Horizontal Directional Drilling Services

Technologies, Inc Horizontal Remediation Wells

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



Horizontal Remediation Well Technology: Access the Inaccessible to **Expedite AST and UST Site Cleanup**

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Brief Company Introduction

- Directional Technologies, Inc. is Celebrating 25th Anniversary.
- Environmental Directional Drilling and 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.



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Presentation Outline

- Part 1: Horizontal Remediation Overview
 - Horizontal Directional Drilling Technology.
 - Horizontal Remediation Well (HRW) Design.
 - Applications & Advantages.
- Part 2: Horizontal Remediation UST & AST Case Studies/Example Projects
 - BioSparge Active Bulk Petroleum Terminal -Florida.
 - 2) Horizontal Injection UST & AST Industrial Facility, New South Wales, Australia
 - 3) Horizontal Injection UST Facility, Colorado.







Horizontal Directional Drilling (HDD) Technology

HDD 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), tool-face, and temperature

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, and therefore increased costs.



Angled face for steering



Drill bit housing with sonde



Walk-over Locating System (DigiTrac F5 Falcon)



Real time tracking beneath building slab.

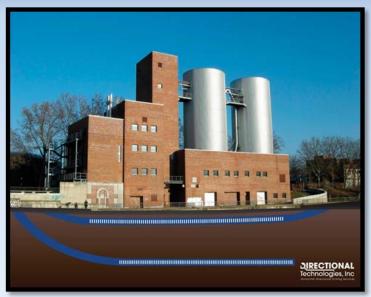
Horizontal Remediation Well (HRW) Design

Design Considerations: Entry-Exit Wells vs. Blind Wells

• Entry-Exit Wells:

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





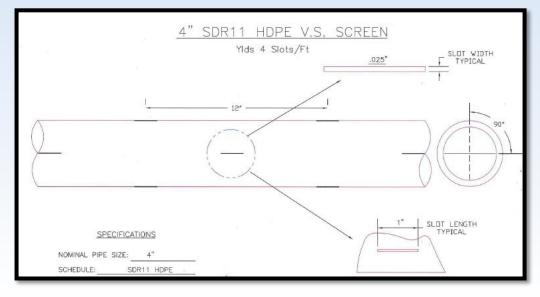


Drill Bit Exiting for Entry-Exit Well

Horizontal Well Screen Design

Design Considerations: Well Screen Engineering:

- Critical to the success of a horizontal well.
- Horizontal wells must be properly designed for the application.
- Ensures desired fluid flow through the entirety of the horizontal well.
- 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.







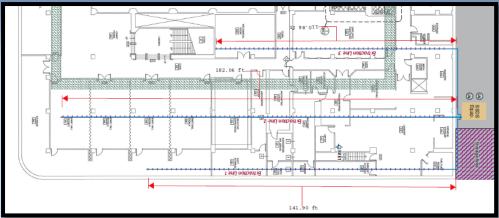
Applications of Horizontal Wells:

Remedial Applications:

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

Most vertical remediation well technology can be successfully applied horizontally

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



Horizontal Hydraulic Control Well for Landfill Leachate Containment



Horizontal Hydraulic Control Well for Landfill Leachate Containment

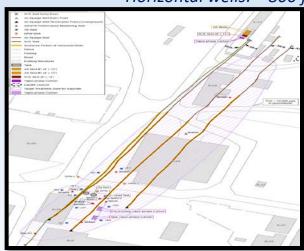


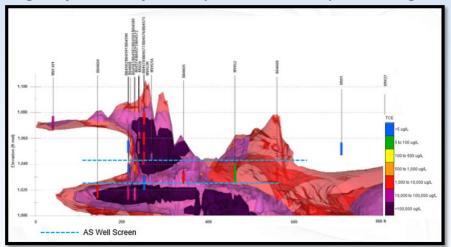
Advantages of Horizontal Wells:

- #1: Access: Horizontal directional drilling enables access beneath surface obstructions.
- #2: Normal Business Activities Continue without Interruption.
- #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 Remediation Example Projects

