

Horizontal Remediation Wells

Horizontal Remediation Technologies • Installation • Design • Engineered Well Screens • Services



Horizontal Wells for Sub-Slab Vapor Intrusion Mitigation and Remediation

Southeastern States Vapor Intrusion Symposium

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Brief Company Introduction

- Directional Technologies, Inc. is Celebrating 25th Anniversary.
- Horizontal Well Technology Company Specializing in:
 - Horizontal Remediation Well (HRW) System Design.
 - HRW Screen Engineering.
 - HRW Installation with Horizontal Directional Drilling.
 - HRW Development, and O&M Support.
- Installed over 1,000 HRWs for the Environmental Industry.
- International Experience and Recognition.
- Woman Owned Small Business.

DIRECTIONAL
Technologies, Inc
Horizontal Remediation Wells



Presentation Outline



- Part 1: Horizontal Remediation Overview
 - Horizontal Directional Drilling Technology.
 - Horizontal Remediation Well (HRW) Design.
 - Applications & Benefits.
- Part 2: Horizontal Sub-Slab Mitigation & Remediation Example Projects
 - Office Building, New Jersey.
 - Catalytic Converter R&D Facility, New Jersey.
 - Former Auto Manufacturing Facility, New York.
 - Former Dry-Cleaner, California.

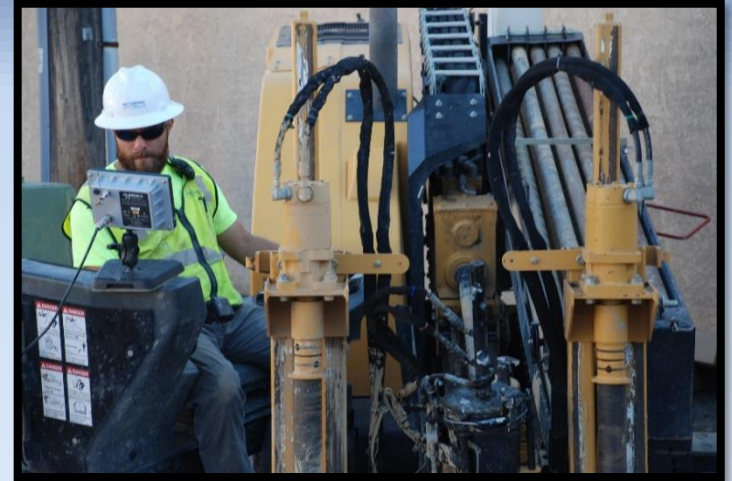


Installing first ever horizontal remediation wells (HRWs) in South Korea

Horizontal Directional Drilling (HDD) Technology

Directional Drilling Rigs

- Angled for near horizontal entry.
- Capable of depths ranging from 1 feet BGS to 100 feet BGS, (but can also drill up-hill).
- Horizontal Bore lengths of over 1,000 feet BGS.
- Steerable drill bits for horizontal and vertical adjustments during drilling.
- Track mounted for off-road mobility.
- Safety built into the design (hands free drilling).



HDD Technology (continued)

Real-Time Drill Bit Tracking Systems:

- Walk-over locators (most commonly used)
 - Depths to 50 feet BGS
 - Data relayed: depth, pitch (bit inclination), and tool-face
- Wire-line locators
 - For greater depths >50 feet BGS
 - Good for inaccessible areas (busy roads, restricted buildings, water or wetlands, etc.)
 - However, more time consuming.



Walk-over Locating System (DigiTrac F5 Falcon)



Drill bit housing with sonde

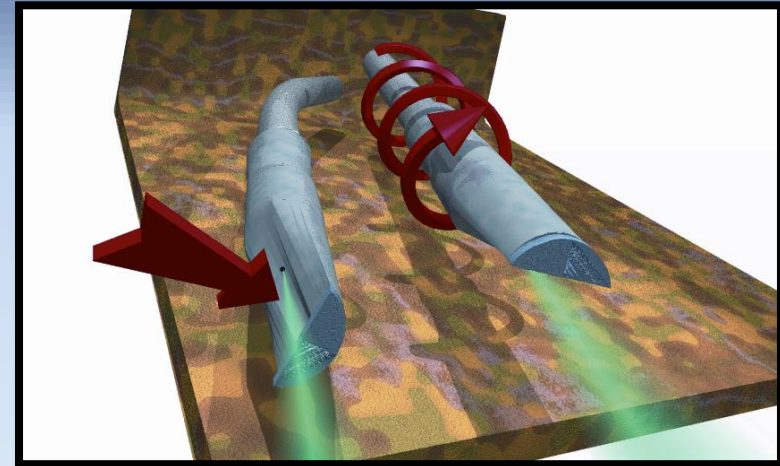


Real time tracking beneath building slab.

HDD Technology (continued)

Steerable Drill Bit:

- All directional bits have an angled face to facilitate turns.
- Forward advancement = rotation.
- Steering adjustment:
 - Tool-face of the bit is rotated into the desired position.
 - Forward thrust is applied from the rig on the drill rods.



