrates the slab. The dimensions of the suction pit shall be based on the experience of the Contractor.

PART 4 - PAYMENT

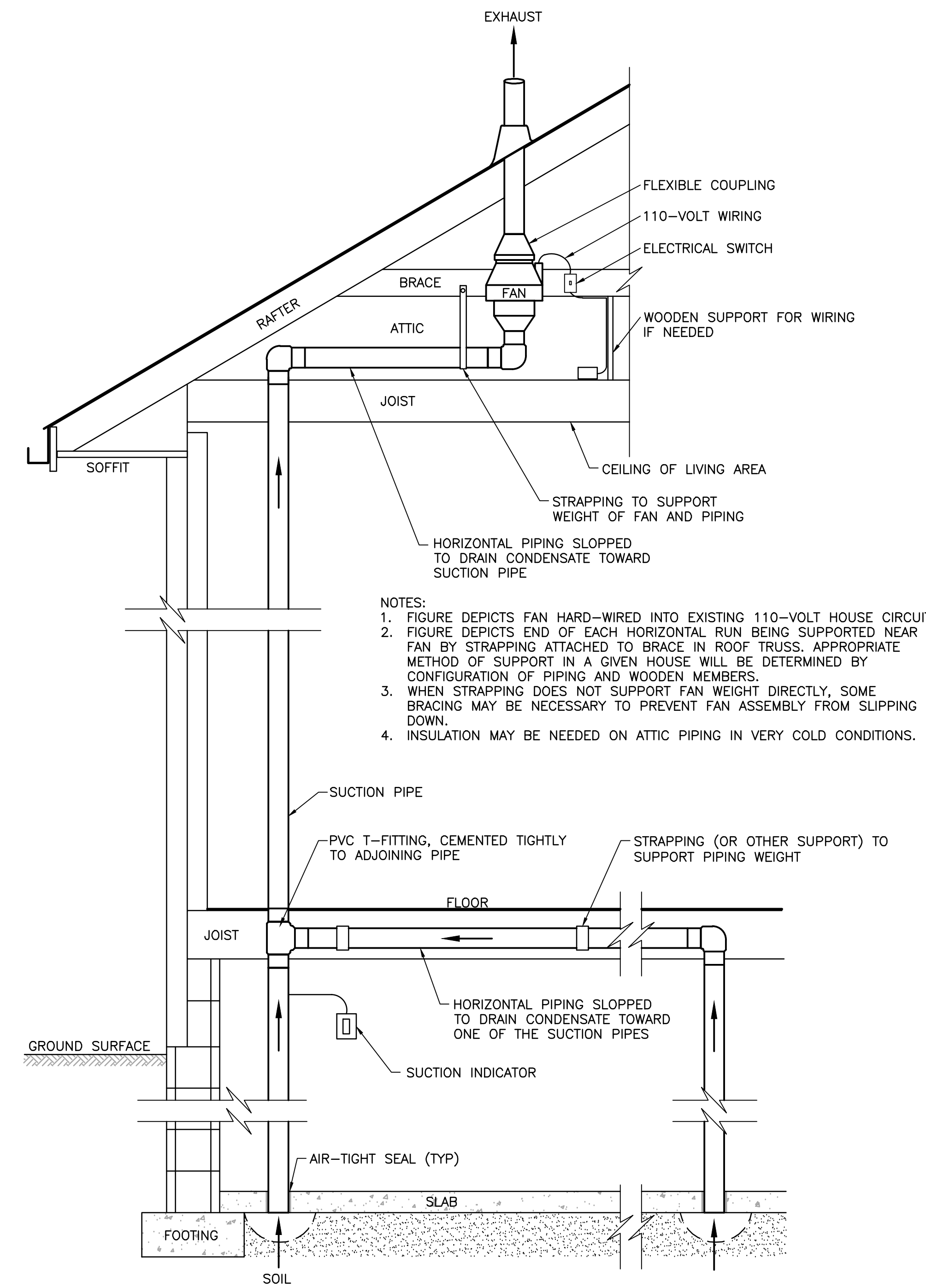
[Section not used]

