

High Resolution Site Characterization (HRSC) to Treatment with One Tool

Presented by:



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Presentation Outline

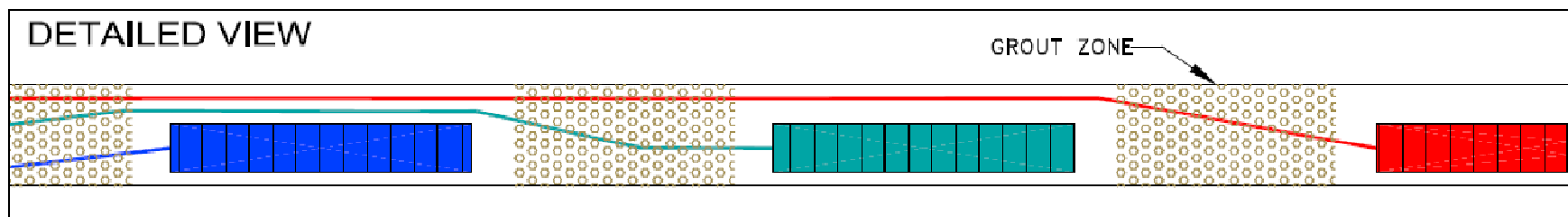
- The Tool Explained
- Horizontal Concepts
 - A Major Problem Solved – Data Gaps
 - A Major Efficiency Gained More Plume Contact
- Process of Installation
- Case Study
- The Cost Concepts

One Tool

- Vertebrae™ Well System

A Multi Function, Multi Well System

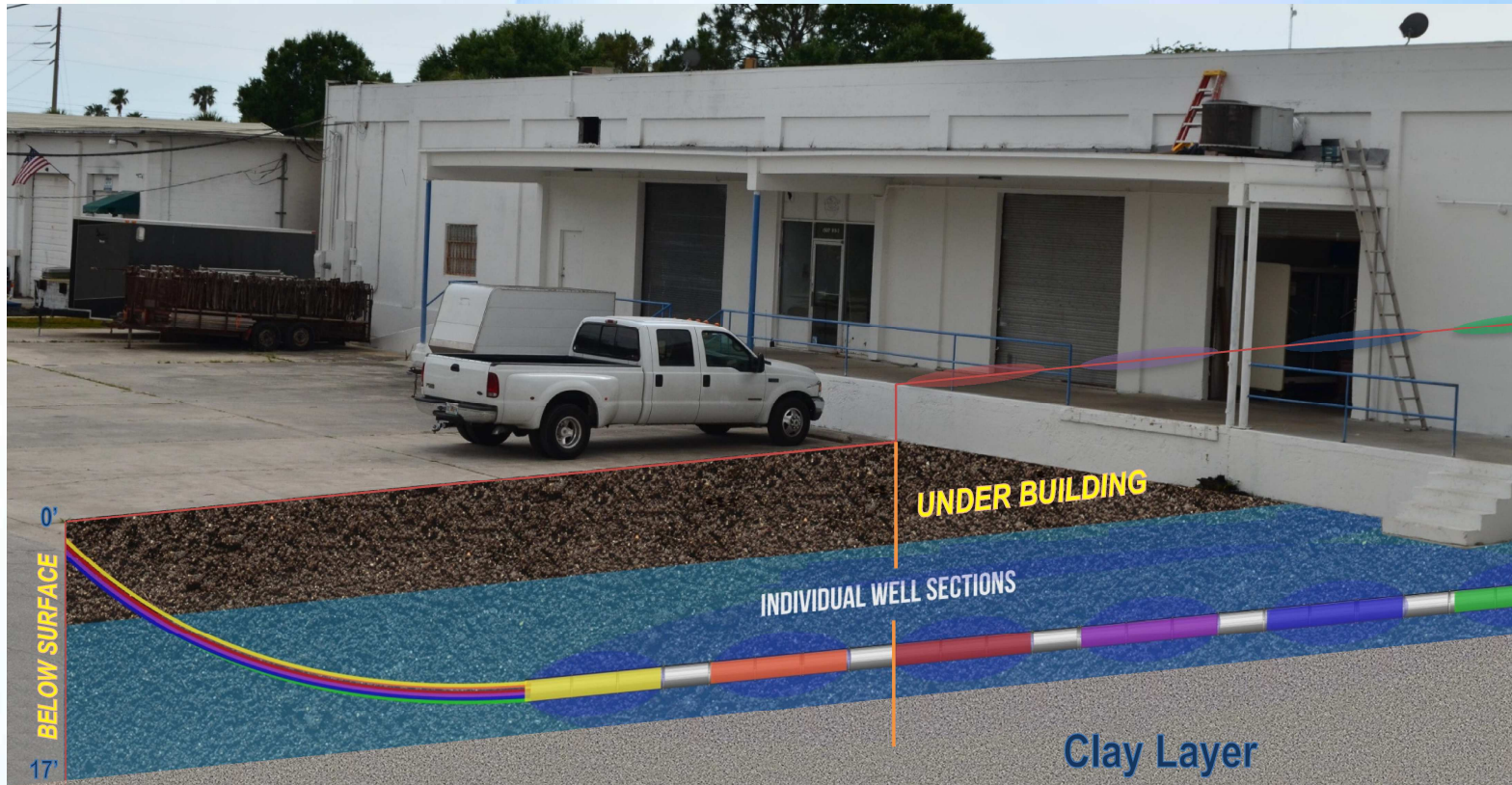
- A segmented and isolated set of permanent subsurface wells oriented horizontally that operate as traditional wells.
- Engineered Variables
 - Number of screened segments,
 - Length of screened sections and intervals





