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Horizontal Directional Drilling Services

Remediation with Directional Drilling beneath an Active Airport Runway

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Mike Sequino

Glenn Nicholas Iosue

Presentation Outline

- Unique conditions and lessons learned when installing horizontal remediation wells (HRWs) beneath active airfield
- HRW pilot data in demonstrating enhanced zones of influence
- Benefits in remediating petroleum releases with HRWs and variables to consider during scoping at airfield
- Case Study:
  - LNAPL and vapor phase mass was removed beneath active runway with HRWs (for AS/SVE and ISCO) to expedite closure while minimizing disruptions at airport

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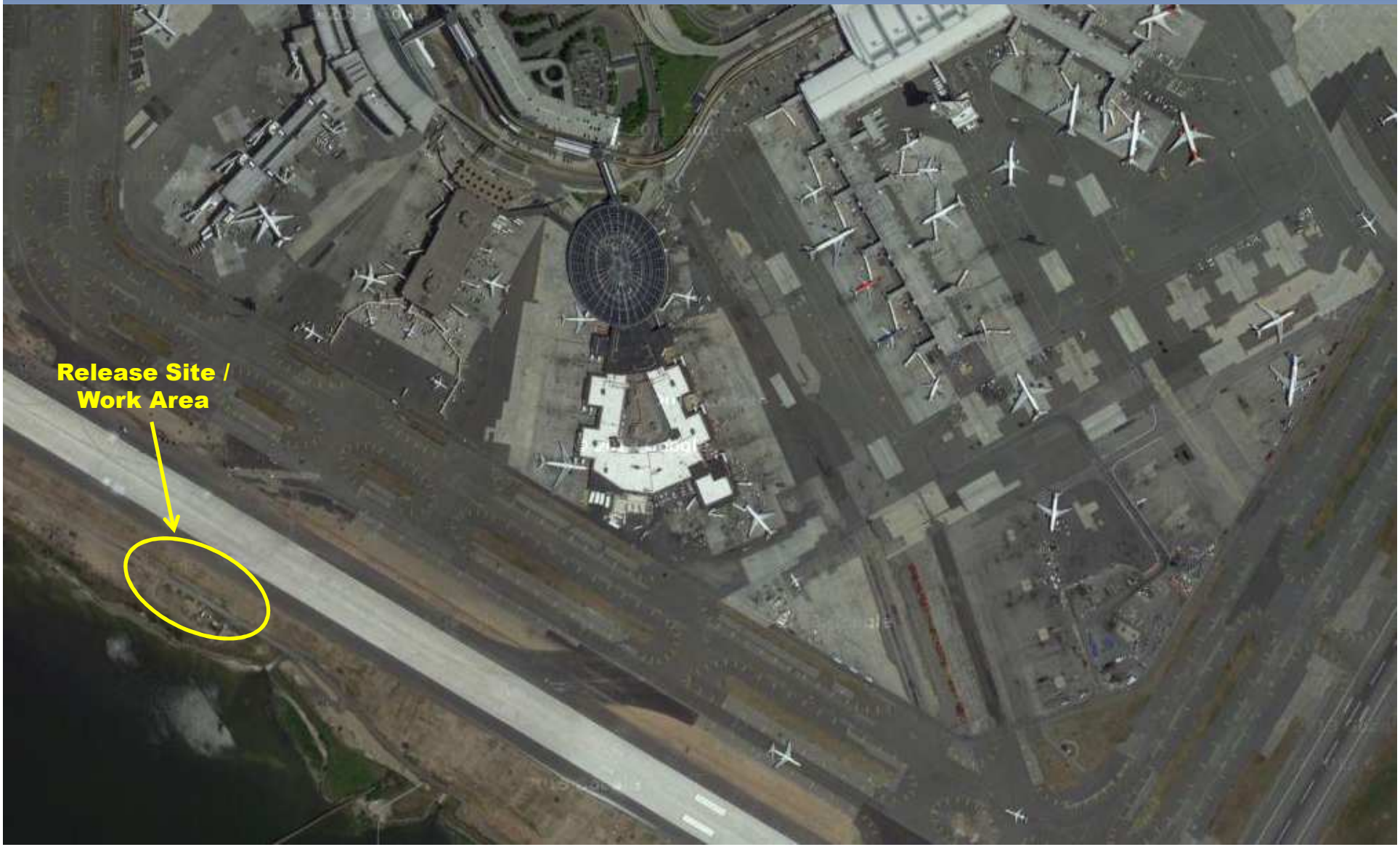
Aerial View of Airport



Aerial View of Release Site

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Mass Removal

- Air Sparge (AS) / Soil Vapor Extraction (SVE) system installed with Horizontal Remediation Wells (HRWs)
  - 130,000 gallons of LNAPL removed
  - 80,000 lbs of vapor phase mass removed
  - No measurable LNAPL after 1 year of operation
  - Groundwater concentrations reduced significantly

