FET Seminar

Wisconsin's Vapor Intrusion Guidance

Part 2

DNR's Vapor Intrusion Guidance

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Vapor Intrusion Reference Documents

- **ITRC Vapor Intrusion Pathway: A Practical Guide**

  http://www.itrcweb.org/guidancedocument.asp?TID=49

- **US EPA 2002 Draft Guidance on Vapor Intrusion**

  http://www.epa.gov/oswer/vaporintrusion/

- **ASTM E2600-10, Standard Guide for Vapor Encroachment Screening on Property Involved in Real Estate Transactions**

Relationship to ASTM Guidance

- **ASTM Guidance focuses on property transactions and uses a 2 tier screening process to eliminate the presence of nearby vapor sources**
  - **Tier 1 – similar to Phase 1 investigation**
  - **Tier 2 – similar to Phase 2 investigation**
- **DNR Guidance focuses on already confirmed contaminants on property. Screening results help determine level of investigative effort.**
  - **Move outward from source**

Vapor Sources

Background Vapor Sources

- **Management of "background" sources**
  - **Common household items**
    - **Survey & Remove, at least 24 hr in advance**
    - **Handout, "Common household materials that may contain VOCs"**
  - **Background outdoor sources**
    - **Always pair indoor & outdoor air samples**
  - **Sample ONLY for chemicals of concern**
    - **Avoids unnecessary complications due to background**
    - **Focuses on the VI pathway**

OSHA Regulated Sources

- **Do not sample indoor air**
  - **“background” can not be eliminated**
- **Sub-surface screening levels based on industrial use; not on OSHA PELs**
  - **PELs applicable to air inside a facility with an occupational safety program**
  - **In soils, PEL concentrations would indicate significant level of contamination**
  - **Lateral vapor migration presents risk to non-OSHA workspaces & buildings**

Other Sources of Vapors

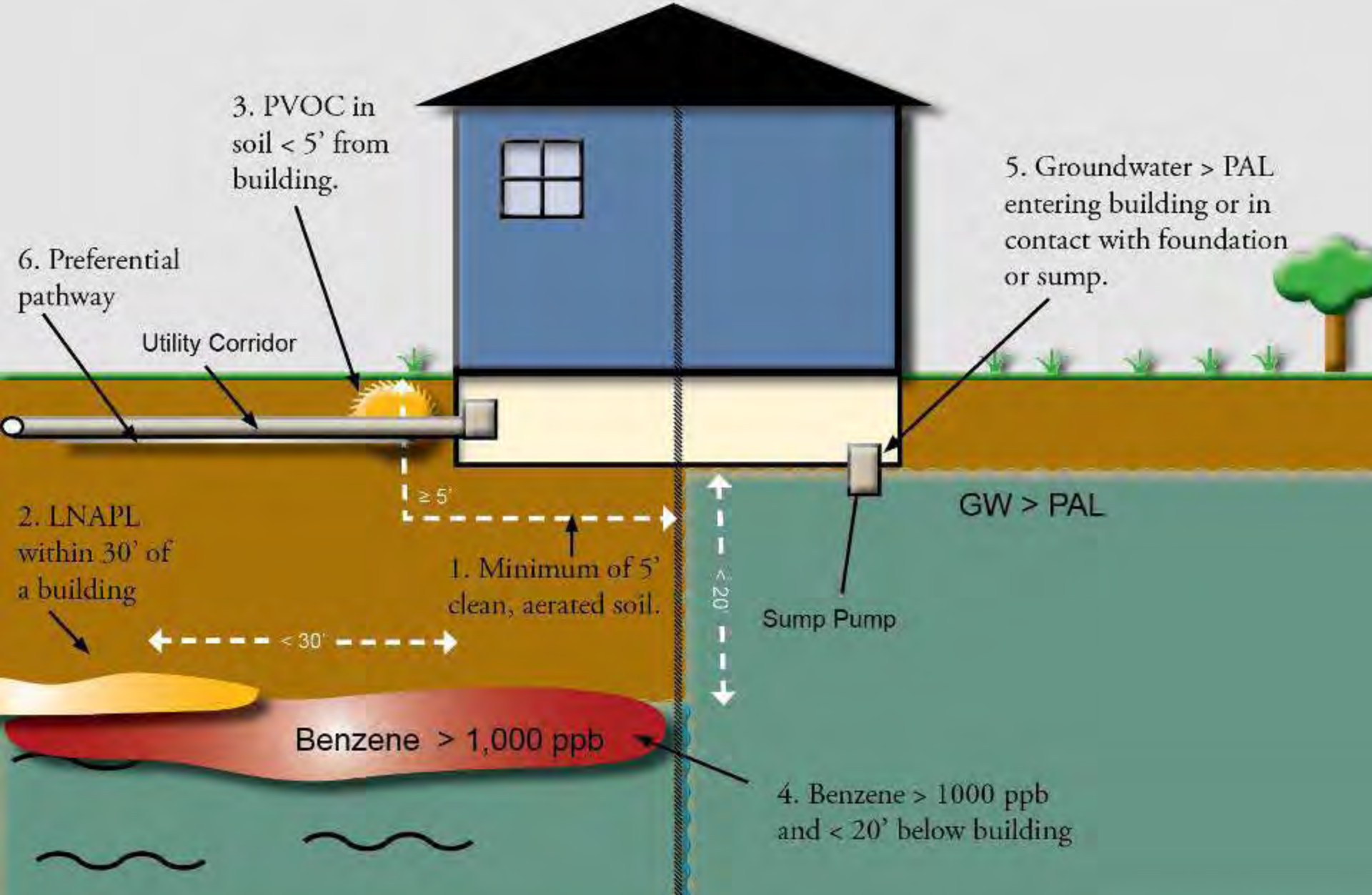
- **Contaminants impregnated in building materials**
- **Contaminants that do NOT originate from a hazardous substance release**
  - **May not be able to distinguish these sources until AFTER vapor mitigation in place**
  - **Involve Dept of Health Services when indoor air exceeds 10-5 risk levels. If mitigation does not reduce risks to acceptable levels, local health department may need to be involved.**