Vertebrae™

- A Vertebrae™ is a device installed by Horizontal Directional Drilling (HDD) with multiple segmented and **isolated screens** providing **individual control**.





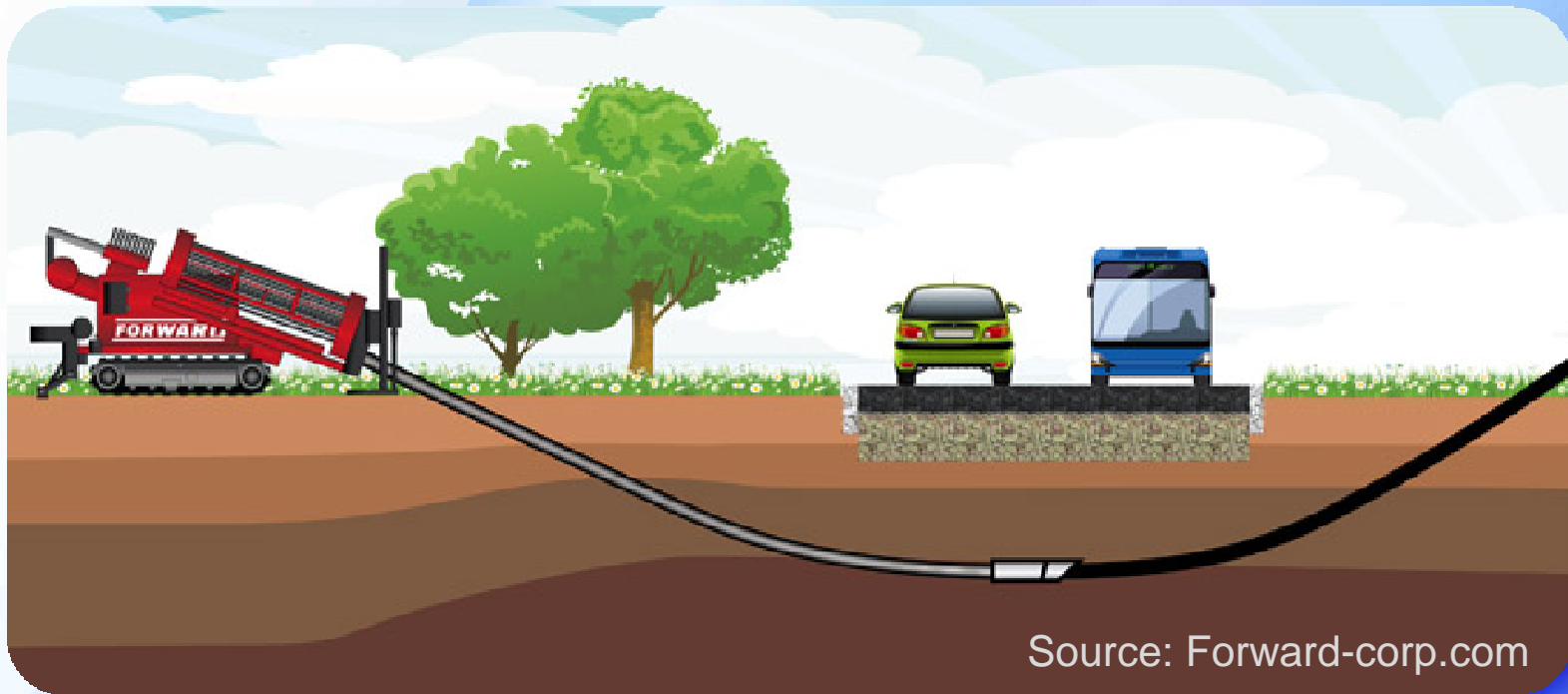
Vertebrae™

- Originally designed to aid with treatment strategies, Vertebrae™ can be used for sampling.
- The drilling methodology allows sample density flexibility.
- The drilling methodology solves a common major problem of data gaps.
- Treatment is more effective due to more plume cross sectional contact and control.