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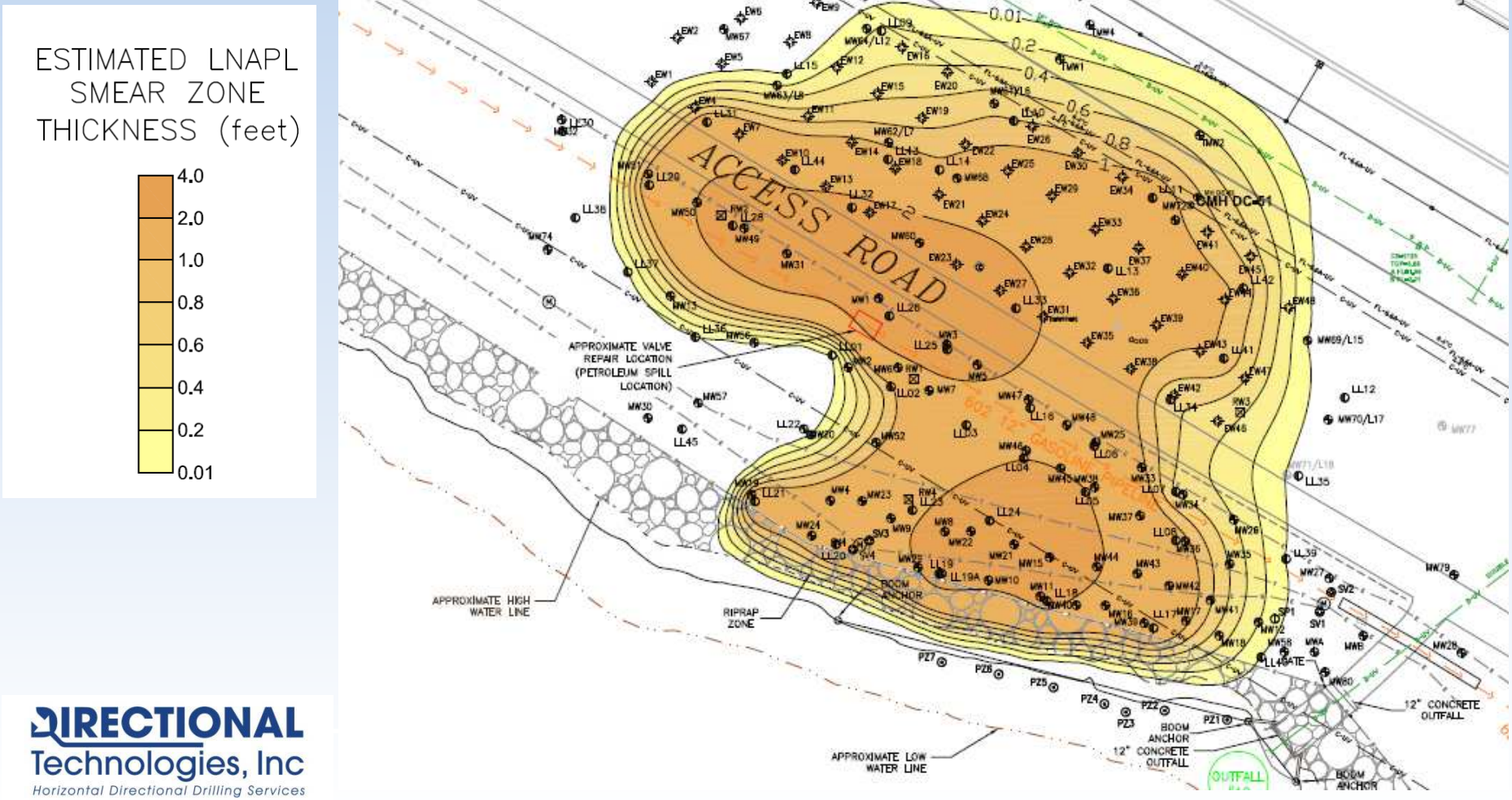
Estimated Smear Zone