Pathway Screening

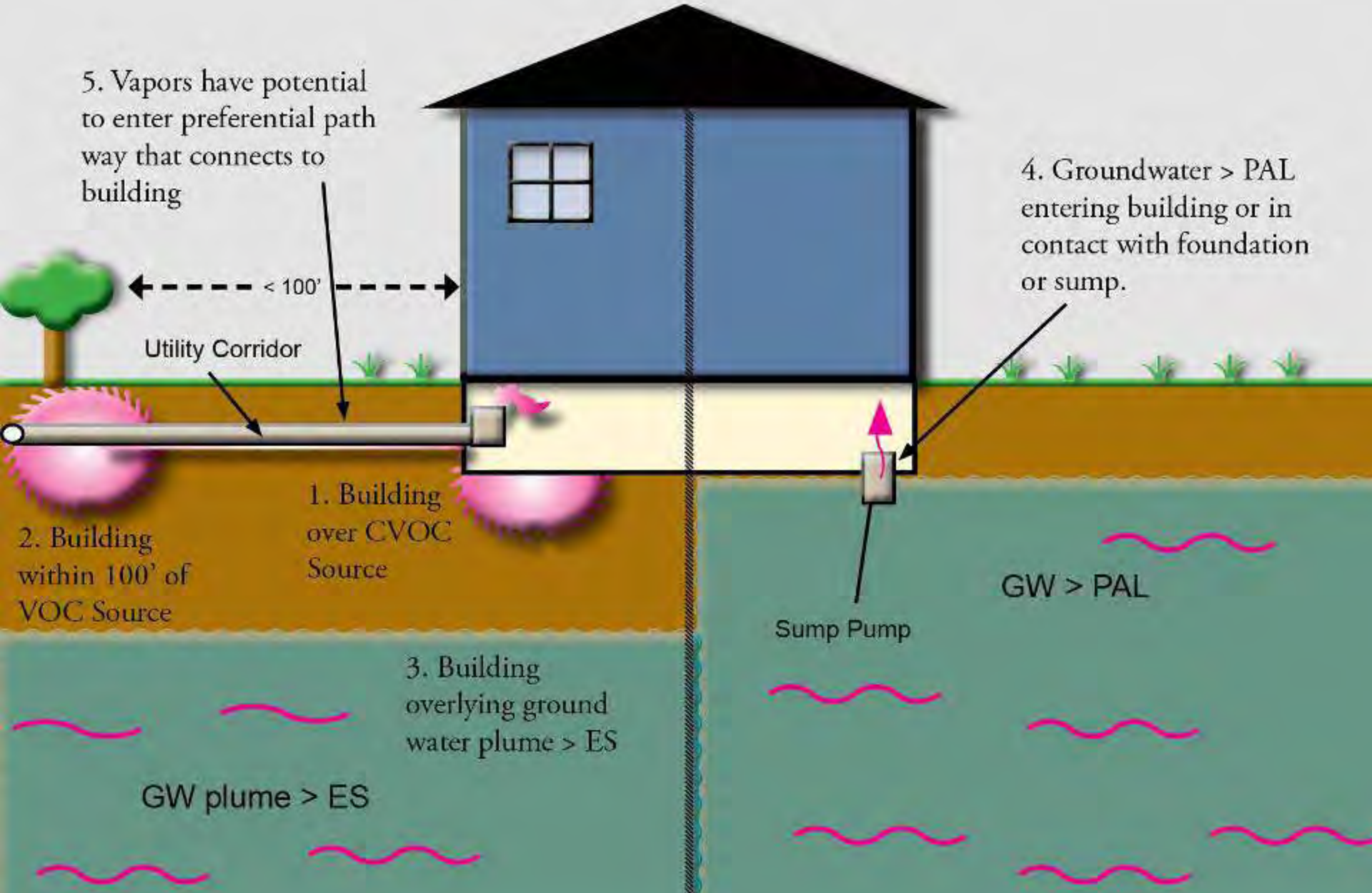
PVOC – Pathway Screening

- **Immediate Action: Explosion risk from petroleum vapors. Strong petroleum odors should be immediately investigated & building evacuated if necessary.**
- **Petroleum vapors can cause irritation of mucus membranes. If people complain of irritation, investigate to determine if this is related to a petroleum release. If so, follow-up investigation necessary.**

PVOC Pathway Screening



CVOC Pathway Screening



Complications of Screening

- **Soil moisture & texture and many other factors affect vapor movement.**
- **The screening distances are not hard & fast rules, but guidelines. Experience of the consultant and PM will help guide decisions at each step.**
- **Every SI report should document how the VI pathway was screened and discuss why or why not further investigation was undertaken.**

Investigating the VI Pathway

Basic investigation Approach – discussed in Part 1

- **Part 1 discussed conceptual site models and where samples should be collected.**

Properties without structures

- **Soil vapor samples can be collected, but may not be helpful in understanding VI risk at undeveloped properties.**
- **Rather than collecting soil gas samples, recommend designing new buildings with vapor barriers and passive or active vapor venting.**
  - **More cost effective than investigations**
  - **Avoids expensive retrofitting in the future**

Vapor Action Levels (VAL)

- **U.S. EPA Regional Screening Level Tables (based on 1 x 10^{-6} risk) : http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm**
- **1 in 100,000 (10^{-5}) excess life time cancer risk or a Hazard Index = 1.**
  - **Applies to individual chemicals as well cumulative risk**
- **Can calculate site specific value using website; use of the tables alone is acceptable**

Review RSL Table On-line

http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm

Converting units for gas phase

- In water, 1 ug/L Benzene = 1 ppb
- In air, 1 ug/L Benzene @ 20ºC=
  - 1000 µg/m^3
  - 1 mg/m^3
  - 308 ppbV
- EPA screening tables use µg/m^3
  - recommends that consultants ask the laboratory to provide results as µg/m^3
- http://www.epa.gov/athens/learn2model/part-two/onsite/ia_unit_conversion.html

Converting µg/m^3 to ppbV

Convert µg/m^3 to ppbV

On-line calculator: Indoor Air Unit Conversion
http://www.epa.gov/athens/learn2model/part-two/onsite/ia_unit_conversion.html

$$ppbV = \frac{\mu g/m^3}{MW} \times 8.3144 \left[\frac{L \cdot kPa}{mol \cdot {}^\circ K}\right] \times \left[T_{\circ C} + 273.15\right]{}^\circ K \times \frac{1}{101.325\, kPa}$$

OR ppbV = (µg/m^3 x **24.05**)/molecular weight

(at 20°C and 1 atm)

Temperature			Conversion Factor
°F	°C	°K	(l/mole or molar volumes of ideal gas)
50	10	283.15	23.23
68	20	293.15	24.05
71.6	22	295.15	24.22
77	25	298.15	24.46

Applying EPA's RSL Table to WI Vapor Action Levels

Contaminant	Screening Levels			
	Resident Air (ug/m^3)	key	Industrial Air (ug/m^3)	key
Benzene	3.1E-01	c	1.6E+00	c*
Chloromethane	9.4E+01	n	3.9E+02	n

Non-carcinogen RSL (nRSL) values represent a HI = 1, therefore NO MULTIPLE is applied to nRSL values.

Carcinogen RSL (cRSL) values represent a 10^{-6} excess life time cancer risk. We allow a 10^{-5} risk, therefore cRSL values are multiplied by 10 for WI screening values.

(c** in the RSL Table means nRSL < 10 x cRSL. Therefore, nRSL will be the screening level for these compounds. c* means nRSL is < 100 x cRSL.)