**12:00
o'clock**



**3:00
o'clock**



**6:00
o'clock**

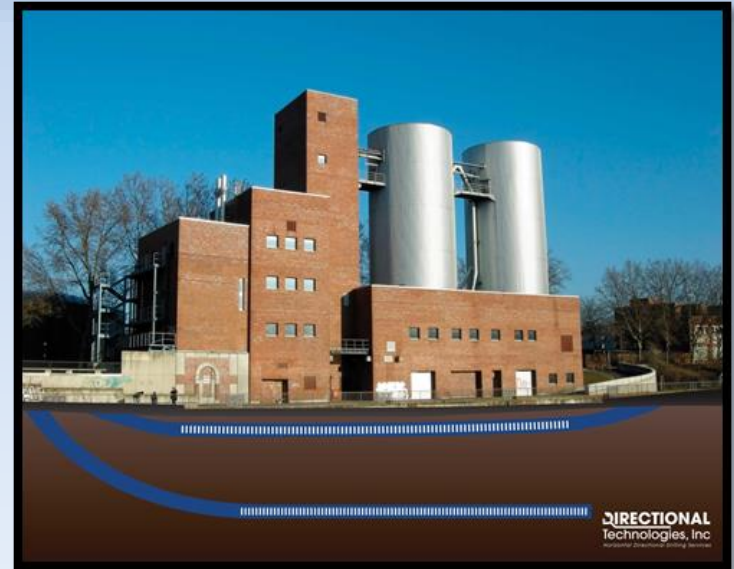


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Horizontal Remediation Well (HRW) Design

Design Considerations: Entry-Exit Wells vs. Blind Wells

- Entry-Exit Wells:
 - Two access points.
 - Larger diameter wells: 2-inch to 12-inch.
 - Easier Maintenance.
- Blind Wells (do not daylight):
 - Exit point not required.
 - More layout options.
 - Reduced total linear feet.
 - Limited to 2-inch and 3-inch diameter wells.



Drill Bit Exiting for Entry-Exit Well

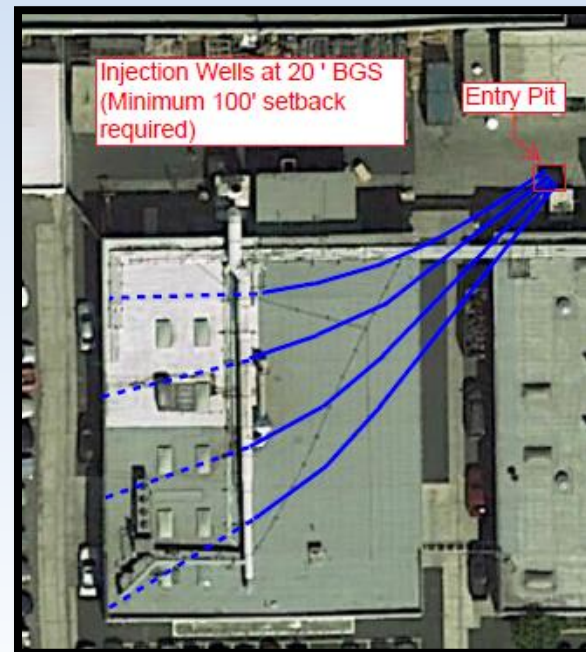
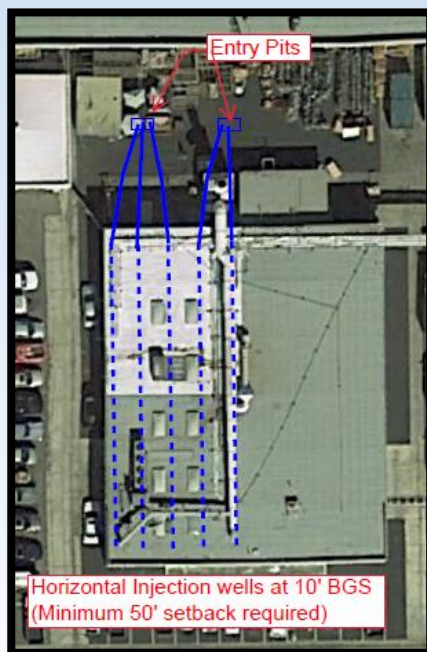
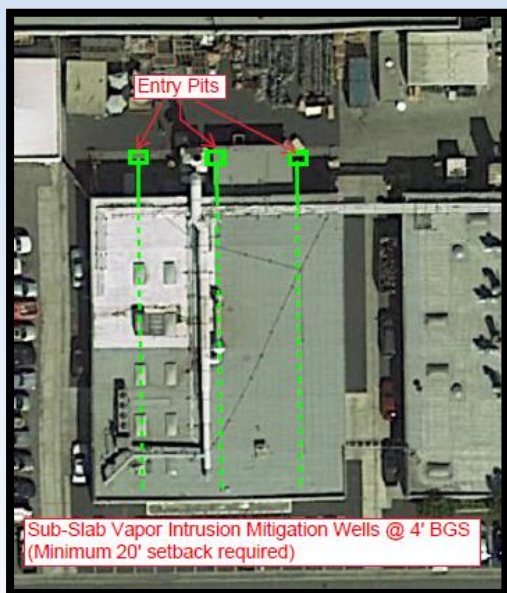


HRW Design (continued)

Design Considerations: Horizontal Well Layouts:

- Set back distance = 5:1 horizontal to vertical ratio (target depth x 5).
- Rig and Equipment Footprint: ~ 40' x 40' area.