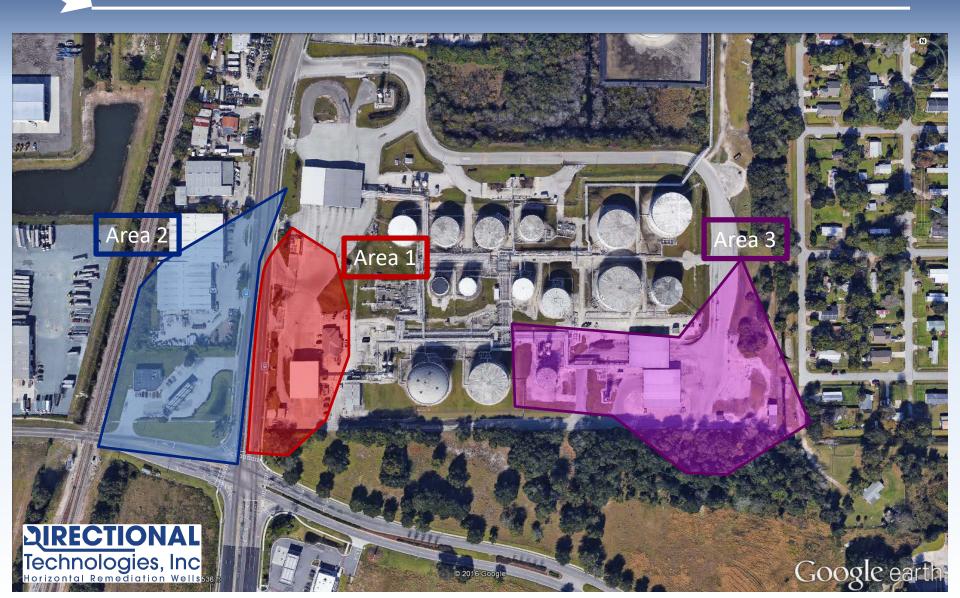
- 1) Bio-Sparge Active Bulk Petroleum Terminal, Florida.
- 2) ISCO Injection UST/AST Industrial Facility, NSW Australia
- 3) ISCO Injection UST Site Colorado.



Example Site # 1: Active Bulk Petroleum Terminal, Florida



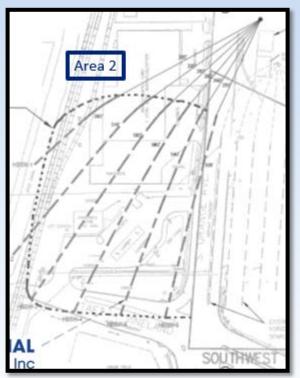
Example Site #1: Active Bulk Petroleum Terminal, Florida

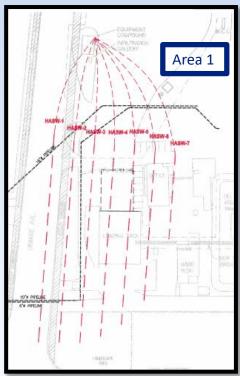


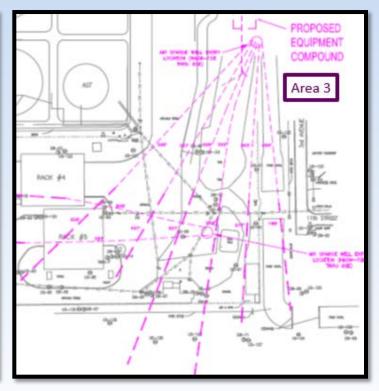
Example Site #1: Active Bulk Petroleum Terminal, Florida

Remedial Design:

- 21 Horizontal Biosparge Wells, installed blind method.
- 3-inch HDPE, screen at 35 feet BGS.

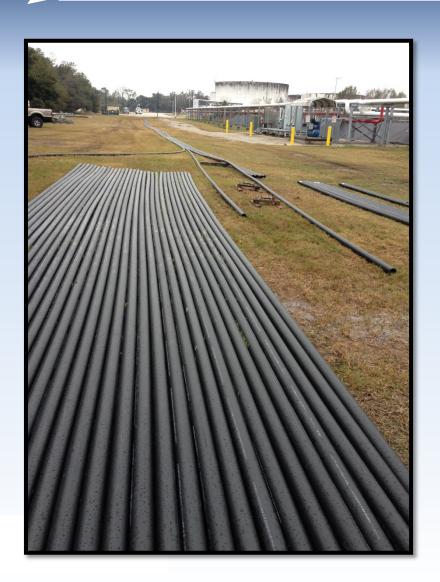








Example Site #1: Active Bulk Petroleum Terminal, Florida







Example Site #1: Active Bulk Petroleum Terminal, Florida

- Avoided disruption to on-site 24/7 operations and truck traffic.
- No loss to client revenue.
- Avoided costly restoration by entry/exit in grass.
- Wireline navigation allowed drilling under roads with no disruption to traffic from above ground locator.