END OF SECTION



NOTES:
1. FIGURE DEPICTS FAN HARD-WIRED INTO EXISTING 110-VOLT HOUSE CIRCUIT.
2. FIGURE DEPICTS END OF EACH HORIZONTAL RUN BEING SUPPORTED NEAR FAN BY STRAPPING ATTACHED TO BRACE IN ROOF TRUSS. APPROPRIATE METHOD OF SUPPORT IN A GIVEN HOUSE WILL BE DETERMINED BY CONFIGURATION OF PIPING AND WOODEN MEMBERS.
3. WHEN STRAPPING DOES NOT SUPPORT FAN WEIGHT DIRECTLY, SOME BRACING MAY BE NECESSARY TO PREVENT FAN ASSEMBLY FROM SLIPPING DOWN.
4. INSULATION MAY BE NEEDED ON ATTIC PIPING IN VERY COLD CONDITIONS.

SOURCE: RADON REDUCTION TECHNIQUES FOR EXISTING DETACHED HOUSES, EPA, 1993



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SOURCE: RADON REDUCTION TECHNIQUES FOR EXISTING DETACHED HOUSES, EPA, 1993

1 / – SECTION: TYPICAL SUB-SLAB DEPRESSURIZATION (SSD) VAPOR ABATEMENT SYSTEM (INSIDE PIPING) – SINGLE EXTRACTION POINT
NOT TO SCALE

2 / – SECTION: TYPICAL SUB-SLAB DEPRESSURIZATION (SSD) VAPOR ABATEMENT SYSTEM (INSIDE PIPING) – MULTIPLE EXTRACTION POINTS
NOT TO SCALE

NO.	BY	CHK.	APP.	DATE	REVISION DESCRIPTION

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

SIGNATURE ______
PRINTED NAME ______
DATE ______ REG. NO. ______

CLIENT
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CONSTRUCTION
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DATE RELEASED

BARR
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www.barr.com

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Checked	
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Approved	

BARR PROJECT No. 23270169.02
CLIENT PROJECT No.
DWG. No. 1
REV. No.