Quick Look-up Table for VALs

Indoor Air Vapor Action Levels for Various VOCs
Quick Look-Up Table[1]
Based on **November 2010** Regional Screening Level Summary Table

Chemical	Non-Residential (1-in-100,000 risk for carcinogens)		Residential (1-in-100,000 risk for carcinogens)		Molecular Weight (MW)	Basis of RSL[2]
	ppbV*	µg/m³	ppbV*	µg/m³	g/mole	
Benzene	4.9	16.0	0.95	3.1	78.11	c
Chloroform	1.1	5.3	0.22	1.1	119.38	c
Chloromethane	190	390	45	94	50.49	n
Dichlorodifluoromethane	180	880	42	210	120.91	n
1,1 – Dichloroethane (1,1-DCA)	19	77	3.6	15	98.96	c
1,2-Dichloroethane (1,2-DCA)	1.1	4.7	0.23	0.94	98.96	c
1,1 -Dichloroethylene (1,1-DCE)	220	880	52	210	96.94	n
1,2-Dichloroethene (cis and mixed)	NA	NA	NA	NA	96.94	n
1,2-Dichloroethene (trans)	65	260	16	63	96.94	n
Ethylbenzene	11	49	2.2	9.7	106.17	c
Methyl-tert-Butyl Ether (MTBE)	130	470	26	94	88.15	c
Methylene Chloride	74	260	15	52	84.93	c
Naphthalene	0.68	3.6	0.14	0.72	128.18	c
Tetrachloroethylene	3.0	21	0.60	4.1	165.83	c
Toluene	5700	22,000	1400	5200	92.14	n
1,1,1 - Trichloroethane	4000	22,000	940	5200	133.41	n
Trichloroethylene	11	61	2.2	12	131.39	c
Trichlorofluromethane	540	3100	130	730	137.37	n
Trimethylbenzene (1,2,4)	6.2	31	1.5	7.3	120.2	n
Trimethylbenzene (1,3,5)	NA	NA	NA	NA	120.2	n
Vinyl Chloride	11	28	0.62	1.6	62.5	c
Xylene (mix)	100	440	23	100	106.17	n
Xylene (n,m,o separately)	700	3100	170	730	106.17	n

Vapor Risk Screening Levels

- **Used to estimate risk to indoor air.**
- **Based on a multiple of VAL**

Sample Location	Attenuation Factor (resident/commercial)	Equivalent "dilution" factor	Equivalent "risk" using Table Values	
			cRSL	HQ
Indoor Air	1	1	10-5	1
Sub-slab	0.1	10	10-4	10
Shallow soil gas	0.1	10	10-4	10
Deep soil gas	0.01	100	10-3	100
Groundwater	0.001	1000	10-2	1000

Definition of Attenuation Factor

Sub-slab or soil gas:

$$AF = \frac{C_{IA}}{C_{ss}}$$

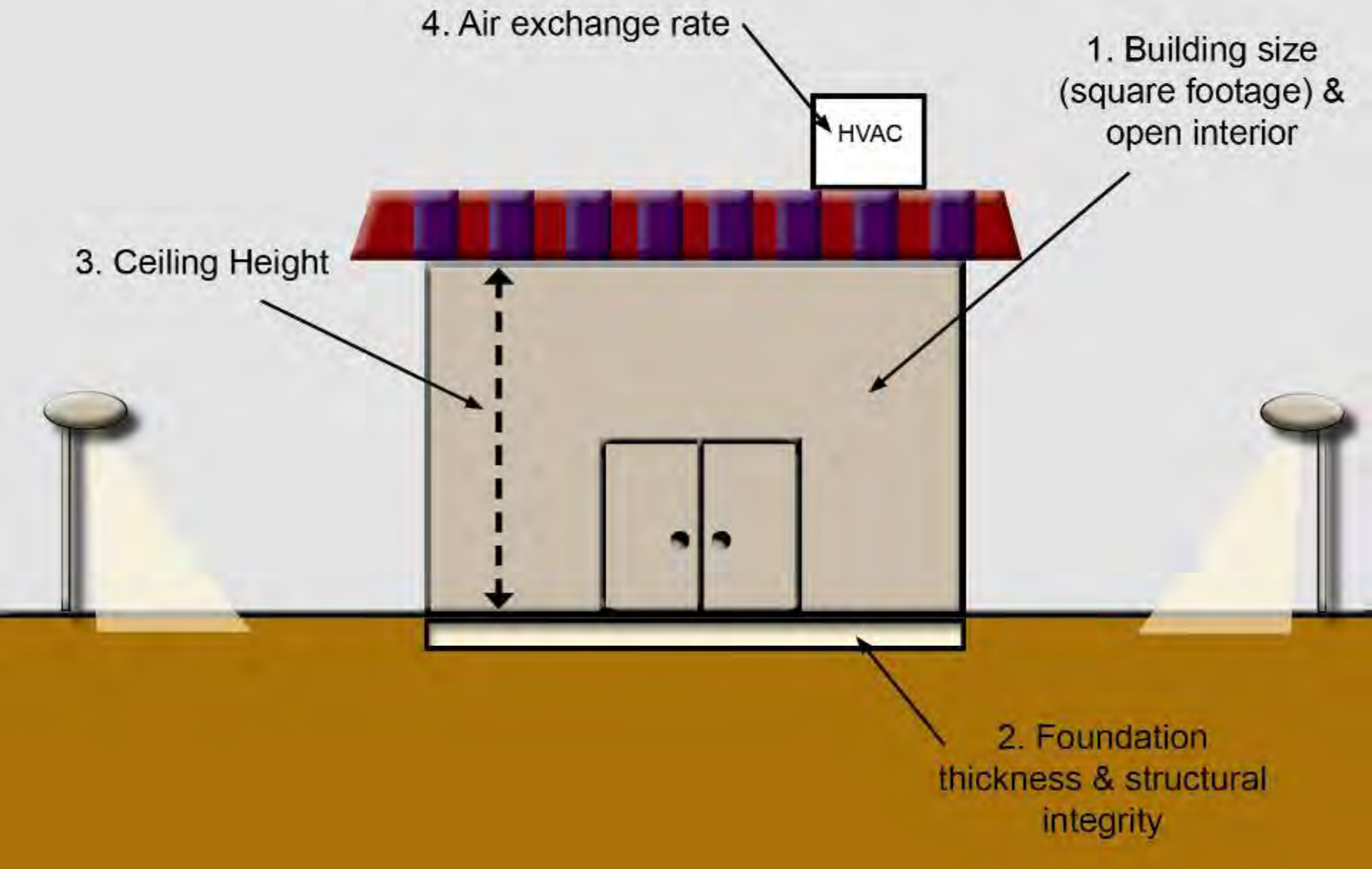
Groundwater:

$$AF = \frac{C_{IA}}{C_{gw}\left(H\right)\left(1000\ {}^{L}/_{m^3}\right)}$$

Henry's Constant: http://www.epa.gov/athens/learn2model/part-two/onsite/esthenry.html

Note: The default AF for groundwater to indoor air is 0.001. If the contaminated groundwater is located close to the building foundation, AF should be increased to 0.1 (i.e., treated as a sub-slab concentration).

Criteria for Reduced Attenuation Factor in Large Commercial/Industrial Buildings



Indoor Air samples

- **Must be paired with outdoor air sample**
- **Can collect simultaneously with or subsequent to sub-slab sampling**
- **Not always needed; should be collected if building occupied & COC not in use**
- **Negative result can not rule out VI**
- **Positive result does not necessarily confirm VI pathway**
- **Inform DHS when IA > VAL**

Sub-slab vapor samples

- **More likely to reveal vapor threat to specific receptor**
- **More likely to originate from sub-surface contamination**
- **Can usually rule out vapor pathway if sub-slab vapor less than screening level**
- **If SS > screening levels, must follow-up with additional investigation and/or mitigation.**

Other media (soil gas /groundwater)

- **Useful to understand vapor migration and identify buildings that need to be screened for VI**
- **Concentrations above screening levels should be followed up. If there is a building nearby, sub-slab within building will usually be necessary to assess the risk of VI.**

Other media (Utility Corridors)

- **Guidance proposes AF=0.01 for vapors in utility corridors.**
- **If there is evidence of preferential pathway, may need unique sampling approach.**
  - **Sub-slab samples often best option**

Assessing Sub-slab vapors at Industrial Buildings

- **Standard sub-slab samples expensive & unwieldy at buildings with large footprints**
- **Recommend “high purge volume sampling” for large buildings**
  - **Produces an integrated sample**
  - **The sample is more representative of the sub-slab volume**
  - **Very similar to a pump test**
  - **Equipment & testing straightforward**

Reference for High Purge Volume Sampling

McAlary, T., et.al., High purge volume sampling – a new paradigm for subslab soil gas monitoring, Ground Water Monitoring & Remediation, v. 30, no. 2, Spring 2010, pp. 73 – 85.