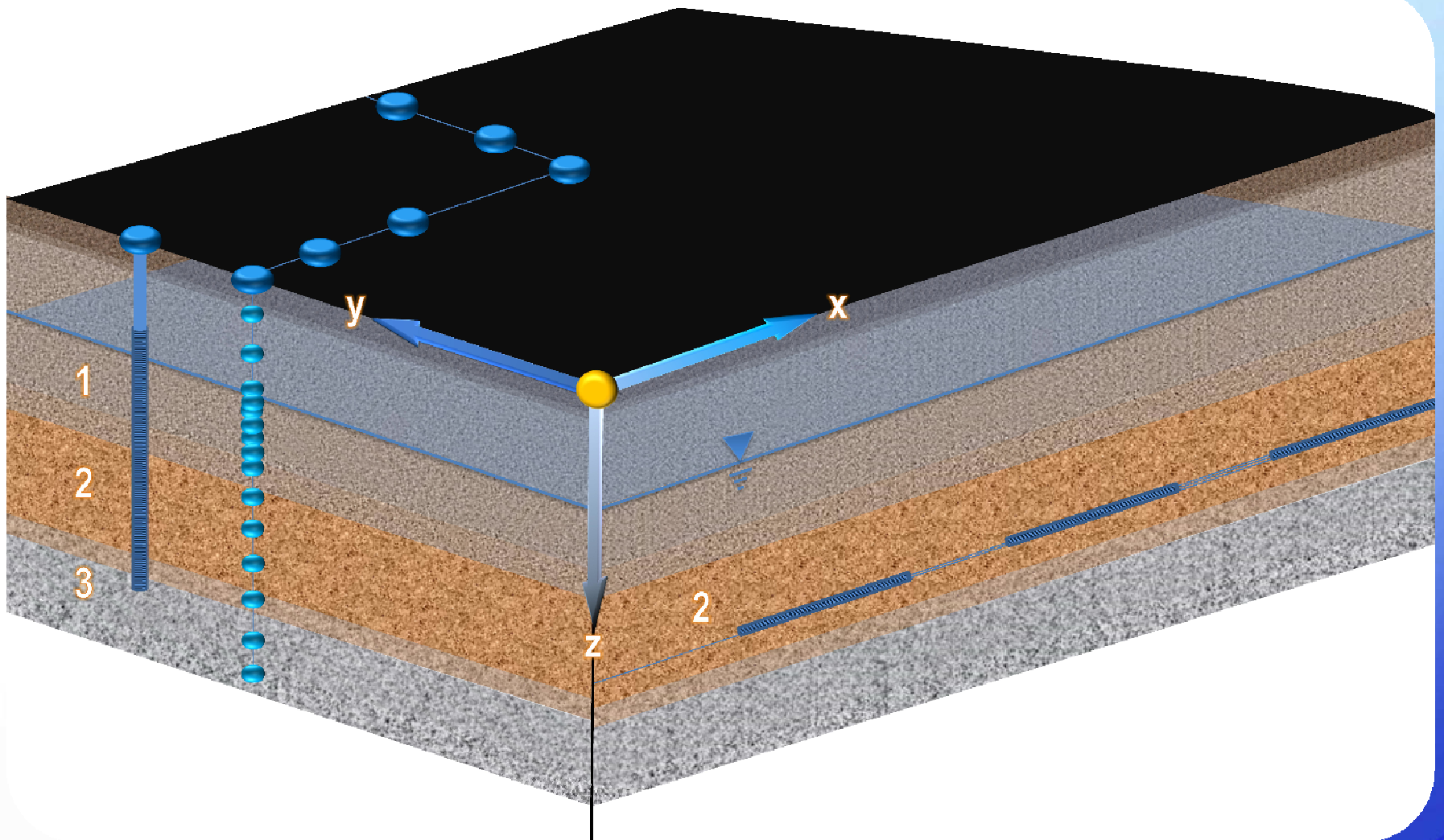
Horizontal Direction Drilling and Wells

- Drill is angled down, planes, and usually exits to make the boring. Drilling is similar to mud rotary.
- Well system is pulled into the boring and set similar to hollow stem installation.



Source: Forward-corp.com

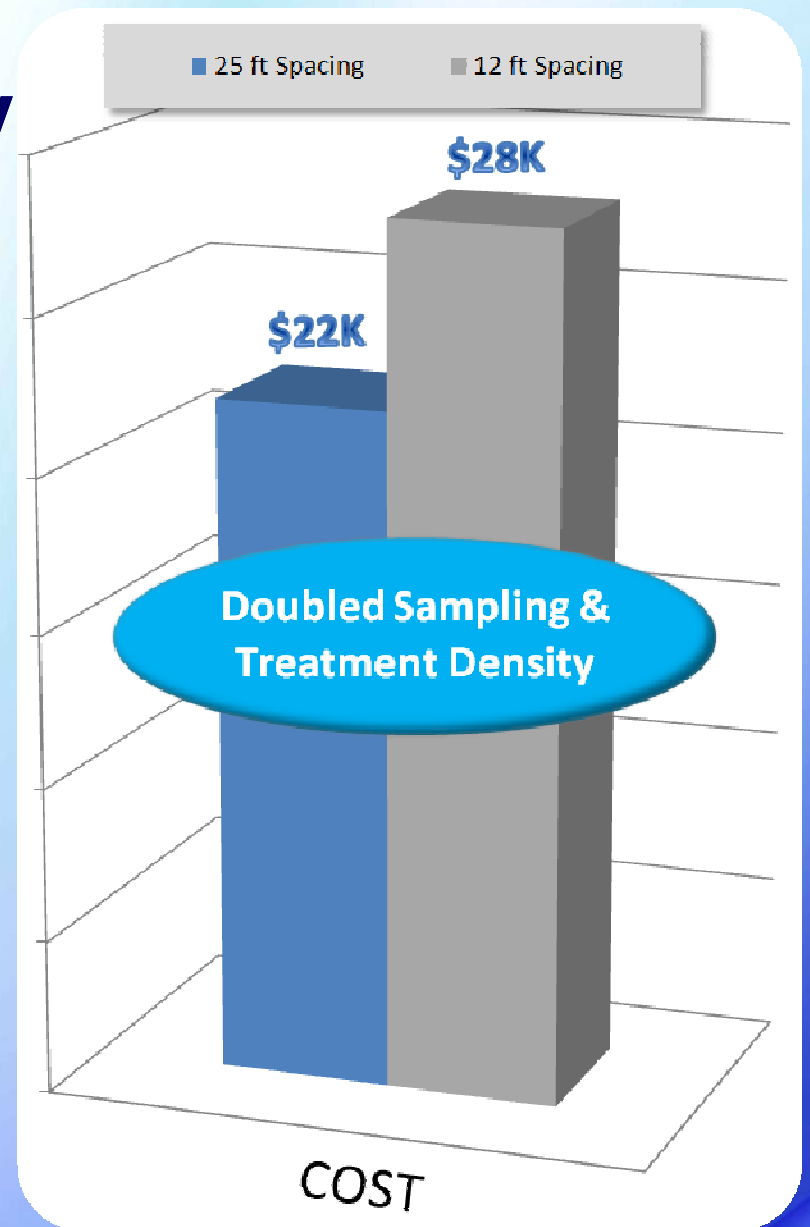
Horizontal Plane Benefits



- Sampling density can be altered in the x or y direction

Economics of Density

- Costs scale benefit applies to the horizontal plane.
- All other tools scale benefit applies to the vertical plane.
- This allows us to see higher resolution iso-contours in the horizontal plane.