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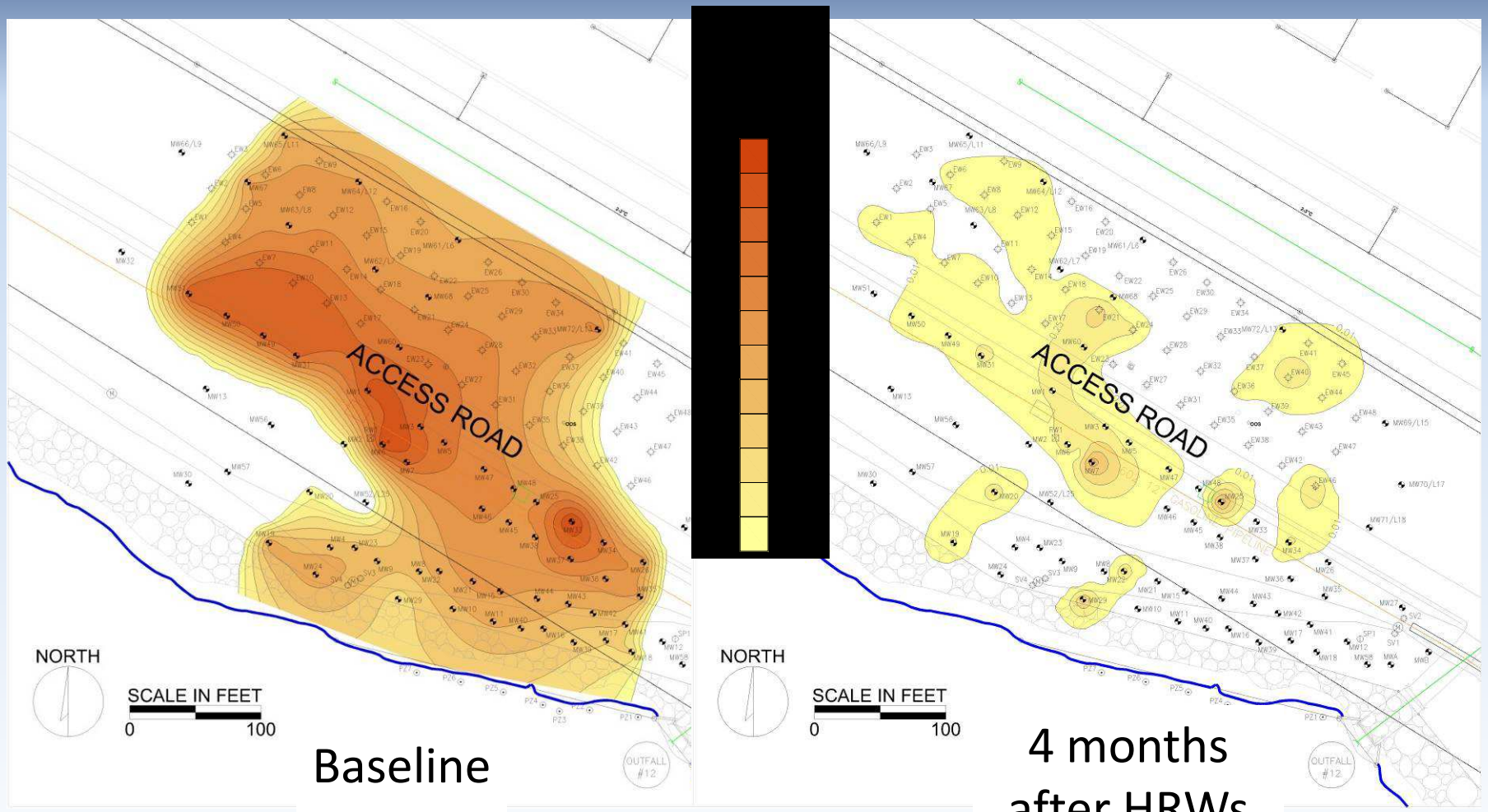
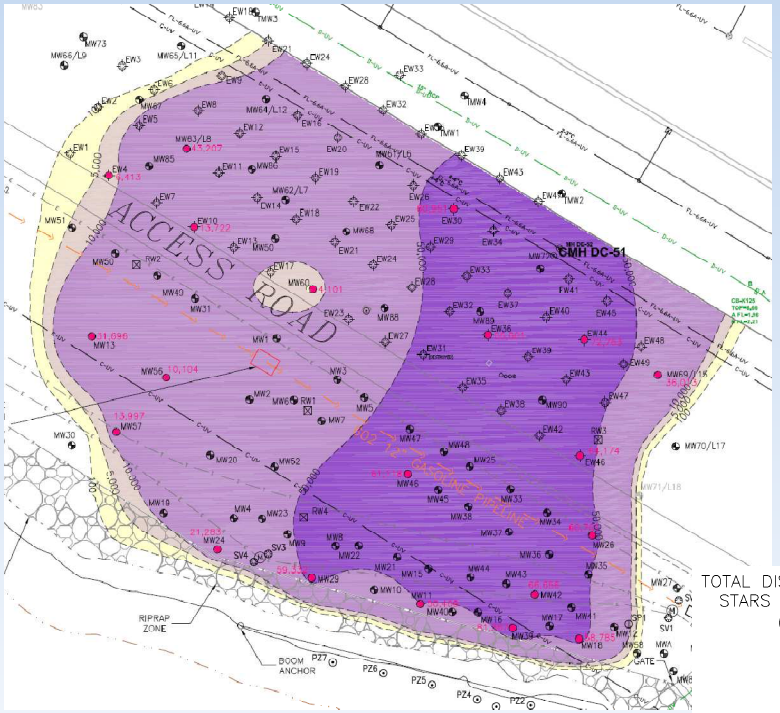
LNAPL Thickness