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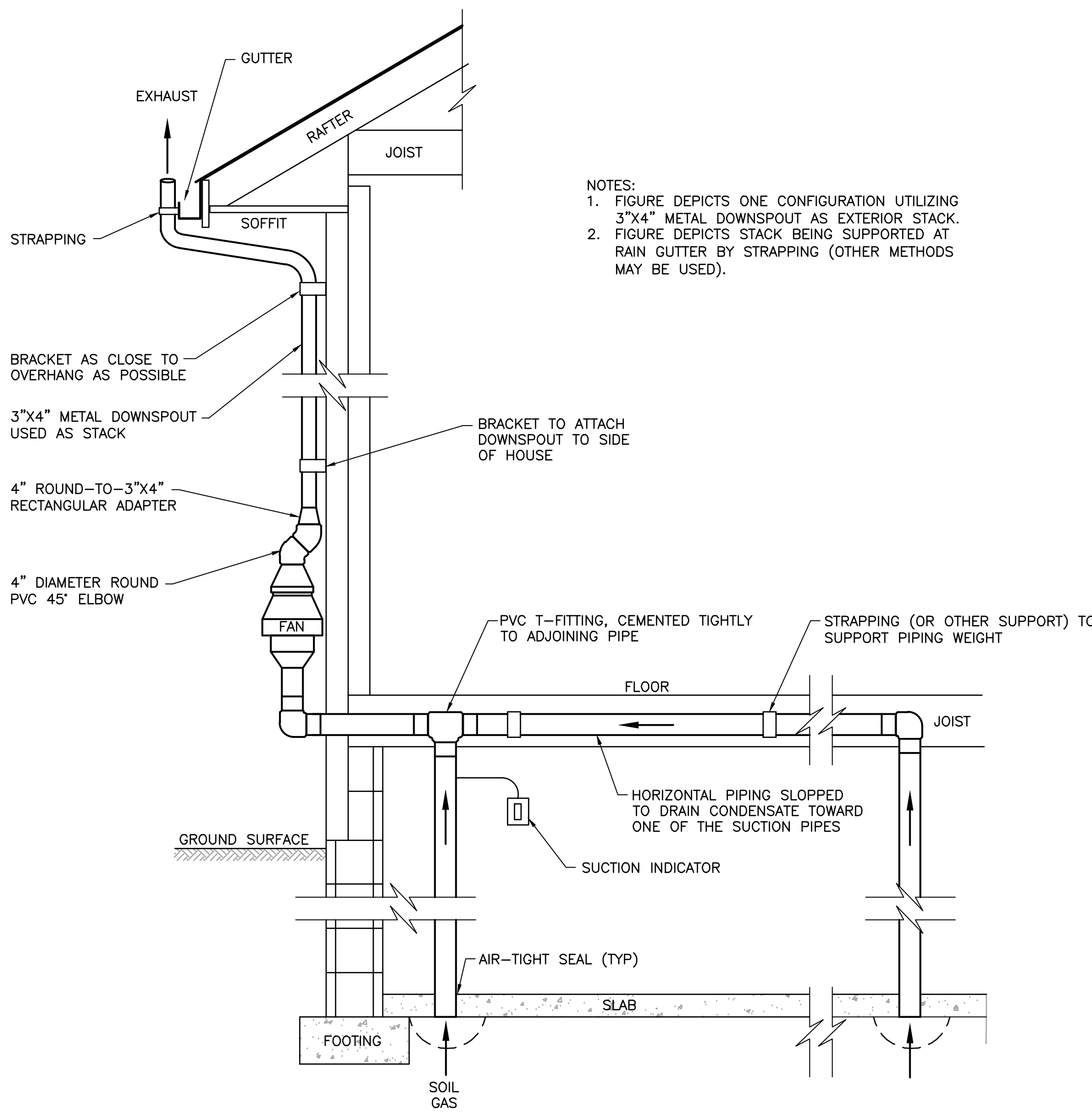
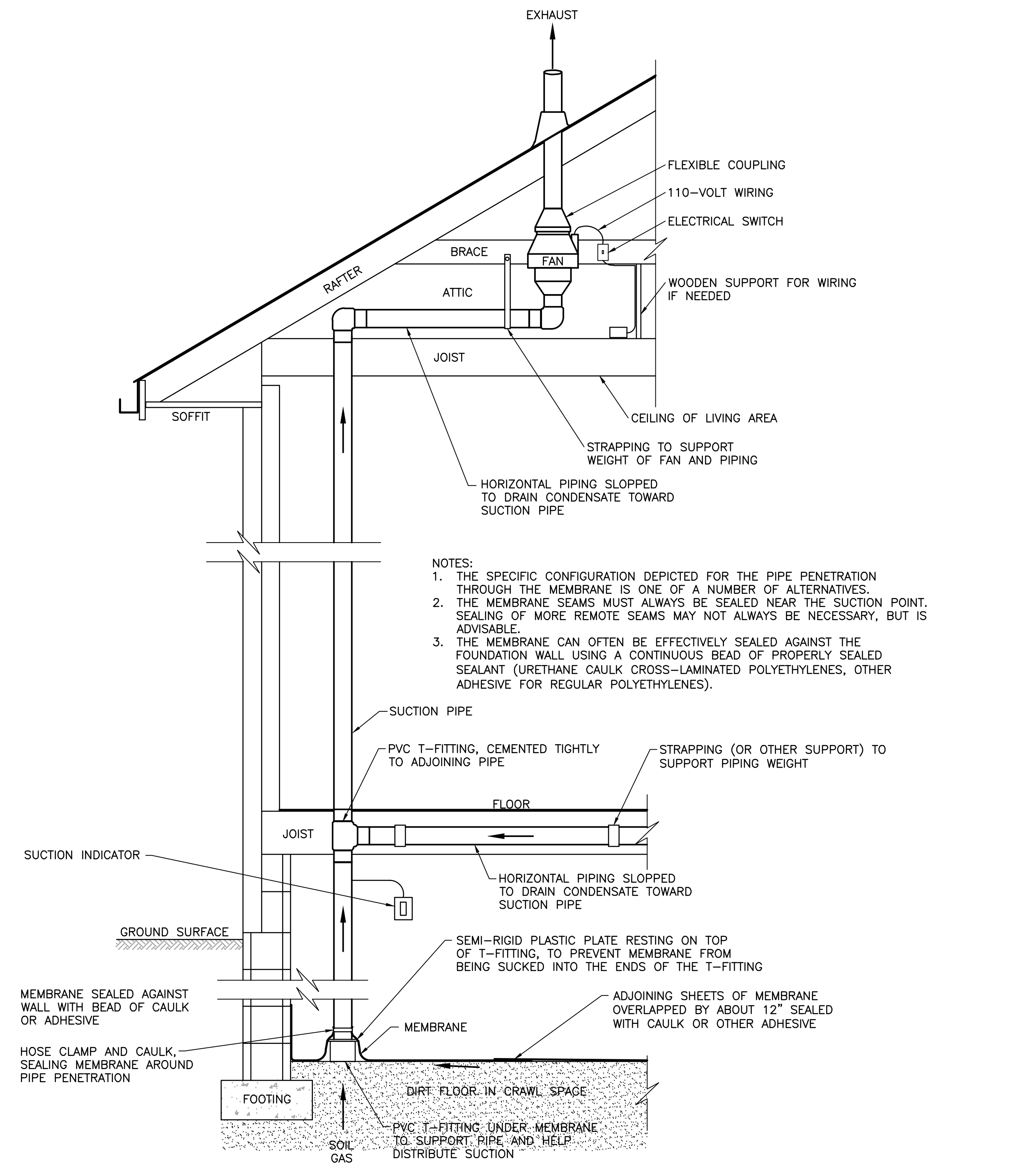