Example Site # 2: ISCO Injection – AST & UST Facility Australia



Example Site #2: ISCO Injection, AST & UST Facility, NSW Australia

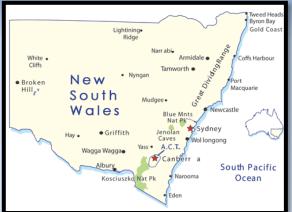
Project Background:

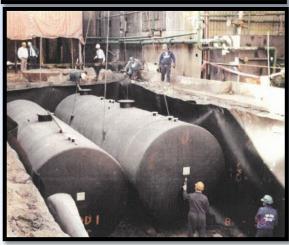
- An active chemical manufacturer in Botany Bay, New South Wales, Australia.
- Source area under manufacturing facilities and above and underground storage tanks.
- Horizontal wells were selected as the best choice to target the source.



Example Site #2: ISCO Injection, AST & UST Facility, NSW Australia











Example Site #2: ISCO Injection, AST & UST Facility, NSW Australia

APPROACH: three (3) horizontal injection wells

- The HRWs were installed via blind method.
- The starting angles of the well paths were adjusted in the field resulting in fan shaped horizontal well pattern allowing for better coverage of the plume.
- The horizontal well screens were designed for site specific remedial goals and engineered to ensure even flow distribution.



Example Site #2: ISCO Injection, AST & UST Facility, NSW Australia

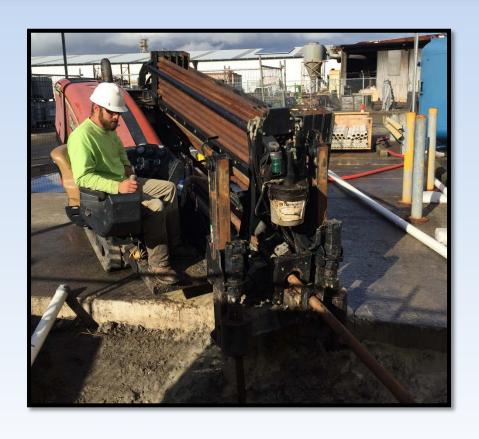






Example Site #2: ISCO Injection, AST & UST Facility, NSW Australia





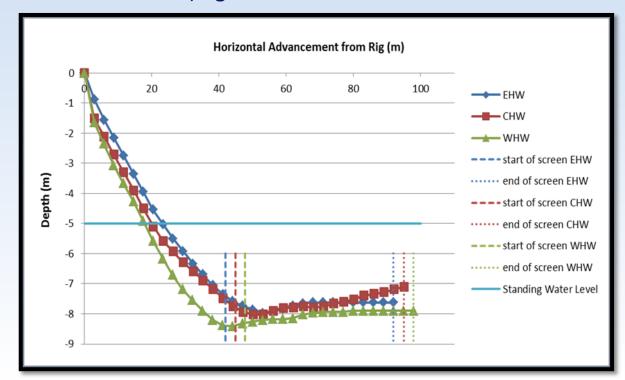




Example Site #2: ISCO Injection, AST & UST Facility, NSW Australia

Horizontal Well Design Details:

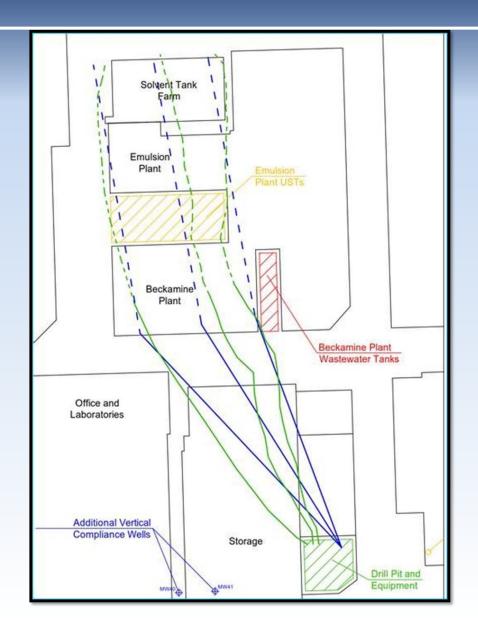
- Screen sections were at depths of approximately 8 meters (26 feet) below ground surface (bgs).
- Ensured successful injection below the groundwater table at 4.8 to 5.2 meters (15.7 feet to 17.0 feet) bgs.





Example Site #2: ISCO Injection, AST & UST Facility, NSW Australia

Horizontal Injection Well Paths Beneath the Facility





Example Site #2: ISCO Injection, AST & UST Facility, NSW Australia

- The three (3) HRWs were utilized for injection of a stabilized hydrogen peroxide and chelated ferrous sulphate combination into the saturated zone.
- The remediation system consists of two progressive cavity pumps connected to 34,000 liter (9,000 gallon) tanks
- Capable of injecting tens of thousands of liters of reagent into the subsurface over relatively short periods of time.