Horizontal Repeatability

- Unlike other HRSC tools the devices offers repeatability.

	Jun-15	Nov-15	Variability
HIC-BK6	3640	4140	13%
HID-P3	960	1080	11%

- Early studies indicate, the data is not as impacted by seasonal water table variations.



Sampling Conclusion

- With added sample density, Vertebrae™ can refine site characterization similar to other HRSC tools.
 - Better understanding
 - More precise treatment
 - Quicker cleanup
 - Cost Savings
- Possibly its biggest sampling advantage is removing data gaps.
 - Not just better but complete!



Transition to Treatment

- Unlike all other Hi-Res tools - The same device can be used for treatment.
- Its higher definition layout now benefits the treatment technology
- The added **discrete** placement is one-of-a-kind for horizontal treatments.



Horizontal Difference

- Horizontal Tools provide a more efficient means to contact most (>90%) plumes because they are generally thin.
- Vertebrae™ is different because the drilling is horizontal.
 - This provides additional data with minimal additional costs through increased horizontal sampling density.
 - And it provides improved treatment with minimal additional costs through increased horizontal treatment density.



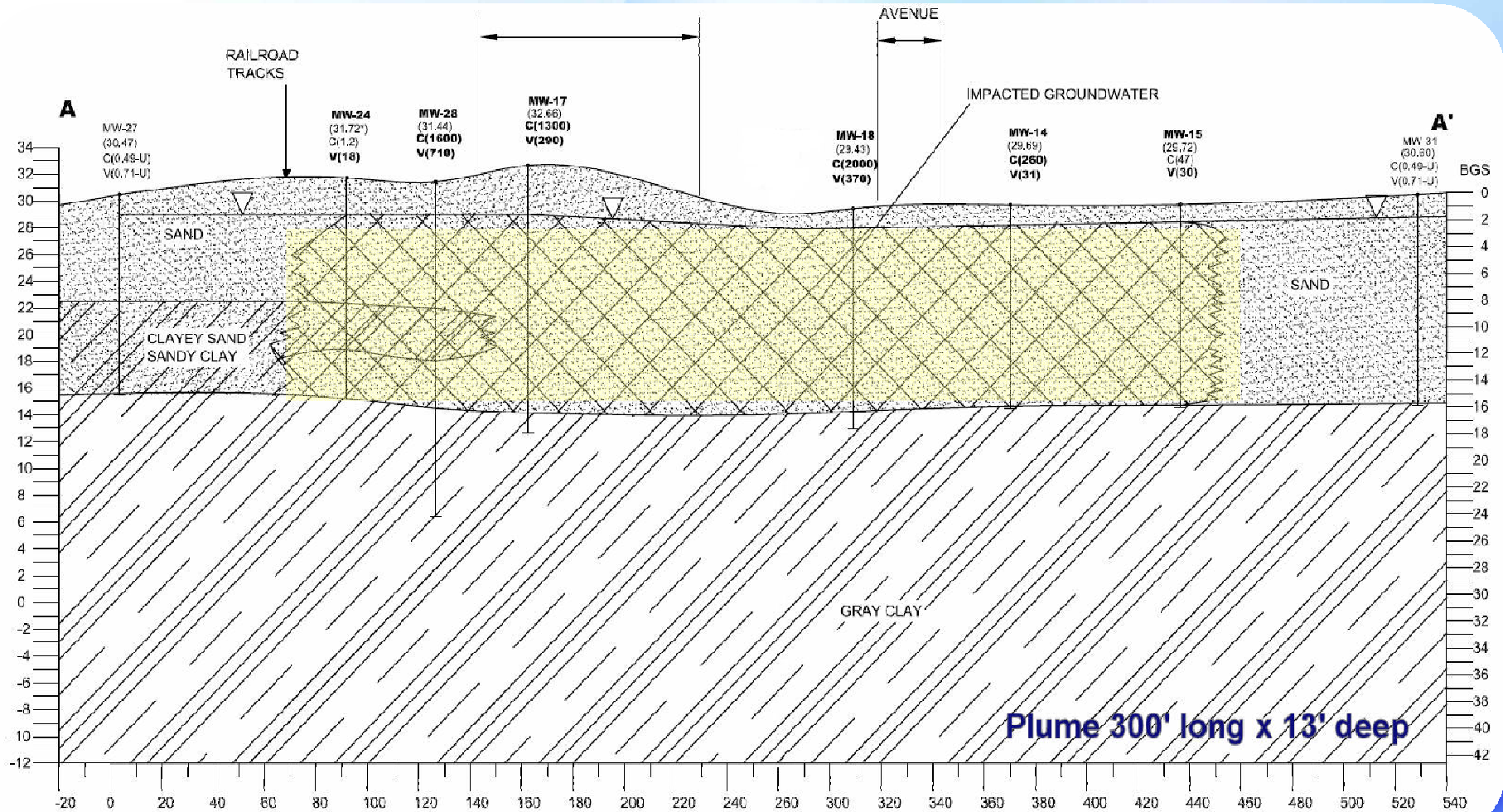
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Flat Plumes