NOTES:
1. FIGURE DEPICTS ONE CONFIGURATION UTILIZING 3"X4" METAL DOWNSPOUT AS EXTERIOR STACK.
2. FIGURE DEPICTS STACK BEING SUPPORTED AT RAIN GUTTER BY STRAPPING (OTHER METHODS MAY BE USED).

SOURCE: RADON REDUCTION TECHNIQUES FOR EXISTING DETACHED HOUSES, EPA, 1993

3 SECTION: TYPICAL SUB–SLAB DEPRESSURIZATION (SSD) VAPOR ABATEMENT SYSTEM (OUTSIDE PIPING)
NOT TO SCALE



NOTES:
1. THE SPECIFIC CONFIGURATION DEPICTED FOR THE PIPE PENETRATION THROUGH THE MEMBRANE IS ONE OF A NUMBER OF ALTERNATIVES.
2. THE MEMBRANE SEAMS MUST ALWAYS BE SEALED NEAR THE SUCTION POINT. SEALING OF MORE REMOTE SEAMS MAY NOT ALWAYS BE NECESSARY, BUT IS ADVISABLE.
3. THE MEMBRANE CAN OFTEN BE EFFECTIVELY SEALED AGAINST THE FOUNDATION WALL USING A CONTINUOUS BEAD OF PROPERLY SEALED SEALANT (URETHANE CAULK CROSS–LAMINATED POLYETHYLENES, OTHER ADHESIVE FOR REGULAR POLYETHYLENES).

SOURCE: RADON REDUCTION TECHNIQUES FOR EXISTING DETACHED HOUSES, EPA, 1993

4 SECTION: TYPICAL SUB–MEMBRANE DEPRESSURIZATION (SMD) VAPOR ABATEMENT SYSTEM (INSIDE PIPING)
NOT TO SCALE

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NO.	BY	CHK.	APP.	DATE	REVISION DESCRIPTION