One Site, Three HRW Layouts:



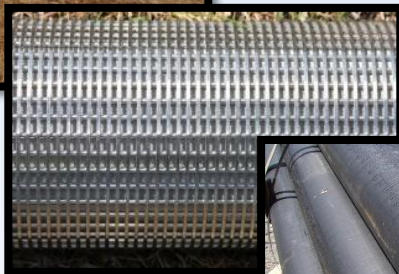
HRW Design (continued)

Design Considerations: Well Screen Engineering:

- Critical for success of the well.
- Ensures even air/water flow through entire screened section of well.
- Directional Technologies owns proprietary wells screen design software.
- Multiple types of well materials: HDPE, Schedule 80 PVC, Stainless Steel.
- Custom slot lengths, widths, and spacing for the desired application.



Water being pumped through horizontal remediation well to demonstrate uniform flow through well screen



Stainless steel well screen



HDPE Custom Slotted Well Screen

Horizontal Air Sparge Well and Porous Media Parameters

Well Flow | Well Screen | Porous Media

Well Screen Properties

Inner Diameter (inches): 3.00
Outer Diameter (inches): 3.50
Well Roughness (inches): 0.0000050
Distance Below Water Table (feet): 6.00 (Ceiling)

Screen Sections

Section	Length (feet)	Open Area (%)	Slot Width (inches)	Slot Length on Inside Wall (inches)	Soil Type	No. Slots per 10A
1	120.00	0.9571	0.120	1.50	Fine Sand	50
2 (1)	120.00	0.8269	0.120	1.50	Fine Sand	51
3 (1)	0.00	0.6342	0.012	1.50	Fine Sand	398
4 (1)	0.00	0.6446	0.012	1.50	Fine Sand	404
5 (1)	0.00	0.6467	0.012	1.50	Fine Sand	406

Section 1 = Closest to the Blow

Screen Shot of Directional Technologies' Well Screen Design Software

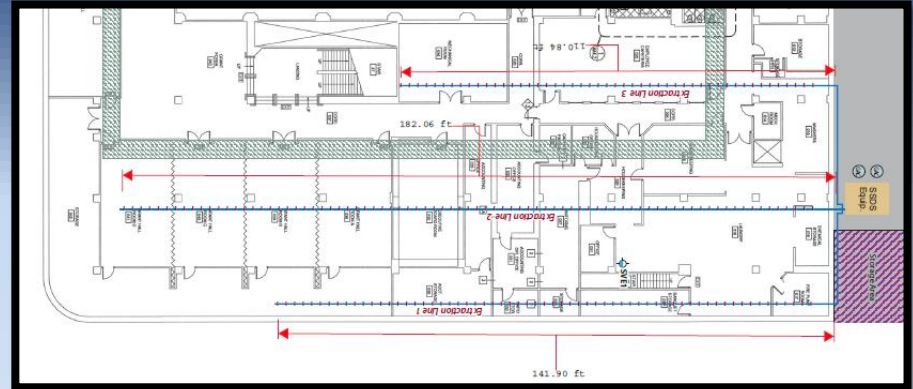
Applications of Horizontal Wells:

Remedial Applications:

- Sub-Slab Vapor Intrusion Mitigation
- Soil Vapor Extraction
- Air Sparging
- Oxygen/Ozone Sparge
- Bio-sparge
- ISCO Injection
- Dual Phase/Multiphase Extraction
- Hydraulic Control/Dewatering
- Electrical Resistance Heating (ERH)

Any vertical remediation well technology can be successfully applied horizontally

Assessment: HDD/HRW technology can be used for horizontal soil & groundwater sampling.



Horizontal Sub-Slab Vapor Mitigation Well Layout



Horizontal Hydraulic Control Well for Landfill Leachate Containment

Benefits of Horizontal Wells:

#1: Normal Business Activities Continue without Interruption.