Questions?

Responses to Vapor Intrusion

Exceedance of VAL or Sub-slab Screening Level

- **Requires response**
- **Additional samples may be collected to confirm initial results**
- **Assess all the evidence to determine if VI poses risk to building occupants**
- **If a risk from the VI pathway exists, then proceed as with other pathways:**
  - **Eliminate immediate threats**
  - **Take appropriate remedial actions**

VAL Exceeded in Occupied Building

- **If caused by VI, action to reduce exposure should be taken as soon as possible.**
- **Sub-slab depressurization (SSD) aka "radon" systems most commonly installed.**
- **Other actions – HVAC adjustment; sealing vapor entry points; building pressurization, etc. may also be useful**

Sub-slab Screening Levels Exceeded

- **In general, vapor mitigation should be implemented where sub-slab vapor concentrations exceed screening levels, even if IA < VAL.**
- **If IA < VAL, mitigation does not need to be implemented immediately.**
  - **However, IA monitoring program should be implemented**
  - **Decisions for monitoring and mitigation based on when remedial action may occur; use of building; etc.**

Remediation of the VI Pathway

- **RP is to undertake remedial action to address the pathway.**
- **Operation of SSD is considered a short-term response to an exposure, not a stand-alone remedial option.**
- **Remedial options assessment and action follows usual NR 700 process.**

Verification Monitoring for Mitigation

- **Verification necessary post VI mitigation to ensure effectiveness**
- **Pressure gradient (SSD)**
  - **Manometer on SSD exhaust pipe**
  - **In certain cases, sub-slab pressure transducers**
- **Indoor air sampling**
  - **Confirm that exposure to VI has been eliminated**
  - **Recommend samples at 3 & 6 mo. after mitigation installed (for SSD).**

Monitoring as a response to exceedance of VAL/VRSL

- **Follow-up monitoring is acceptable when SS > VRSL with following criteria:**
  - **Indoor Air > 10 x VAL – immediate action to halt exposure**
  - **Indoor Air > VAL – immediate follow-up testing & assessment to interrupt pathway**
  - **Indoor Air < VAL – On-going, long-term monitoring program can be implemented.**

Monitoring as a response to exceedance of VAL/VRSL

- **Where the contaminant source underlies a building (such as a dry cleaner) - don't rush into SSD when IA < VAL and a remedy being implemented. May be best to implement remedy and reassess sub-slab levels in the future to determine the need for mitigation.**

Site Closure

VI sites can be closed when:

- **NR 726 requirements met**
- **Indoor Air < VAL & verified**
- **Contaminant source remediated to the extent practicable**
  - **Reduce to extent practicable the length of time mitigation must be operated**
- **Property owners notified of O&M responsibility for mitigation system.**
- **Source property and off-source property (if affected) entered into on-line database.**

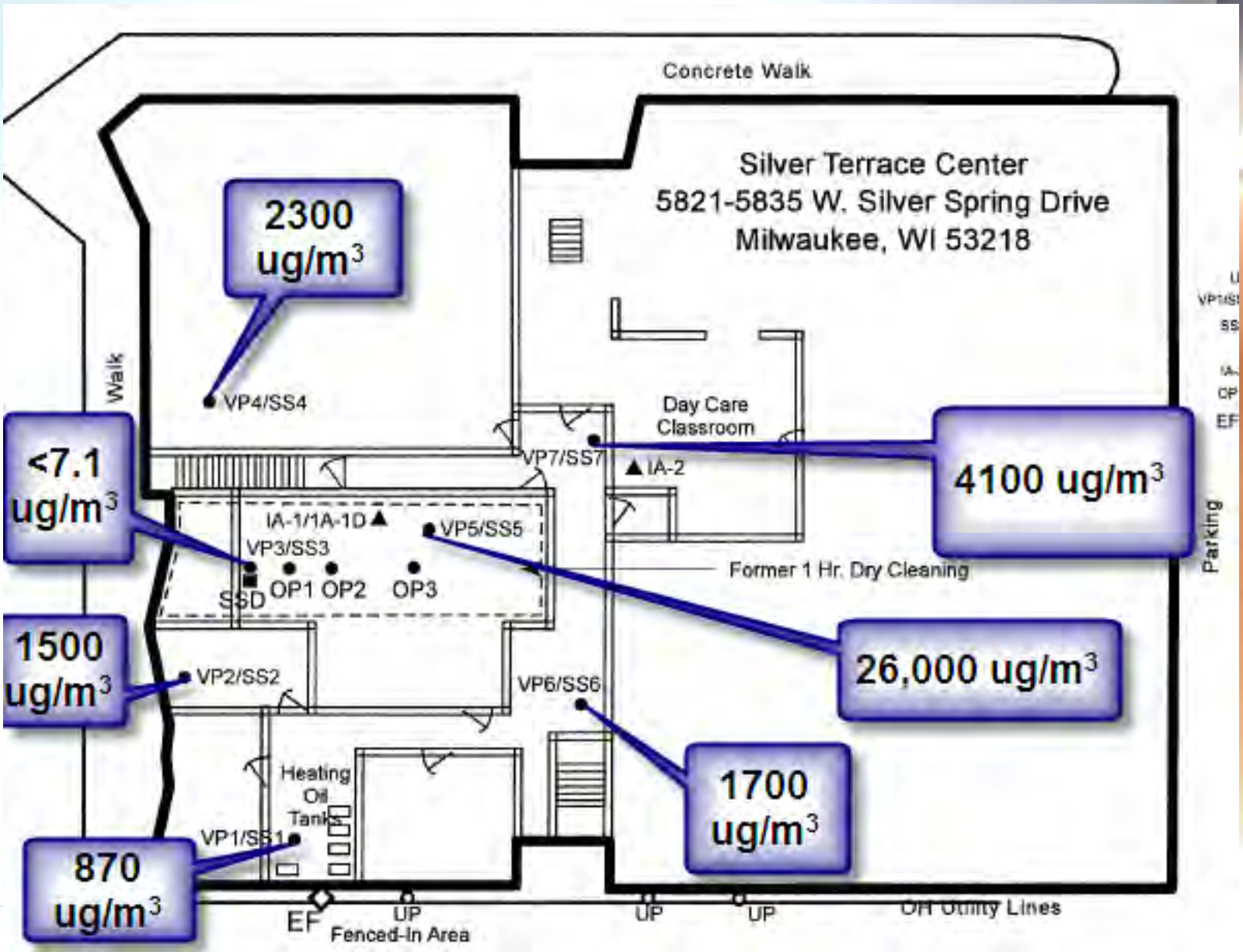
VI Closure Conditions

- **BRRTS Action Code (226) enhanced with drop-down list of options**
  - **Vapor mitigation system due to hydrogeologic conditions**
  - **Vapor mitigation system where sub-slab levels >VRSL**
  - **Vapor mitigation system where compounds of concern are used**
  - **Vapor controls during future redevelopment (residual contamination from CVOCs)**
  - **Vapor mitigation system with specific exposure conditions**