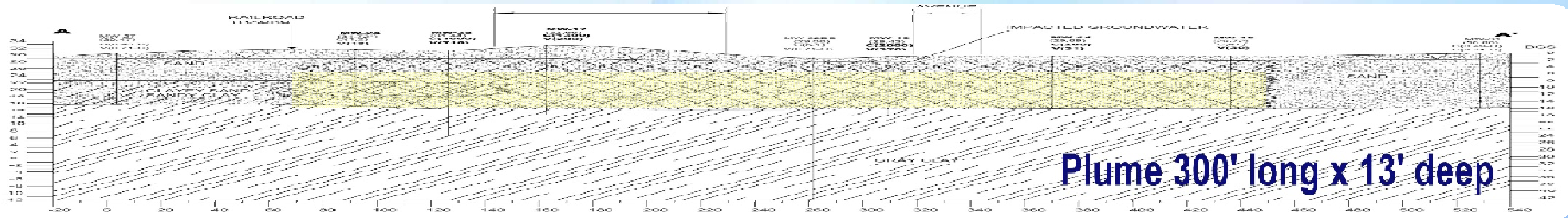
- 23:1 flat ratio





Flat Plumes

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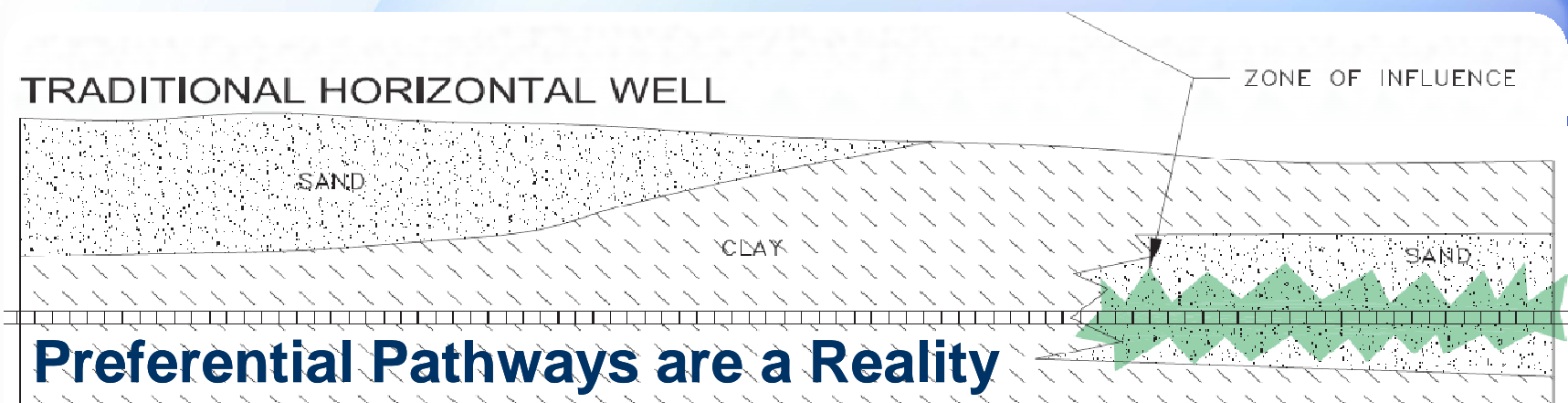
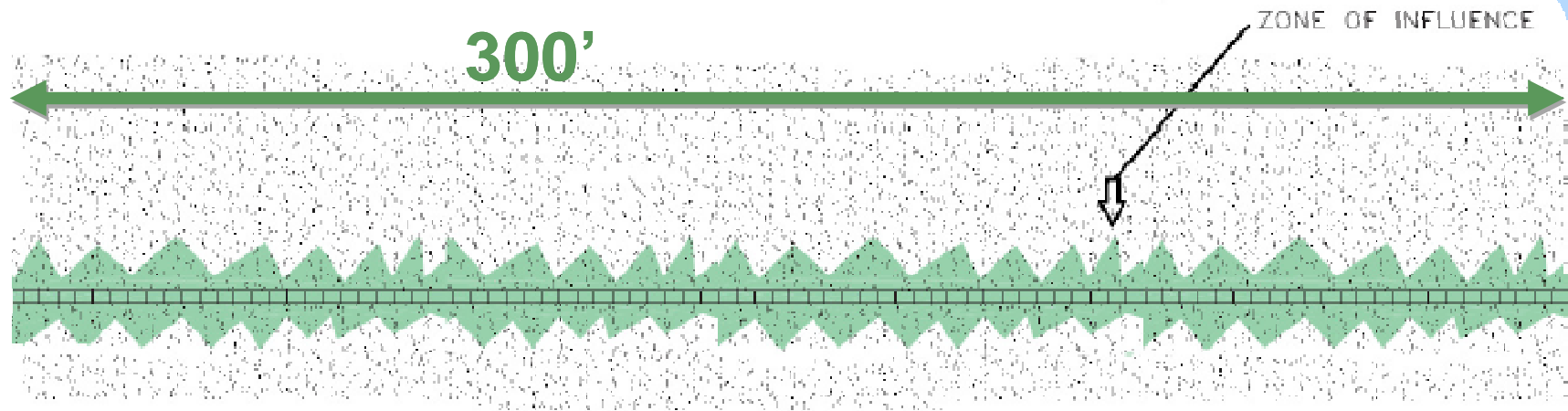
- Always remember the scale is typically skewed.
 - Most cross sections have been altered for reporting layout.
 - This alters the Z perception of the plume.

This is very typical of plumes throughout the US.



Why Does Discrete Matter?