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BARR
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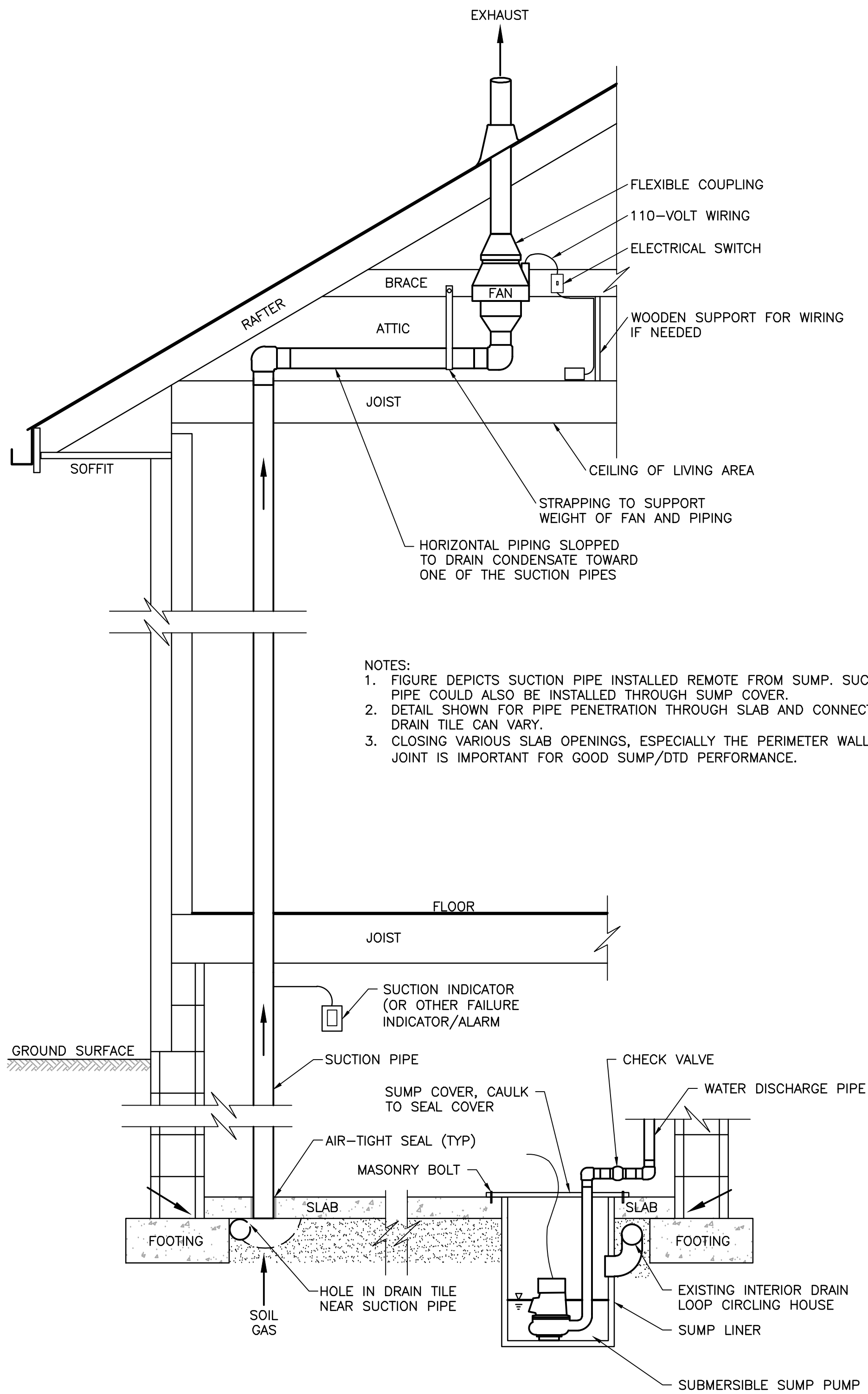
BARR PROJECT No. 23270169.02
CLIENT PROJECT No.
DWG. No. 2
REV. No.



NOTES:
1. FIGURE DEPICTS SUCTION PIPE INSTALLED REMOTE FROM SUMP. SUCTION PIPE COULD ALSO BE INSTALLED THROUGH SUMP COVER.
2. DETAIL SHOWN FOR PIPE PENETRATION THROUGH SLAB AND CONNECTION TO DRAIN TILE CAN VARY.
3. CLOSING VARIOUS SLAB OPENINGS, ESPECIALLY THE PERIMETER WALL/FLOOR JOINT IS IMPORTANT FOR GOOD SUMP/DTD PERFORMANCE.