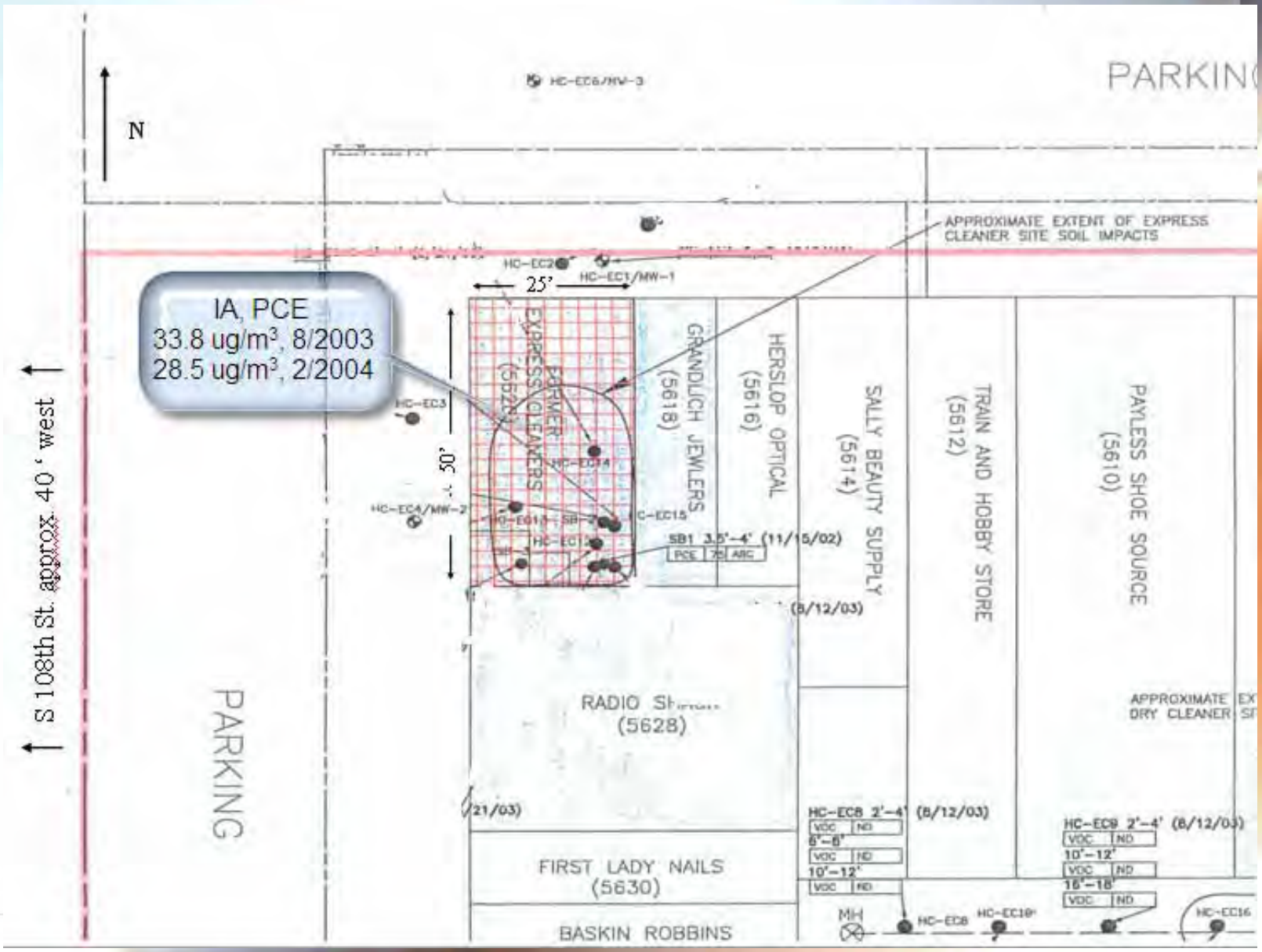
Questions?

VI Case Examples

SS>VRSL; IA = ND
Silver Terrace (PCE)



SS >VRSL; IA >VAL
Express Cleaners



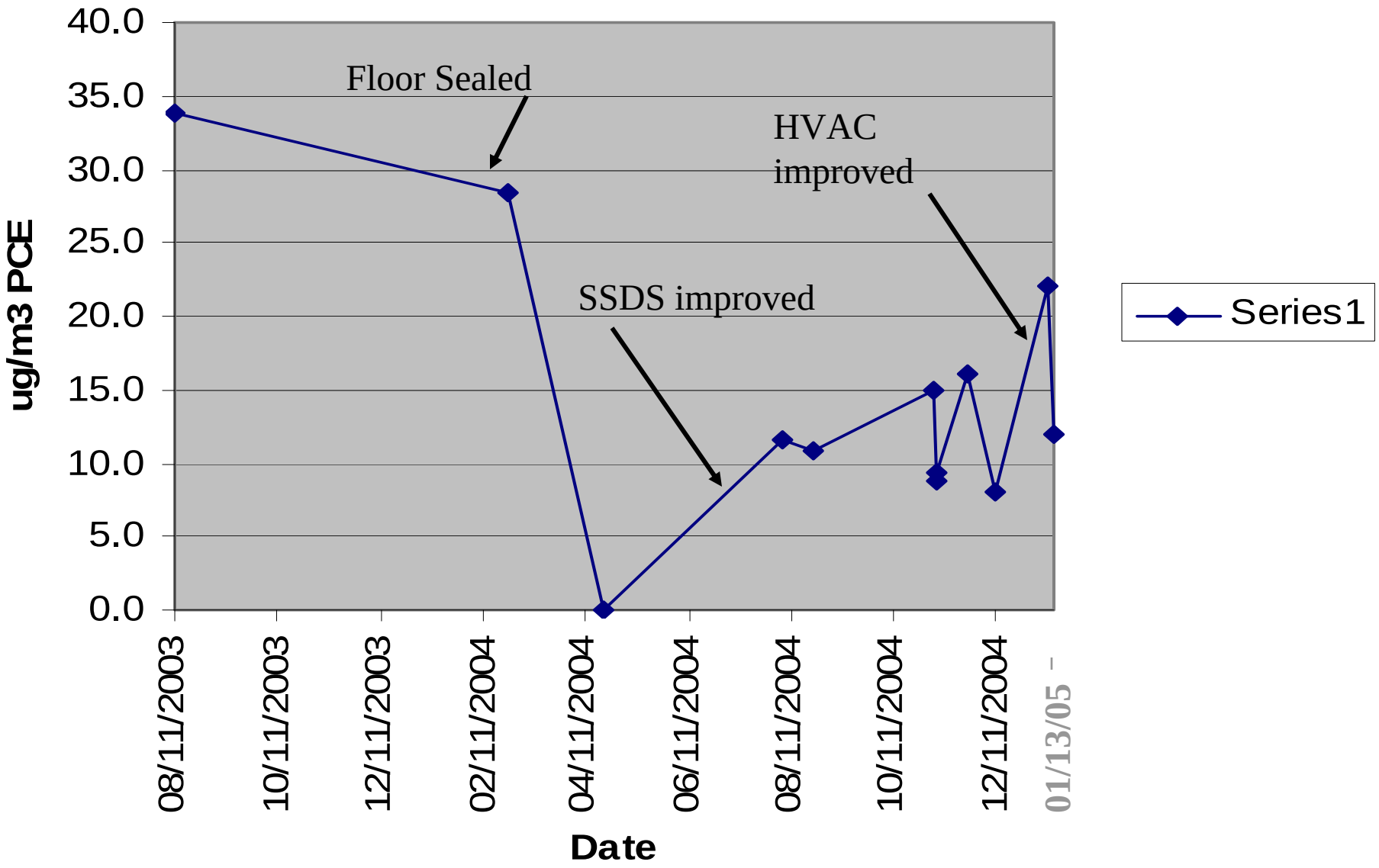
Express Cleaners – horizontal trench, pipes for SSDS