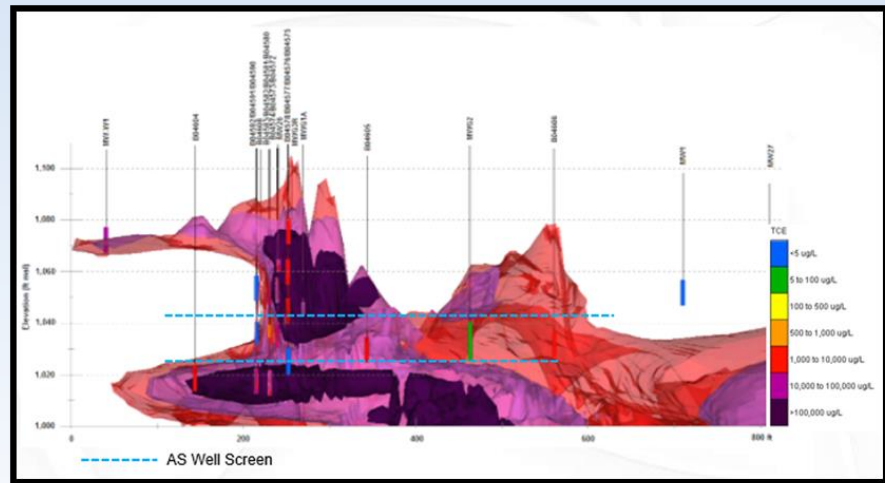
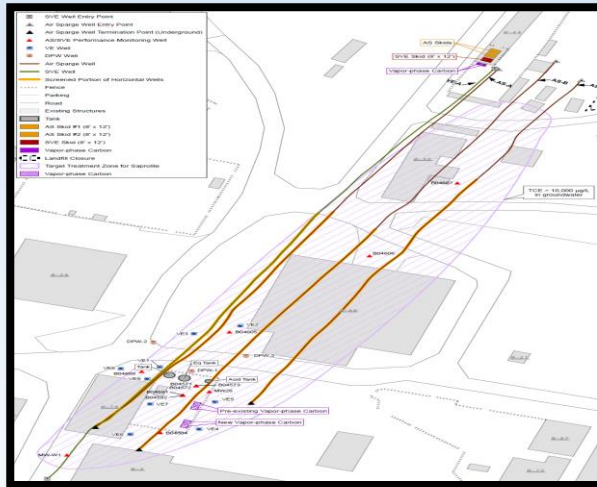
#2: Access: Horizontal directional drilling enables access beneath surface obstructions.

#3: More screen contact with planar contaminate plumes = Expedited site cleanup.

#4: Remediation of large areas: One horizontal well can take the place of multiple vertical wells within a linear path (see below example site).

#5: Safety.

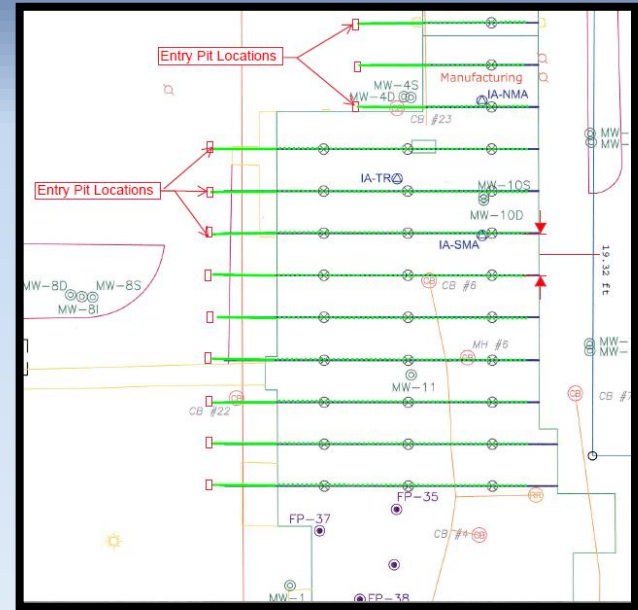
Horizontal wells: ~800 feet long, 60 feet to 80 feet deep, beneath multiple buildings.



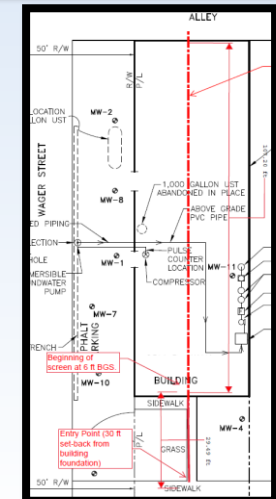
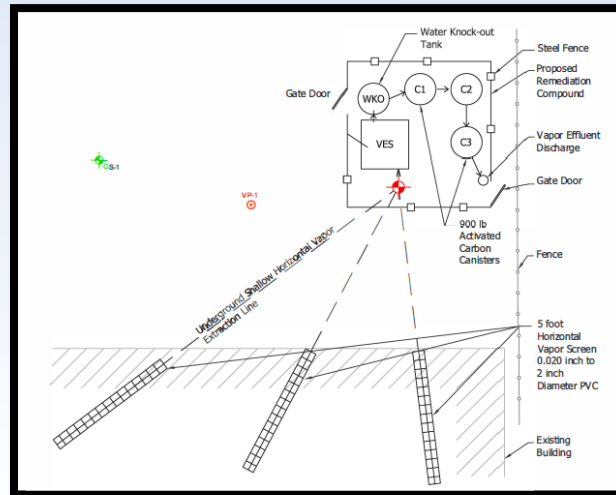
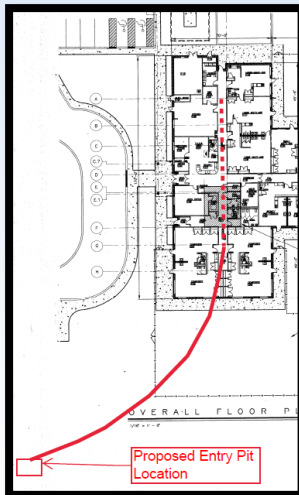
Part 2: Horizontal Sub-Slab SVE Example Projects



Installation of Horizontal Sub-Slab SVE wells directly into building footing.