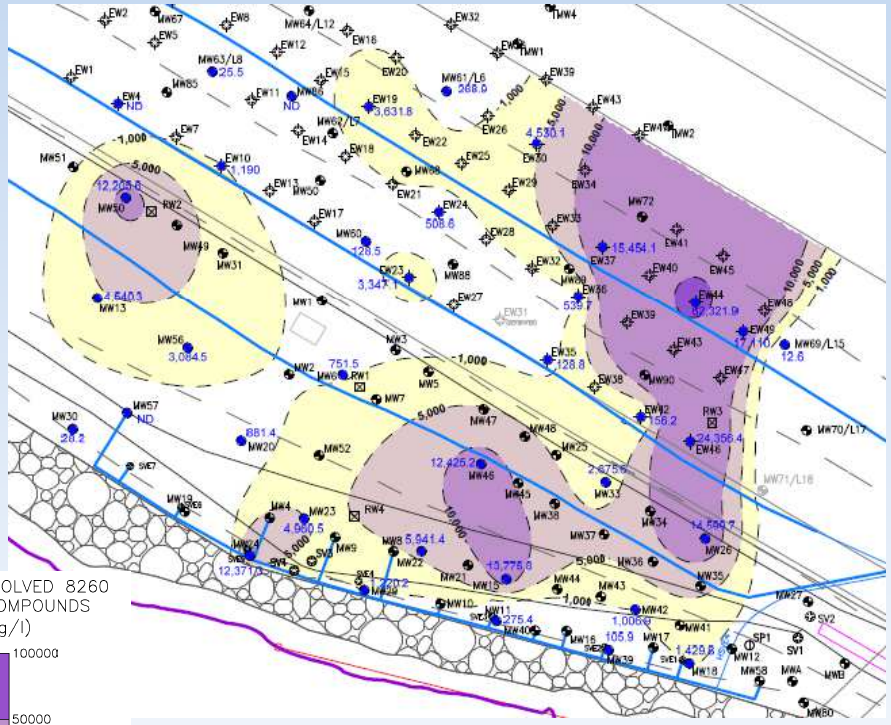
Baseline

4 months after HRWs

Total VOCs – Baseline vs. 10 Months after AS/SVE with HRWs



Baseline



TOTAL DISSOLVED 8260 STARS COMPOUNDS (µg/l)

100000
50000
10000
5000
1000

10 months after AS/SVE with HRWs

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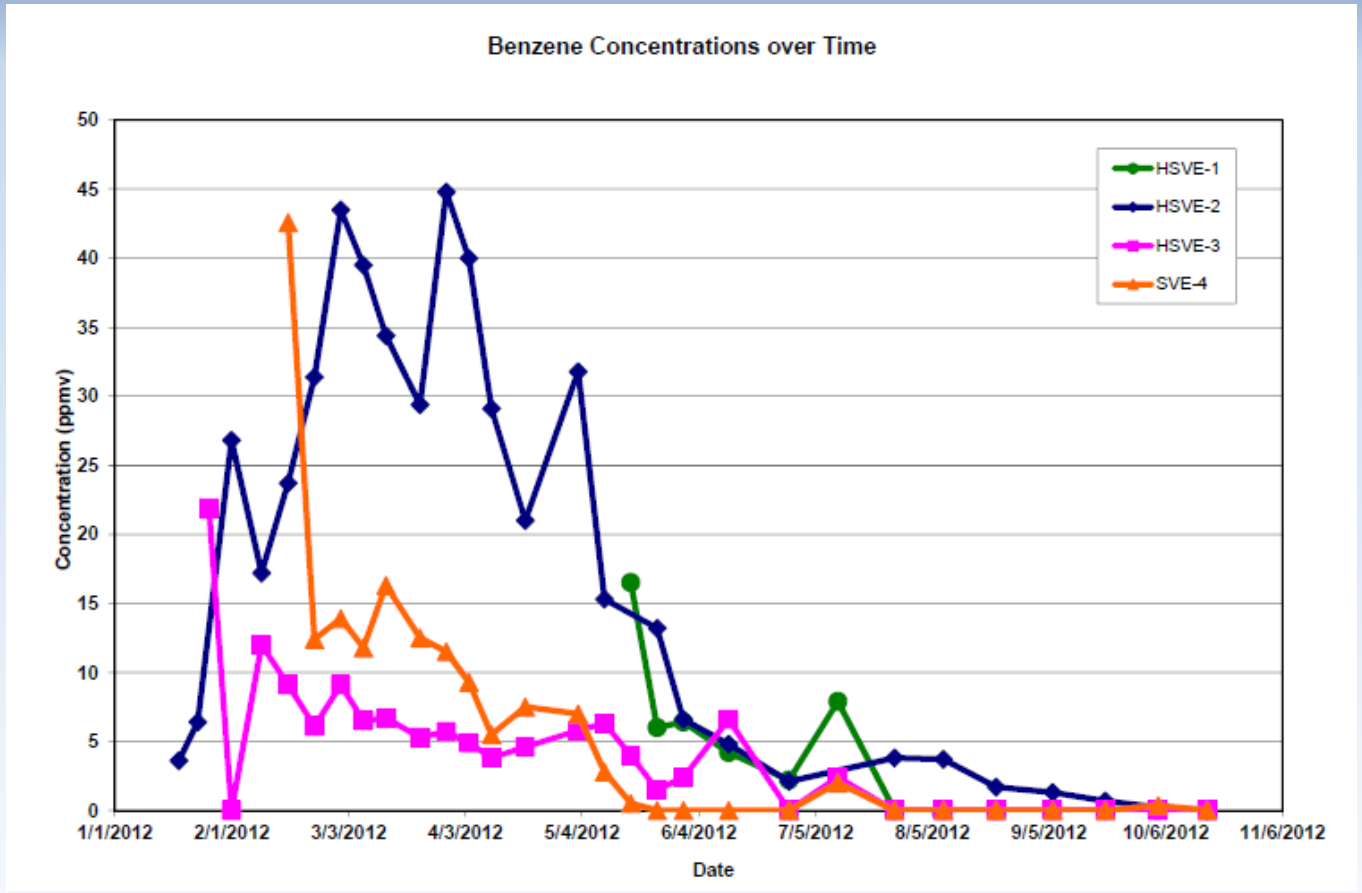
Concentration Reductions AS/SVE with HRWs