5. General view of 4" perforated pipe within the trench. This is the new extraction pipe for the sub-floor vapor mitigation system.

6. The placement of pea gravel on top of the sub-floor vapor mitigation extraction pipe. Floor drain piping lying on top of the gravel.


Air intake
SSDS
exhaust

Express Cleaners - Indoor Air PCE Levels



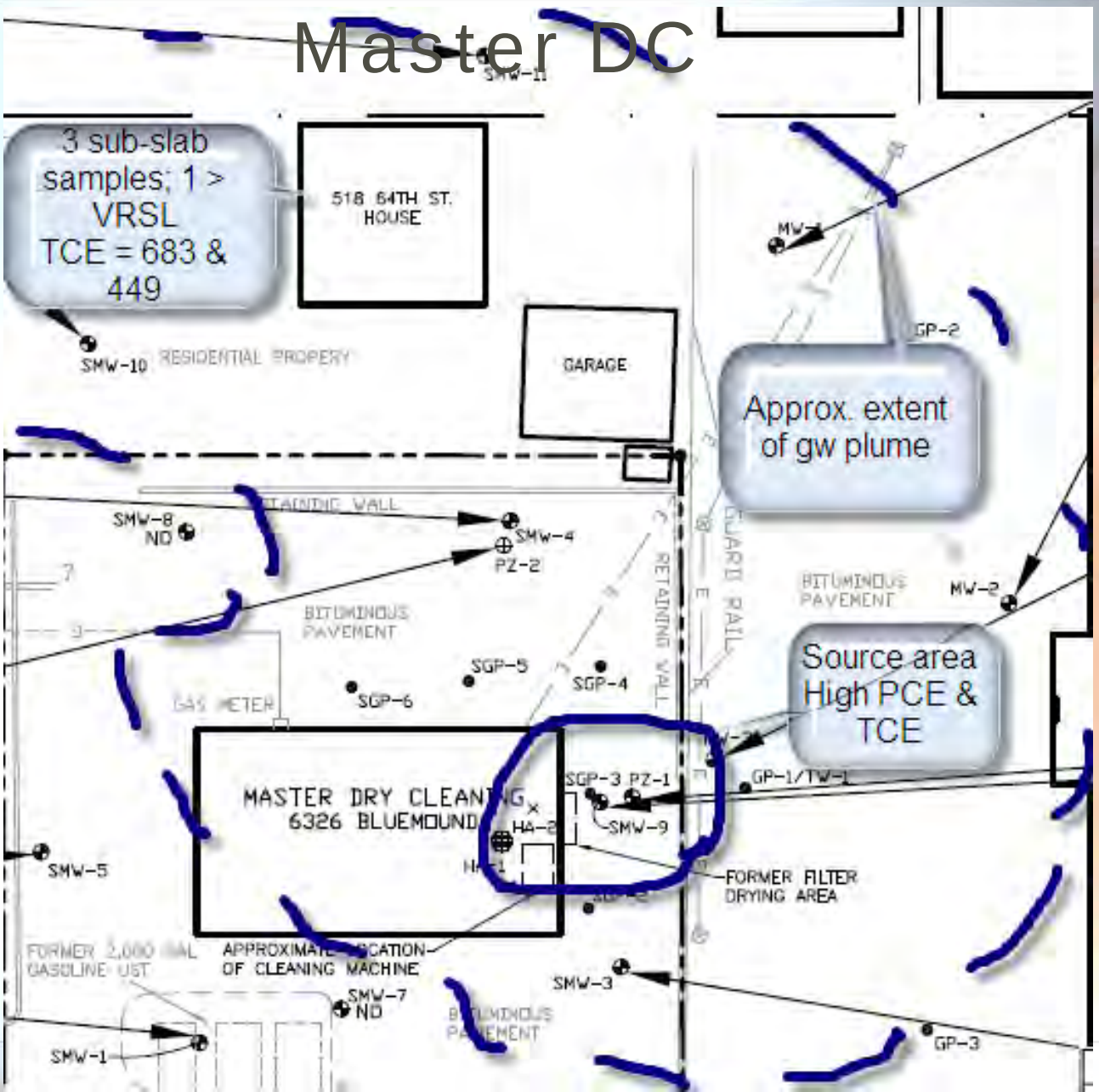
Redevelopment & Protecting VI Pathway: Humboldt Ave site