Example Sub-Slab SVE Well Layouts:



Example Site # 1: Office Building, New Jersey

Example Site #1: Office Building in New Jersey

Background:

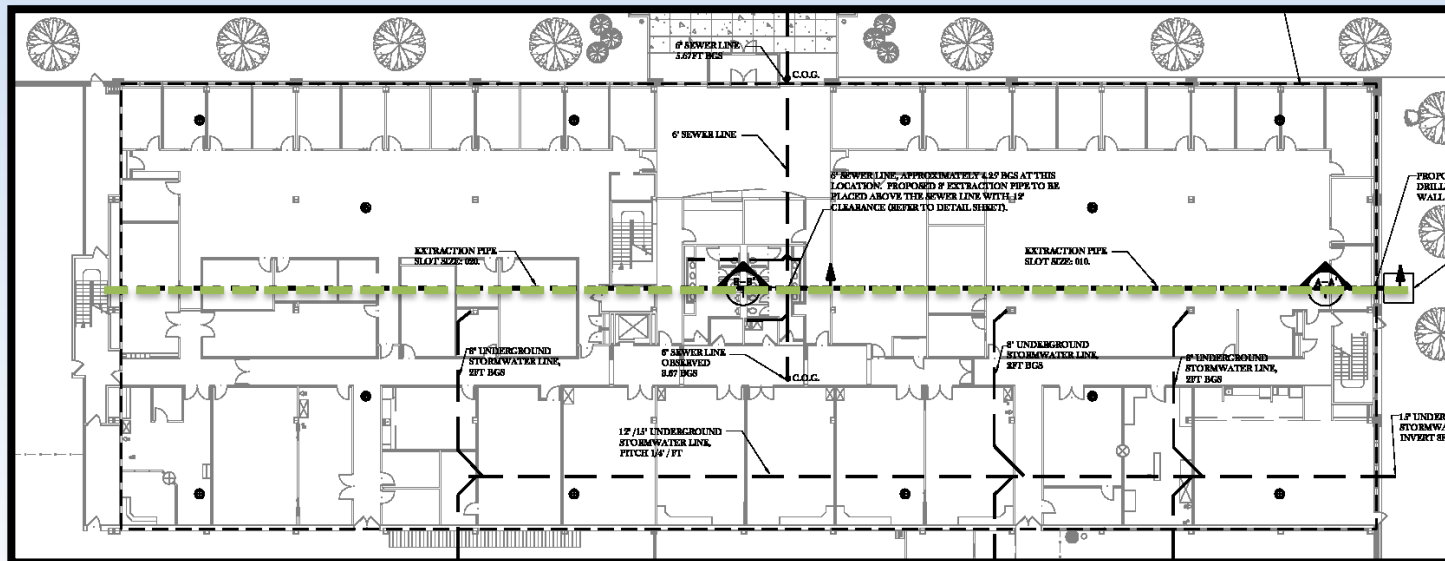
- Building owner becomes aware of VI issue.
- Structure: 300 ft X 100 ft slab-on-grade.
- Concern that the tenant will vacate.
- Design a solution that avoids business disruption to tenant.



Example Site #1: Office Building in NJ

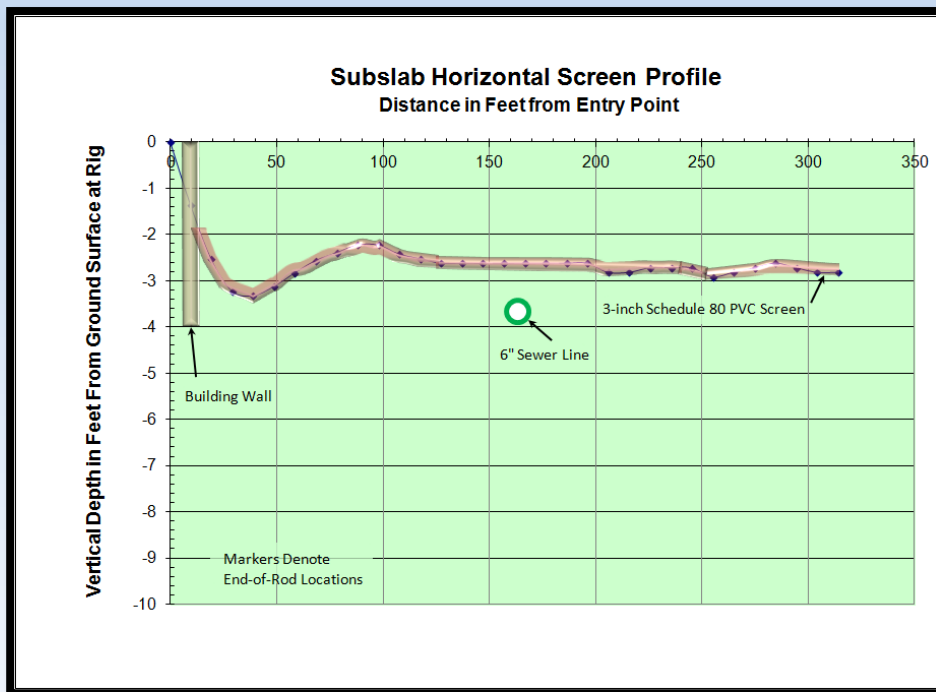
Horizontal Mitigation Approach:

- One horizontal screen installed centerline of building.
- 3-inch PVC screen is installed in a blind wellbore, with no exit point.