– Baseline vs. 10 Months after HRWs

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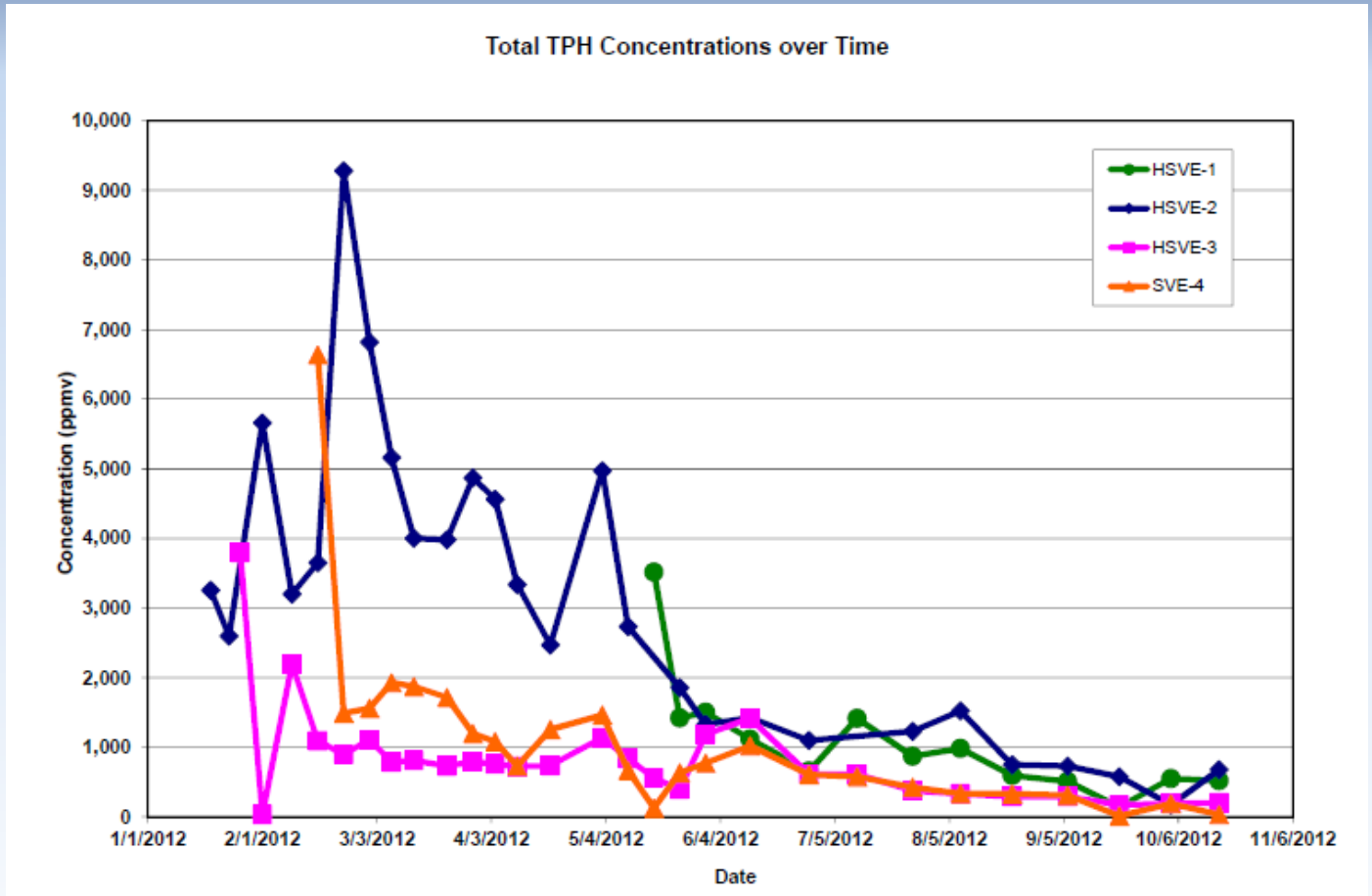
Concentration Reductions AS/SVE with HRWs



– Baseline vs. 10 Months after HRWs

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ISCO Implementation

- In-Situ Chemical Oxidation (ISCO) Implementation with horizontal Soil Vapor Extraction (SVE)
- After shutting off AS/SVE system, ISCO with SVE was implemented at locations exhibiting total STARS VOC concentrations above 5,000 ug/L
- ISCO event included 24 existing monitoring wells and 3 new injection wells
- 108,000 gallons of 10% hydrogen peroxide (H_2O_2)
- 4,000 gallons H_2O_2 at each of 27 injection wells