Humboldt Ave – Vapor Barrier Trench

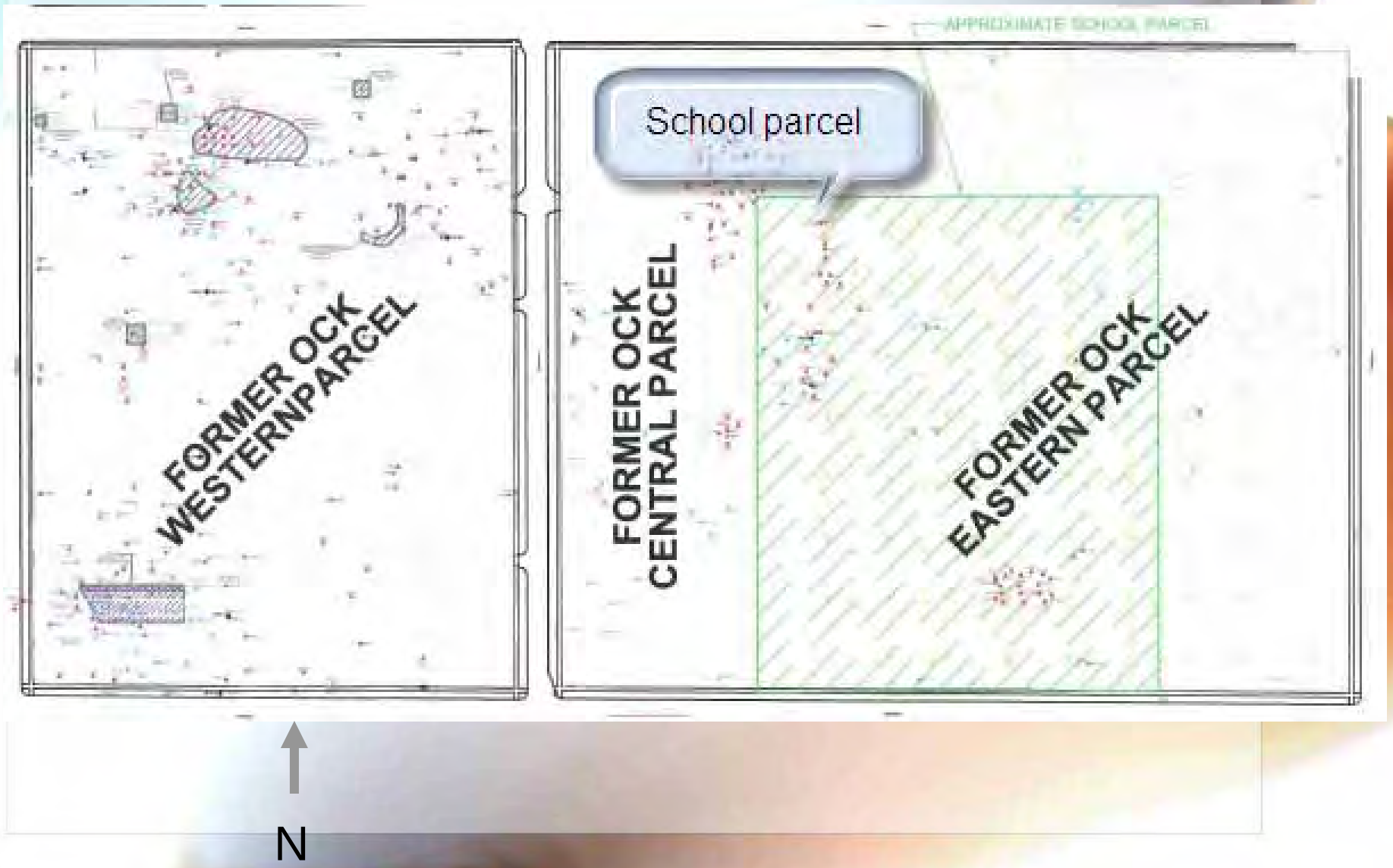
Humboldt – Installing passive vent pipe in trench