Example Site #1: Office Building in NJ

Sub-Slab Horizontal Screen Profile:



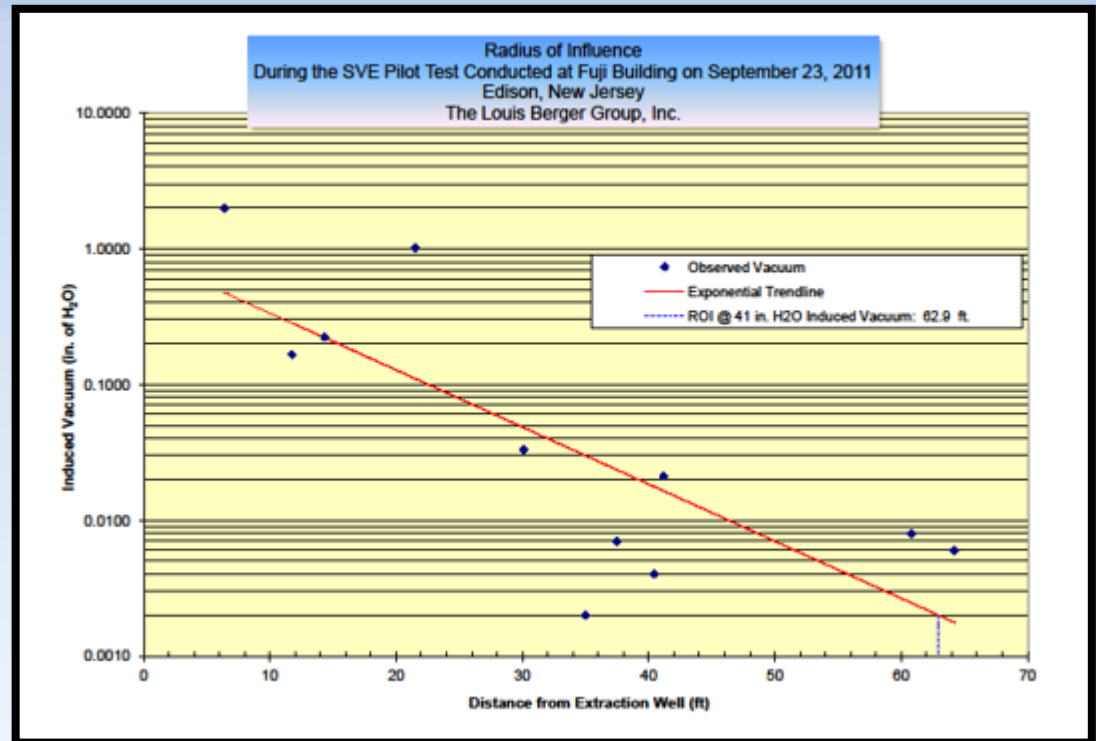
- Target Depth: 2 feet to 3 feet below slab.
- Drilled through building wall
- Installed well above 6-inch sewer line.



Example Site #1: Office Building in NJ

Results:

- Zone of influence = 60 ft from horizontal well.
- One horizontal well depressurizes entire 30,000 square ft slab



Example Site # 2: Catalytic Converter R&D Facility, New Jersey

Example Site #2: Catalytic Converter R&D Facility, New Jersey



Background:

- Leaking USTs release several thousand gallons of gasoline to the subsurface.
- 80% of gasoline mass is beneath building.
- Regulators highest concern was vapor intrusion exposure pathway.



Example Site #2: Catalytic Converter R&D Facility, New Jersey

Technical Approach:

- Horizontal subsurface sampling and characterization.
- Pilot Test.
- Horizontal air sparge/soil vapor extraction chosen as remedy.



Example Site #2: Catalytic Converter R&D Facility, New Jersey



Horizontal Remediation Well System: AS/SVE combination

- Two identical HRW-AS:
 - diameter: 4-inch
 - riser length: over 500 ft
 - screened interval: 260 ft
 - depth: 22 ft BGS; 7-9 ft beneath water table
- One HRW-SVE
 - diameter: 4-inch
 - riser length: 480 ft
 - screened interval: 240 ft
 - depth: 8 ft BGS; 7-9 ft above the water table

Example Site #2: Catalytic Converter R&D Facility, New Jersey

Remediation Results:

- 17,000 lbs. gasoline removed.
- Gasoline plume beneath building eliminated.
- Human health risk mitigated.
- NJDEP approved NFA for this site.

Footnote: another UST gasoline release occurred several years later – system reactivated, site was remediated – client removed USTs and installed aboveground storage system.