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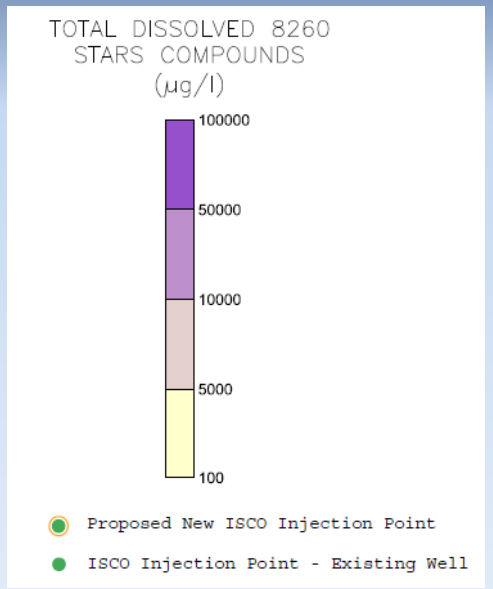
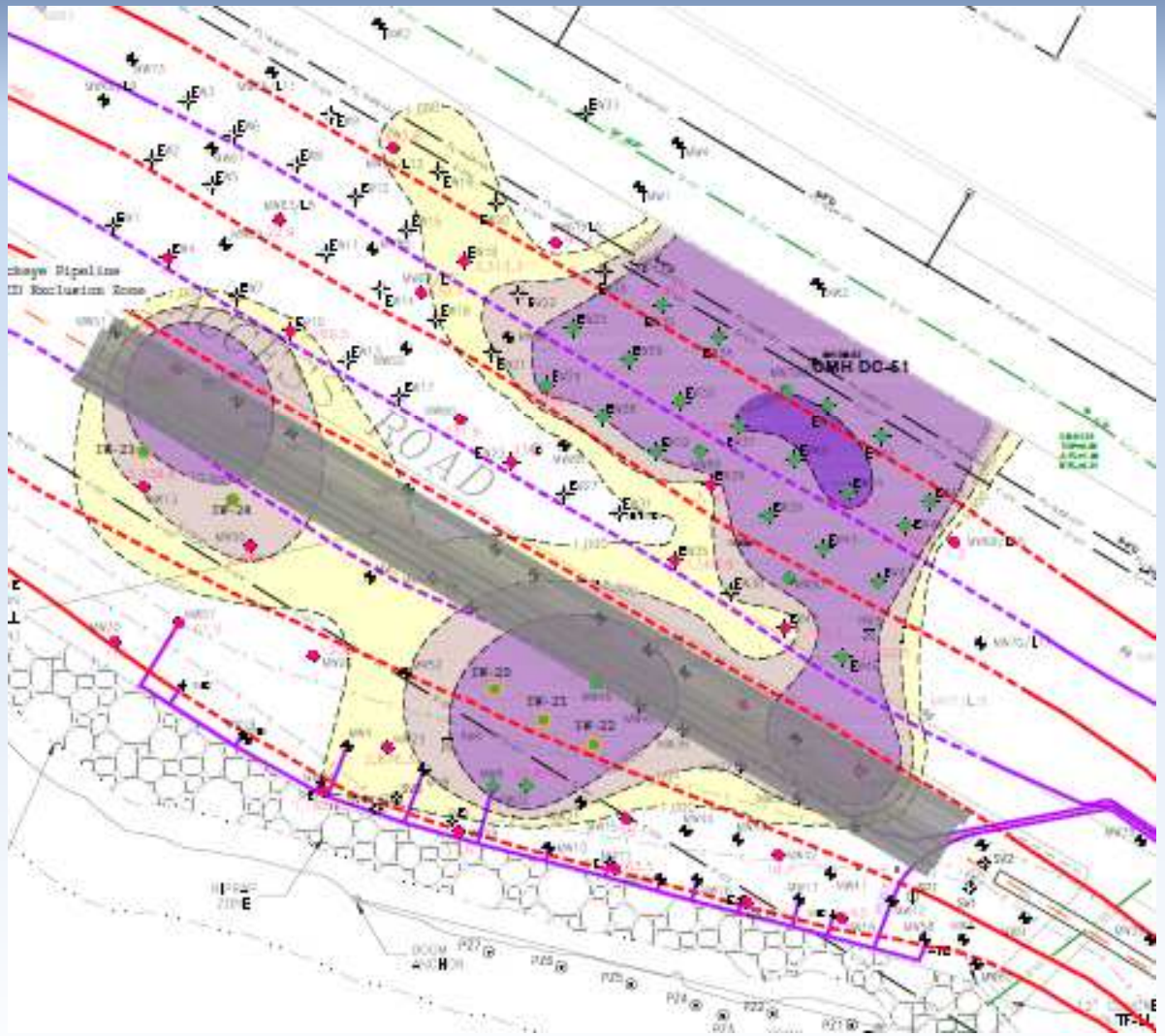
Proposed ISCO Event





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ISCO Schedule

- Day 1: Begin ISCO equipment mobilization
- Day 4: Deactivate AS/SVE system to prepare for ISCO
- Day 7: Begin AS/SVE equipment demobilization
- Days 7-18: Begin 27 well ISCO event
- Days 19-34: Shut down site operations for holiday
- Days 35-46: Finish 27 well ISCO event, demobilize remediation equipment
- Days 47 to 49: Post-ISCO groundwater sampling

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ISCO Assumptions

- Injections during day

  [*Limited duration with changing flight patterns*]

- No night work
- Unrestricted access to entire site for injections
- Storage of tanks and chemicals south of access road during injection activities
- Access to FAA runway lights for sampling