Example Site #2: ISCO Injection, AST & UST Facility, NSW Australia

- Start-up: September 2017
- Initial injection successfully influenced the groundwater by creating groundwater mounding of 40 centimeters (16 inches) and temperature increases observed at nearby groundwater monitoring wells.
- After only 6 months of operation, an estimated 36% of the mass in the target zone has been remediated.



Australian and American companies partnered to successfully complete this project within budget and schedule deadlines.

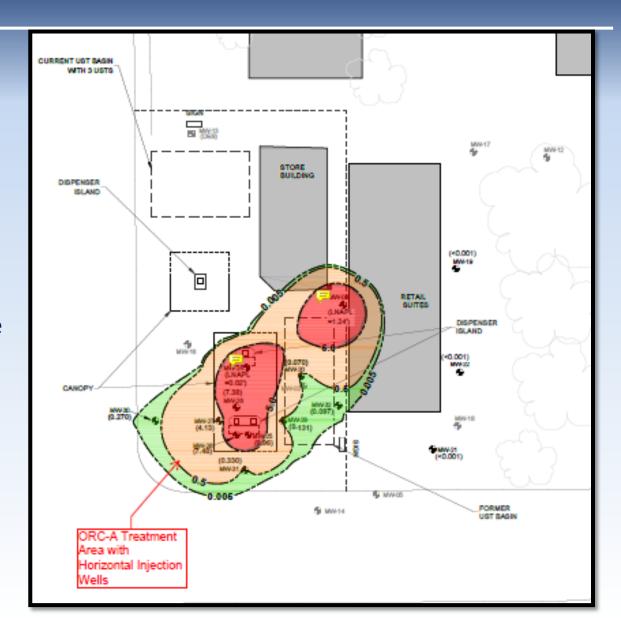






Background:

- Active Corner UST Site
- ISCO Injection required beneath active dispenser island
- Prior vertical injections and MEME events unable to fully treat plume

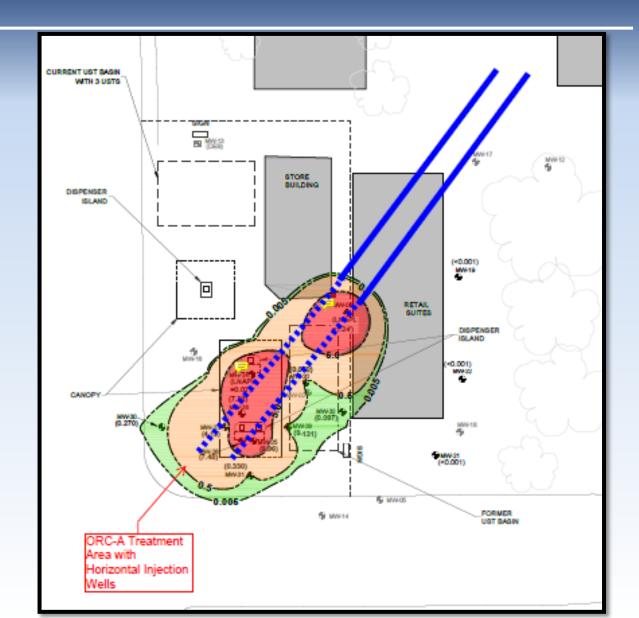






Remedial Strategy:

- Two parallel horizontal injection wells.
- 3-inch diameter.
- 21 feet BGS.





Remedial Strategy: 2 Parallel Horizontal Injection Wells, 3-inch Diameter, 21 feet BGS



Remedial Strategy: 2 Parallel Horizontal Injection Wells, 3-inch Diameter, 21 feet BGS



Remedial Strategy: 2 Parallel Horizontal Injection Wells, 3-inch Diameter, 21 feet BGS



- Post-installation water injection testing:
 - HW-01: 500 gallons 45 gpm @ 10 psi
 - HW-02: 500 gallons 45 gpm @ 13 psi
- Regenesis Remediation Services injected PetroCleanze June 2018.
- Initial Remedial Results Favorable





Summary

- Horizontal Remediation Well systems are mature technology with 25+ years of case studies, site closures, and regulatory acceptance.
- Numerous remedial applications.
- HRWs allow for a creative placement to avoid obstructions and minimize disruptions.
- HRW can lower project costs when compared to multiple vertical wells.





Horizontal Remediation Wells

Remedial Construction and Design Services



Questions?

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