Example Site # 3: Former Auto Manufacturing Facility, New York

Example Site #3: Former Auto Manufacturing Facility, Upstate NY



Background:

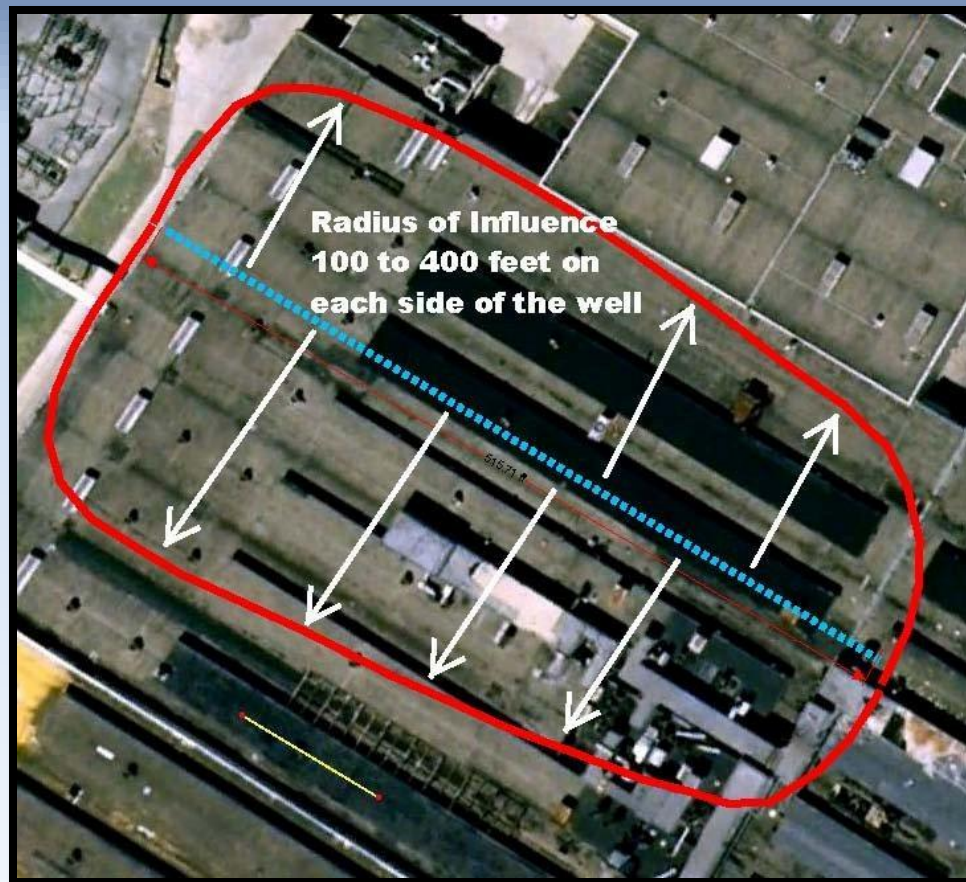
- Large building approx. 1200 ft. X 800 ft.
- Structure now used as warehouse.
- Design an active VI mitigation solution that avoids disruption to building floor slab.
- Scope:
 - install pilot well along building centerline.
 - determine radius-of-influence.
 - install additional HRWs to depressurize entire slab.

Example Site #3: Former Auto Manufacturing Facility, Upstate NY



Remediation Results:

- Vacuum point tests: pilot well's ROI encompasses entire slab.
- No additional HRWs required.
- Pilot test well successfully supplied enough influence.

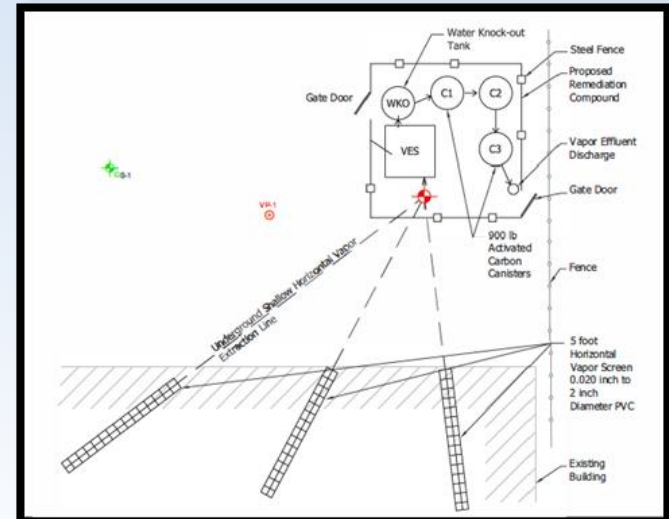
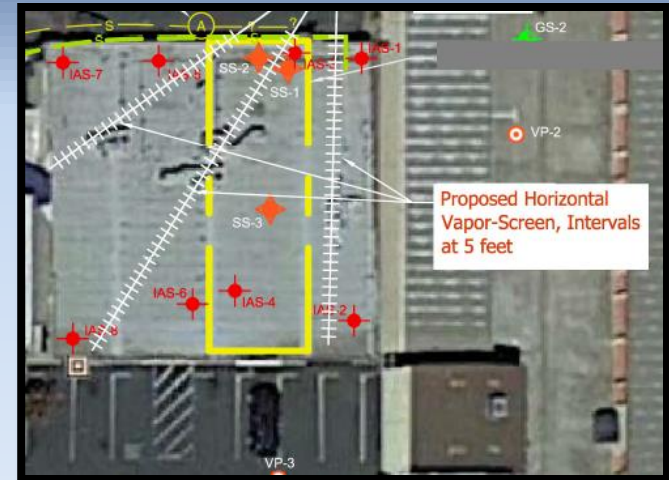