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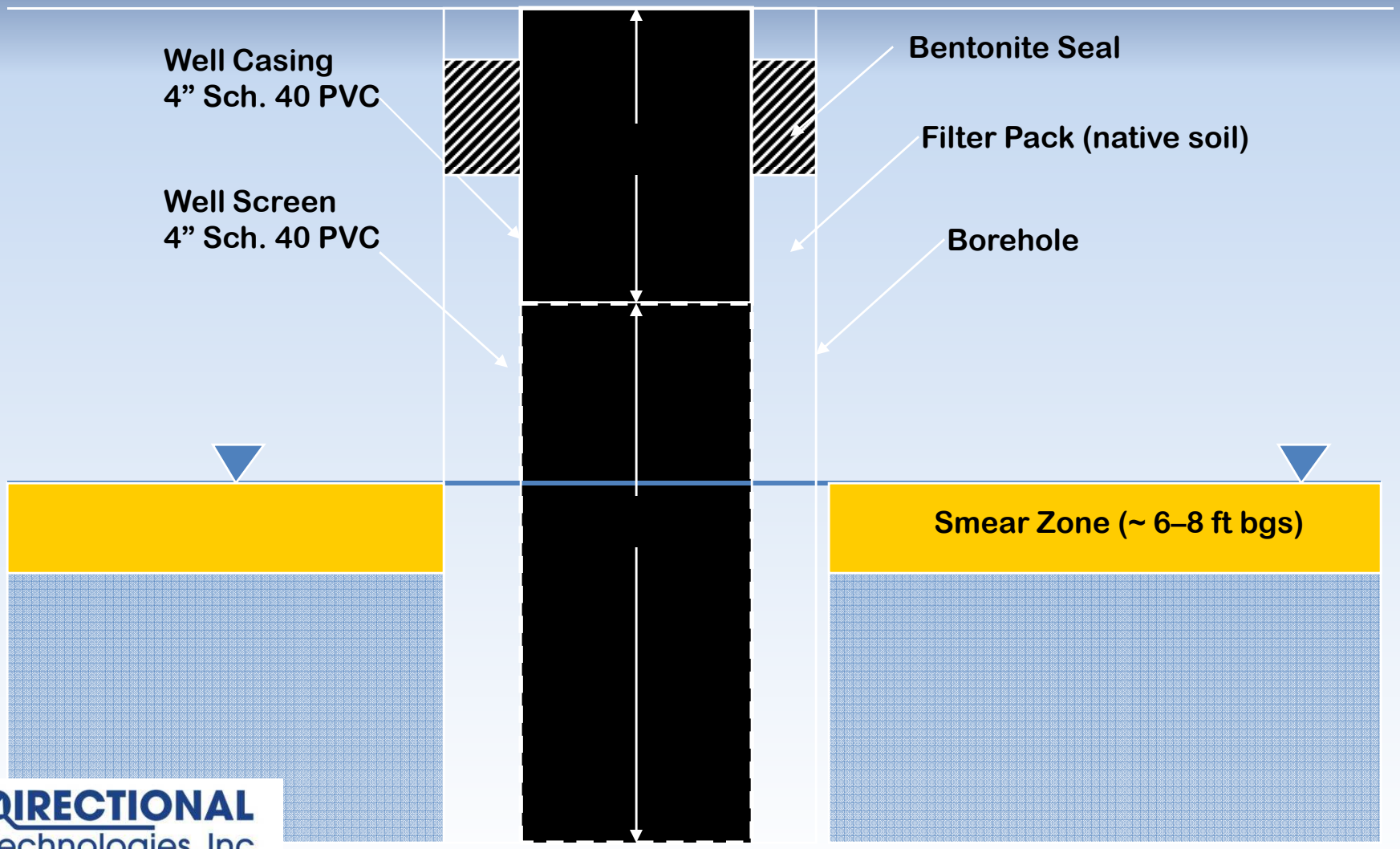
Typical Injection Well