Off-site Plume with Possible VI

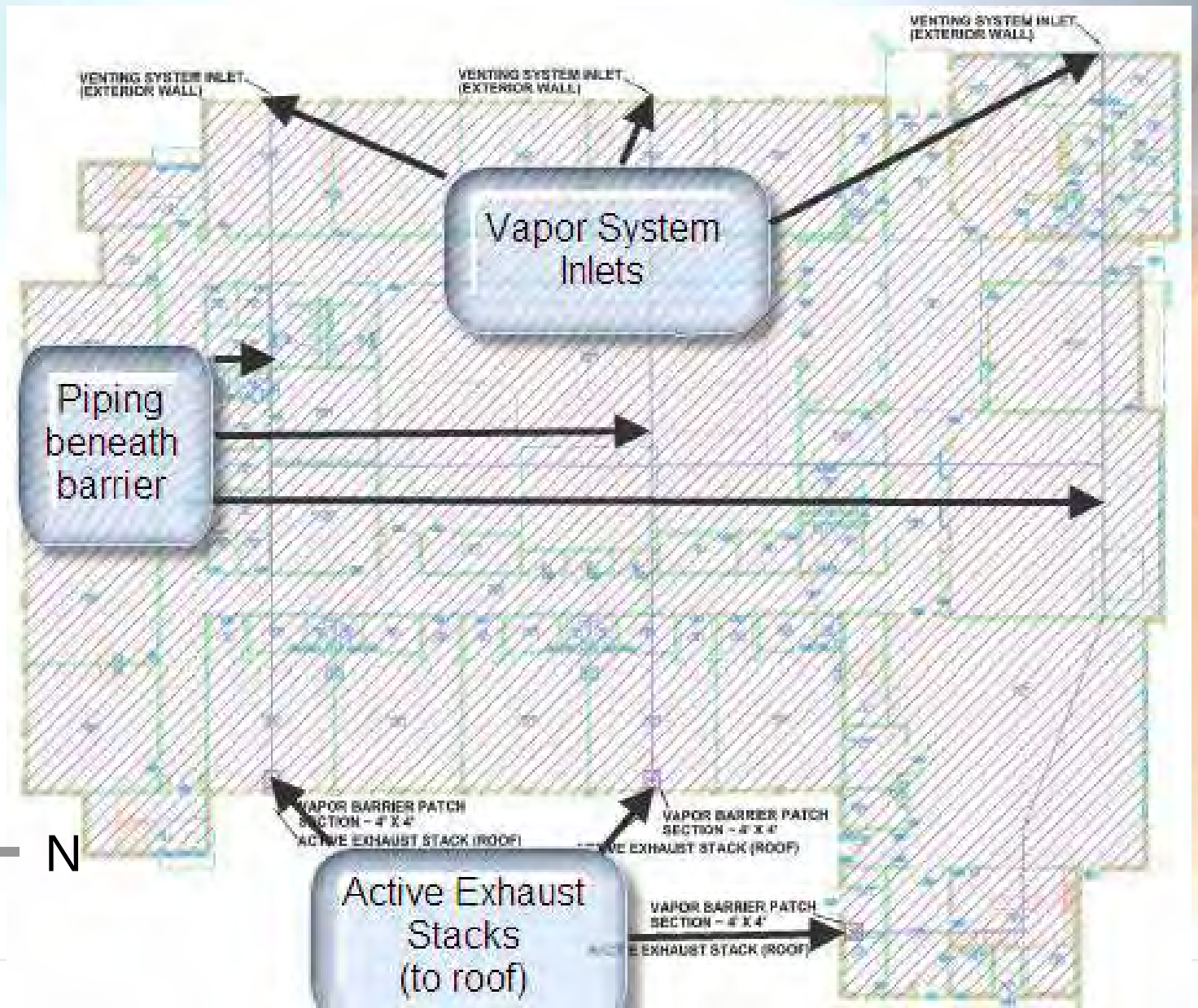
Master DC



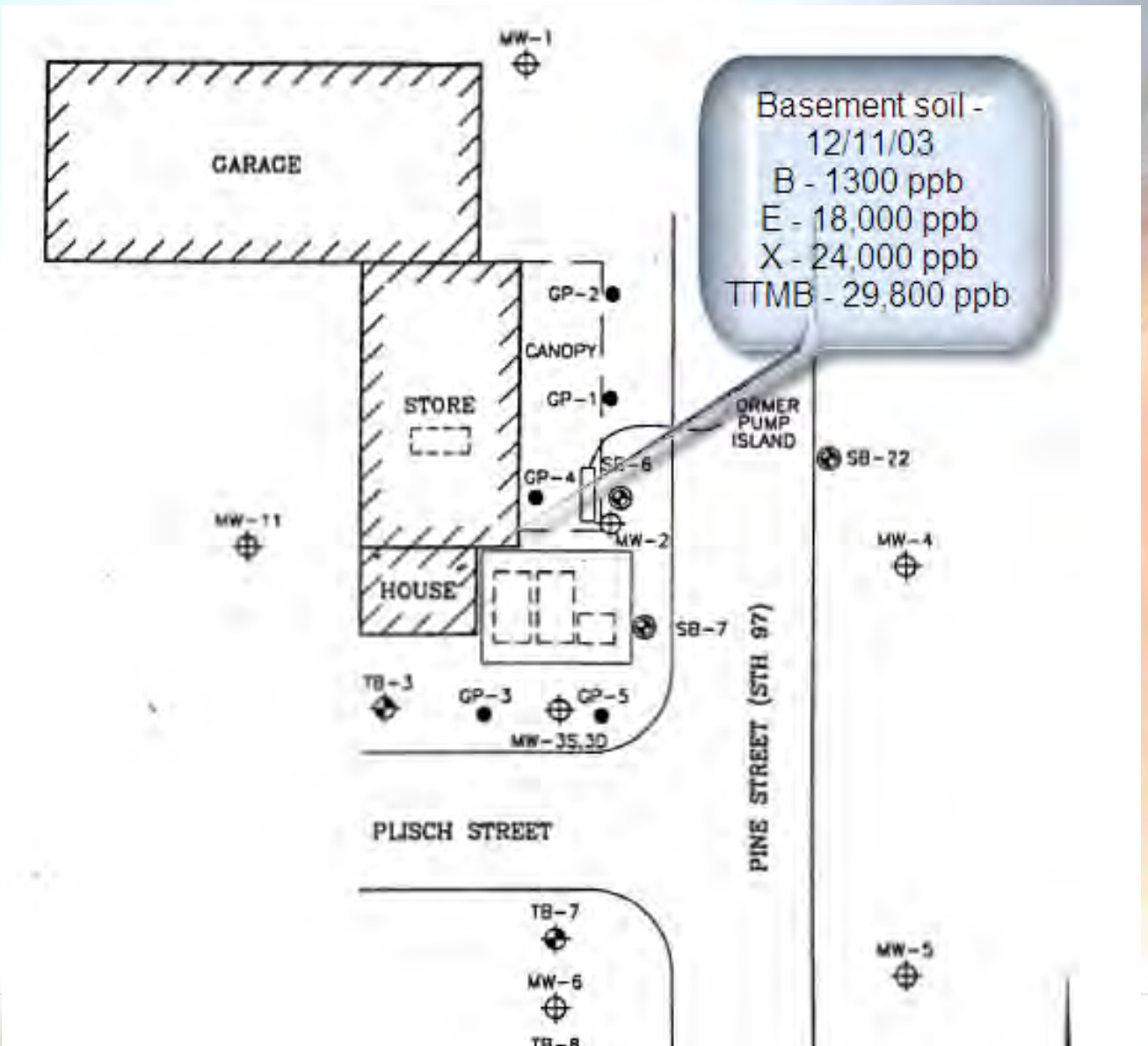
New construction on CVOC contaminated property: Brass School



Redevelopment of CVOC contaminated property: Brass School (TCE)



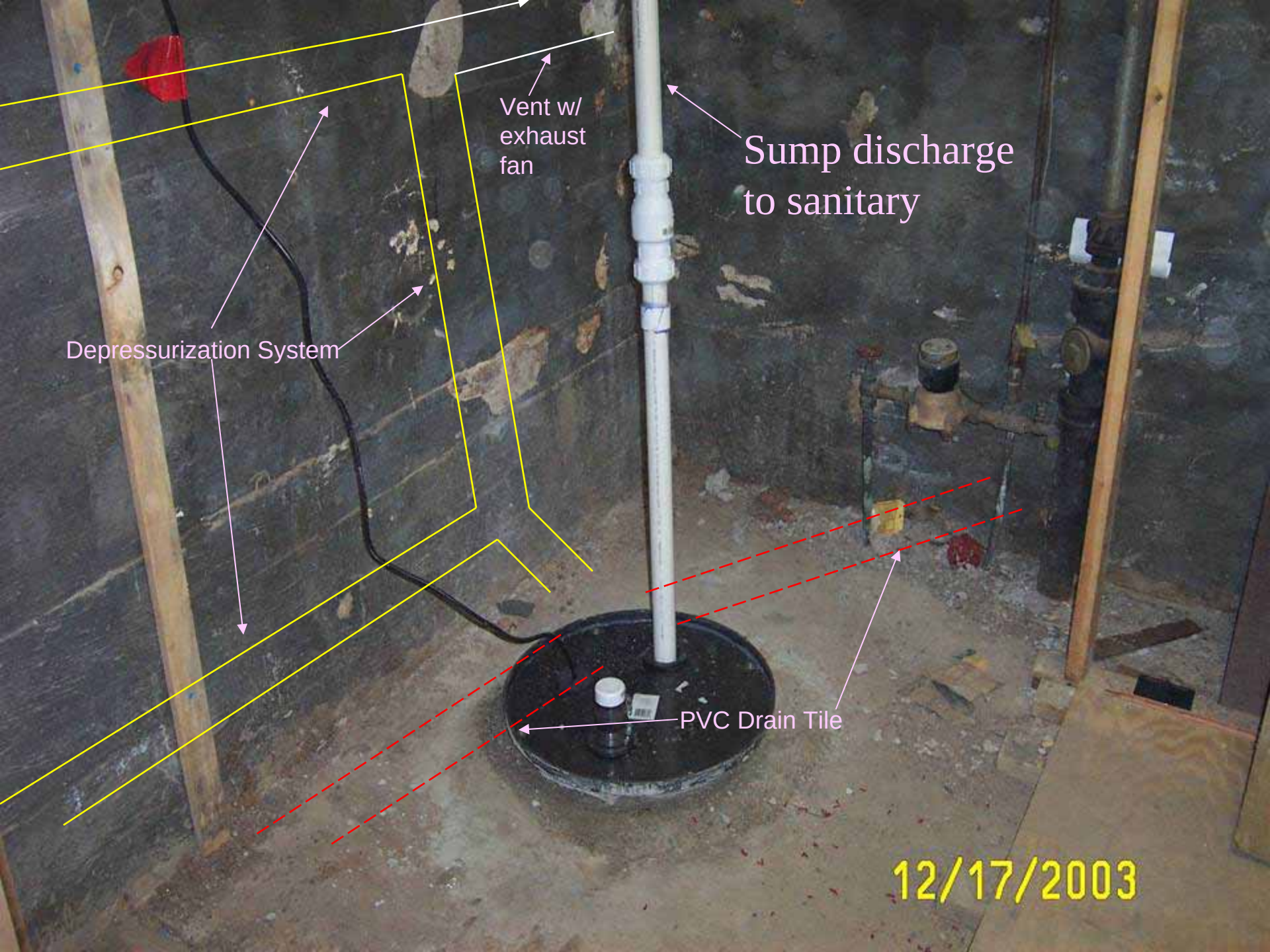
Petroleum Release with Free Product – Gauerke Tire (Closed)



Petroleum Release with Free Product – Gauerke Tire (Closed)

Installation of the depressurization system. Bottom tier.

Depressurization system being tied into sump inside basement.


Vent w/
exhaust
fan
Sump discharge
to sanitary
Depressurization System
PVC Drain Tile
12/17/2003