Example Site # 4: Emergency Response, Sacramento, CA

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Background:

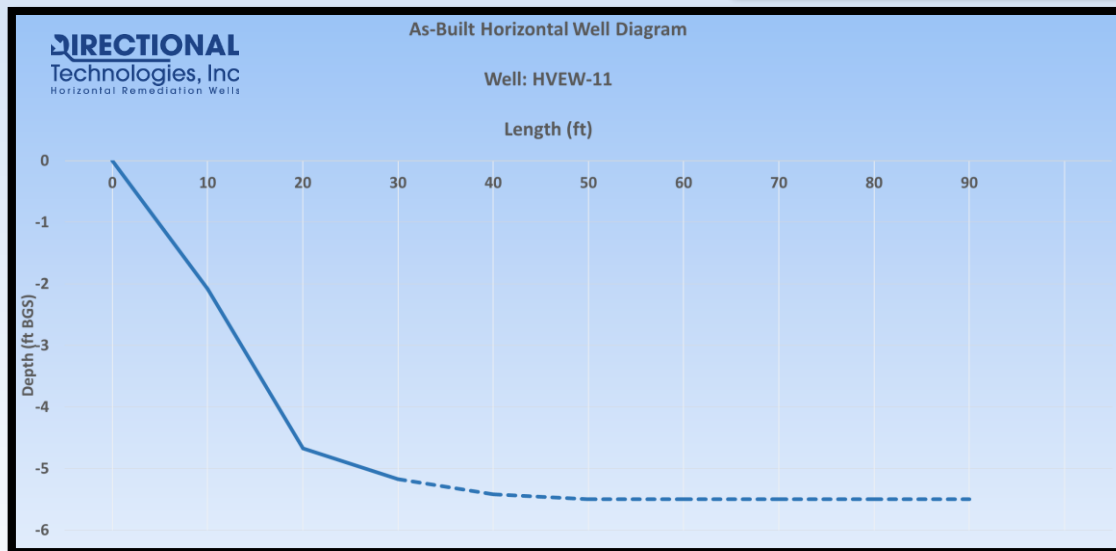
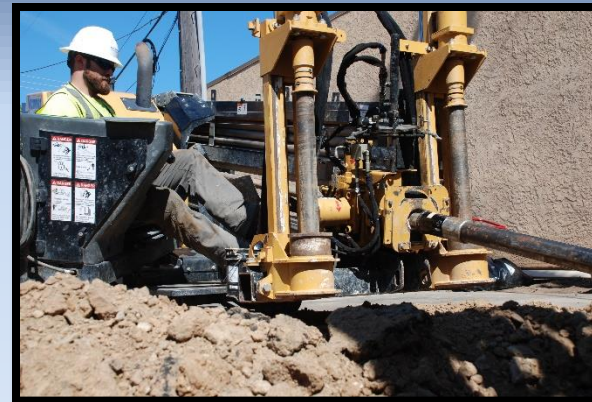
- Former dry-cleaning operation contributed to chlorinated solvent vapor intrusion.
- Tenant complaints of odors.
- State regulators threatening fines for property owner.
- Risk of losing tenants.
- Very short turnaround time required.



Example Site #4: Emergency Response, Sacramento, CA

Design and Results:

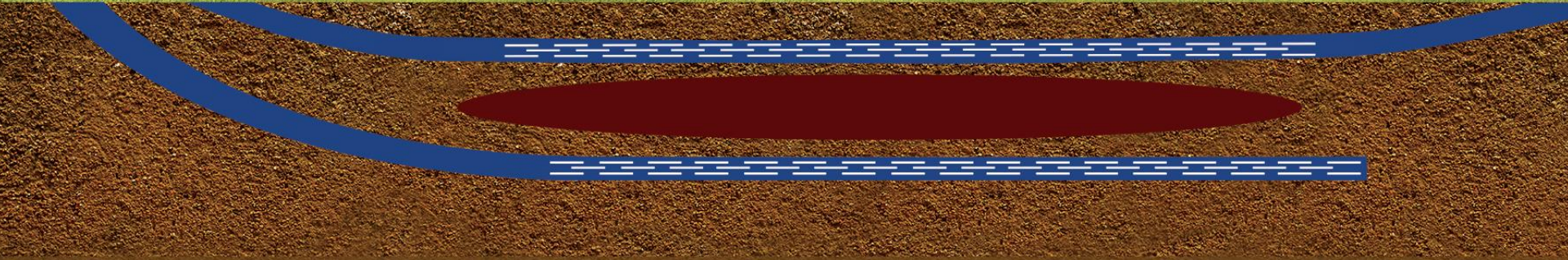
- Prioritized mobilization to site.
- Three horizontal SVE wells installed in 3 days.
- Blind installation method.
- Worked through the weekend, tenants undisturbed.



Summary



- I. Horizontal directional drilling enables sub-slab access without vertical penetration of the slab.
- II. Horizontal wells can be used for active sub-slab vapor mitigation, AND sub-slab source remediation.
- III. HDD/HRW technology does not disrupt interior operations of the buildings.
- IV. Proven results from across the country.



Questions?

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