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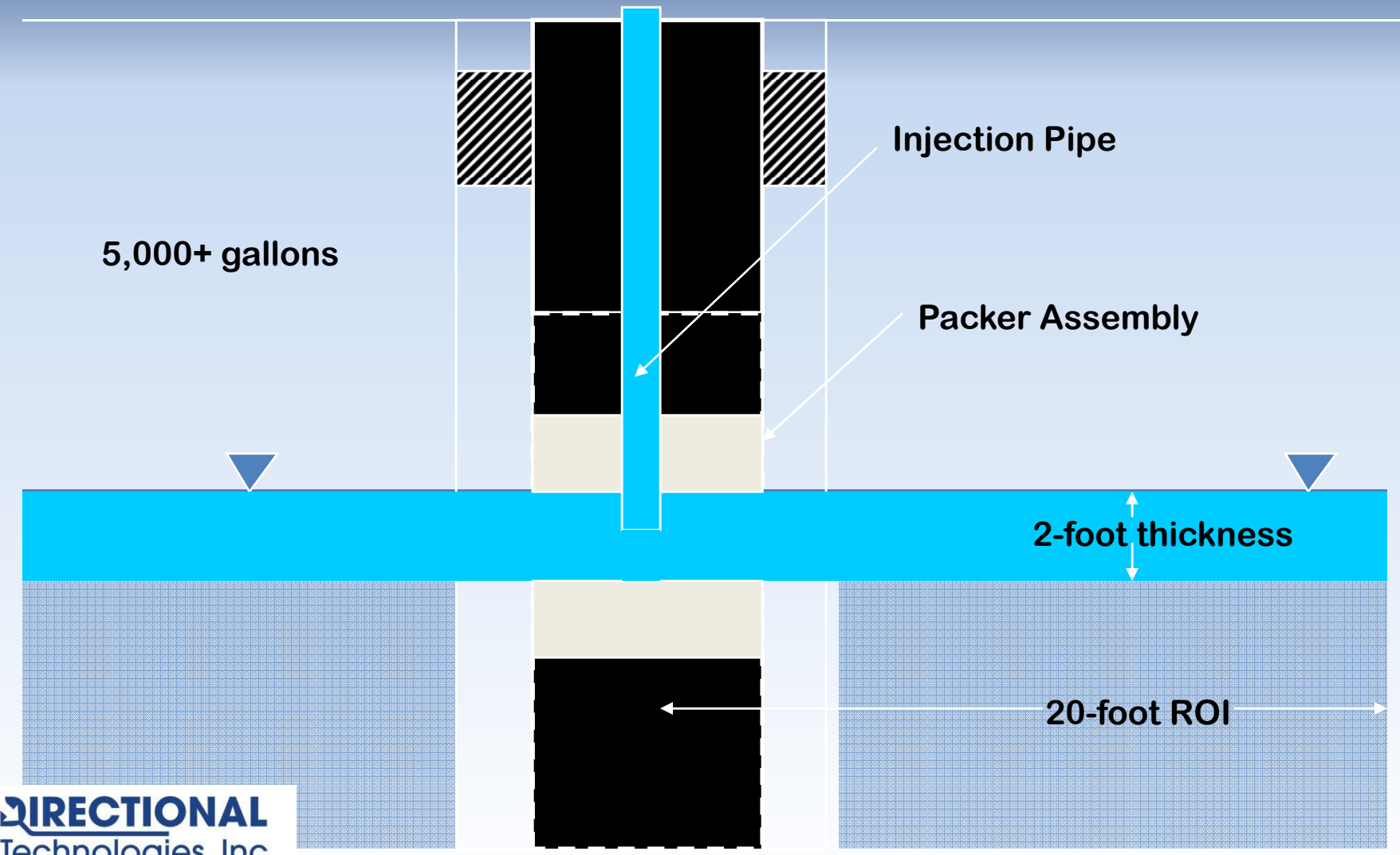
Oxidant Flow Path



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Pre-Planning ISCO at Airport

Temporary horizontal SVE System for ISCO at Airport

1. Identification of underground utilities in ISCO Area
   A. Review existing documents
   B. Identify utilities using knowledge of site
   C. Review by Professional Engineer
   D. Verify location identified utilities relative to ISCO injection wells (field inspection)
2. Runway Light Power Conduit Protection Plan
   A. As-built drawing review
   B. Authorization to sample and implement protective measures
   C. Abatement plan preparation (pressurization with ambient air)
   D. Establish action levels for VOC and oxygen concentrations

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Pre-Planning ISCO at Airport

Temporary horizontal SVE System for ISCO at Airport (cont'd)

3. Match Injection Wells with Wells to Use as SVE Points
   A. Risk mitigation and proximity
   B. Establish minimum flow rate and vacuum for SVE
   C. Identify all monitoring locations to ensure sufficient SVE
4. Off-Gas Treatment Requirements
   A. Flow rate
   B. Estimate VOC mass rate for sizing
   C. Design VGAC units
   D. Water flooding system for VGAC
   E. Temperature monitoring (thermocouples)

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Pre-Planning ISCO at Airport

Temporary horizontal SVE System for ISCO at Airport (cont'd)

5. Monitoring Plan for horizontal SVE System
   A. VOCs with PID and LEL
   B. Benzene Draeger tubes for compliance monitoring
   C. Oxygen and Temperature
   D. Establish action levels and limits for parameters
6. Monitoring Plan for Horizontal and Vertical Wells
   A. VOC headspace with PID and LEL
   B. Oxygen headspace
   C. Vacuum
   D. Groundwater Temperature
   E. Establish action levels and limits for parameters

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Grounding of HRWs

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Hazard Identification

1. Identify all possible modes of failure
2. Establish monitoring plan for each risk factor
3. Prevention plan for each risk failure
4. Prepare response plan for each failure/risk factor

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Conclusion

- HRWs can overcome the challenges and unique conditions beneath an active airfield
- Enhanced zone of influence with HRWS beneath airport runways
- HRWs provide rapid site closure in remediation petroleum releases
- **No Flight Delays**= no disruption to airport operations when using HRWs

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Horizontal Remediation Wells

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

Questions?

Founded in 1992, Directional Technologies, Inc. has installed over 1,000 horizontal remediation wells thru out the world.

Corporate Headquarters in Wallingford, CT
Branches offices in Philadelphia, PA; Ashby, MA; Tallahassee, FL

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www.directionaltech.com | mike@directionaltech.com