SOURCE: RADON REDUCTION TECHNIQUES FOR EXISTING DETACHED HOUSES, EPA, 1993

5 SECTION: TYPICAL DRAIN-TILE DEPRESSURIZATION (DTD) VAPOR ABATEMENT SYSTEM

NOT TO SCALE

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SIGNATURE ____________

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DATE ________ REG. NO. ________

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BARR PROJECT No. 23270169.02

CLIENT PROJECT No.

DWG. No. 3

REV. No.

Appendix H

Mitigation System Diagnostic SOP

EAST HENNEPIN AVENUE STUDY AREA
Vapor Intrusion Mitigation System Installation/Inspection Checklist

Property Address:	**Inspection Date and Time:**
Inspector (s) /Company:	**Date system installed:**
Make and model of fan:	**Mitigation system ID#:**

Minimum Recommendations	**Yes**	**No**
1.0 Interior Piping		
1.1 Are all manifold and suction point piping solid, rigid pipe with the required diameter for the designed air flow?		
1.2 Are all vent pipes and connections constructed of schedule 40 PVC and/or meeting all applicable codes?		
1.3 Are all pipe interior joints and connections in mitigation systems sealed permanently? (Exceptions include installation of fans and sump covers)		
1.4 Does the system piping avoid attachment to or support by existing pipes, ducts, conduits or any kind of equipment?		
1.5 Does the system piping avoid blocking window and doors or access to installed equipment?		
1.6 Are supports for system piping installed at least every four (4) feet on horizontal runs?		
1.7 Are pipe supports present at ends of branches and at changes in elevation or direction?		
1.8 Are vertical runs secured and within all applicable codes?		
1.9 Are suction point pipes supported and secured in a permanent manner that prevents their downward movement to the bottom of suction pits or sump pits, or into the soil beneath a soil-gas-retarder membrane?		
1.10 Are horizontal runs in system piping sloped to ensure that water from rain or condensation drains downward into the ground beneath the slab or soil-gas-retarder membrane?		
2.0 General Sealing		
2.1 Are openings around the suction point piping penetrations of the slab properly sealed using methods and materials that are permanent/durable and pass the smoke stick check?		
2.2 Are openings / cracks sealed where the slab meets the foundation wall (if appropriate)?		
2.3 At any point where vent pipe and electric conduit exits the building, is urethane caulk or equivalent material used, and when the joint is greater than ½ inch in width, is a foam backer rod or other comparable filler material inserted into the joint before the application of the sealant (principally from the outside)?		
2.4 Are all utility and other penetrations through a soil-gas-retarder membrane sealed?		
3.0 Labeling		
3.1 Does each suction point have a mechanism to measure vacuum?		
3.2 Is the pressure reading from the latest commissioning clearly marked on the vent pipe?		
3.3 Is a system description label noting “Vapor Mitigation System” placed on the system piping or other prominent location and legible?		

Minimum Recommendations	Yes	No
3.4 Does the label contain the name and phone number of the contact person in case the system isn't working?		
4.0 Fan Installation		
4.1 Is the fan installed in a configuration that avoids condensation buildup in the fan housing or is a condensate bypass system present?		
4.2 Is the fan mounted on the exterior of buildings rated for outdoor use or installed in a weatherproof protective housing? (leave blank for inside systems)		
4.3 Is the fan mounted and secured in a manner that minimizes transfer of vibration to the structural framing of the building? (leave blank for inside systems)		
4.4 Does the system operate without noise or vibration above normal conditions?		
4.5 If a fan is installed in the interior of a building, is the fan installed in an unoccupied attic or garage not beneath conditioned spaces?		
4.6 Is the fan installed in a vertical run of pipe?		
4.7 Is the fan mounted to the vent pipe with removable or flexible connections?		
5.0 Notes and Comments		
6.0 Required Corrective Actions		