Existing Technology Design VS Reality

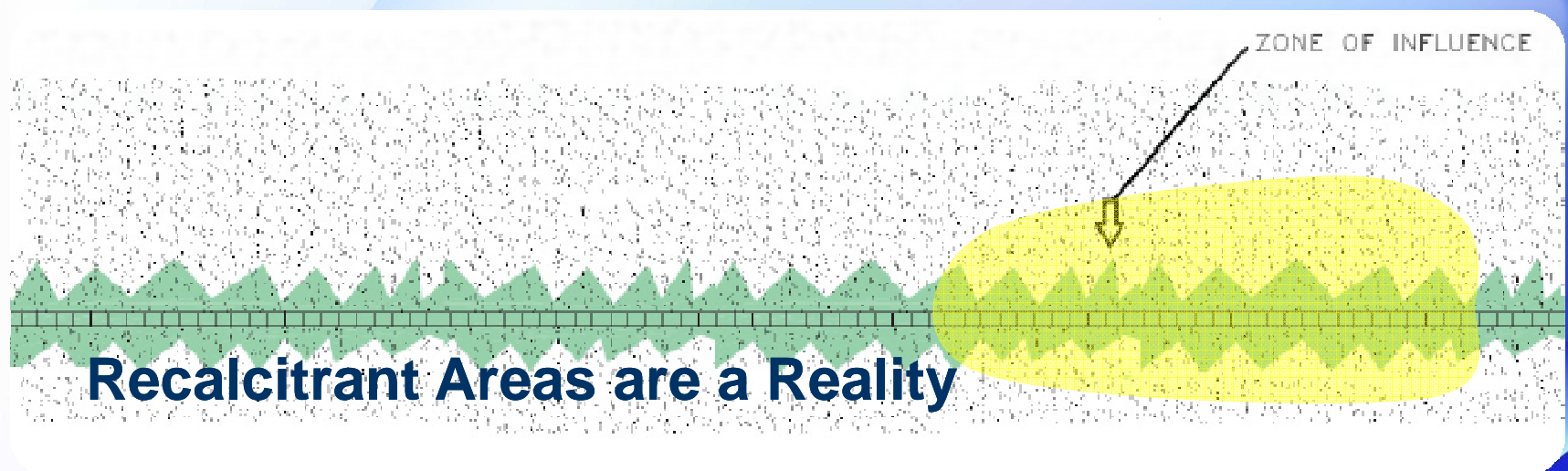
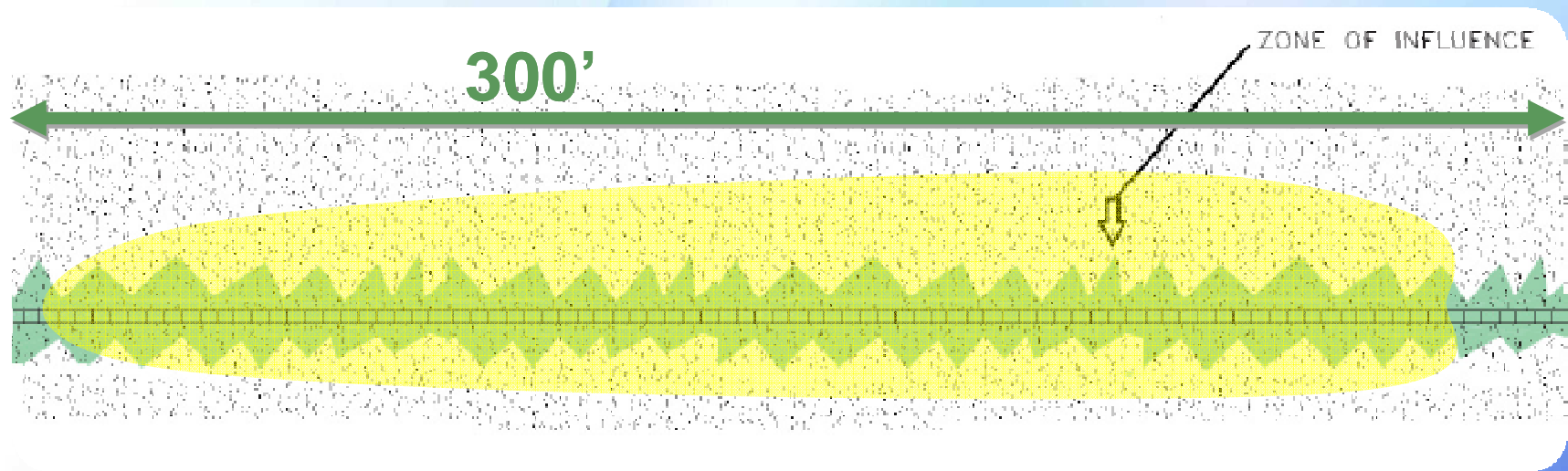


Preferential Pathways are a Reality



Why Does Discrete Matter?

Existing Technology Design VS Reality





Why Does Discrete Mater?

- To give us control!
 - To eliminate or minimize preferential pathways.
 - These might exist over time
 - Lithologic difference may create these.
 - To allow for adjustment of distribution.
 - To pinpoint initial treatment in a source area
 - Or when a recalcitrant area is less responsive to treatment.



The Problem

- Define the plume and addresses data gaps
 - Under tanks, fuel lines, dispensers, and canopies
 - Under buildings, busy parking lots, in ROW or under road ways
 - Under utilities below grade or when over head
 - Under wetlands, ponds, lakes, or on boggy or rough terrain.

**OFTEN
THE
DATA
GAP IS
THE HOT
SPOT**

- A south Florida site with known solvent impact was evaluated and a remedial action plan was designed for the project site.
- The industrial type release likely occurred under the building, but due to limited access within the active commercial facility, only two assessment monitoring wells were installed within the building.



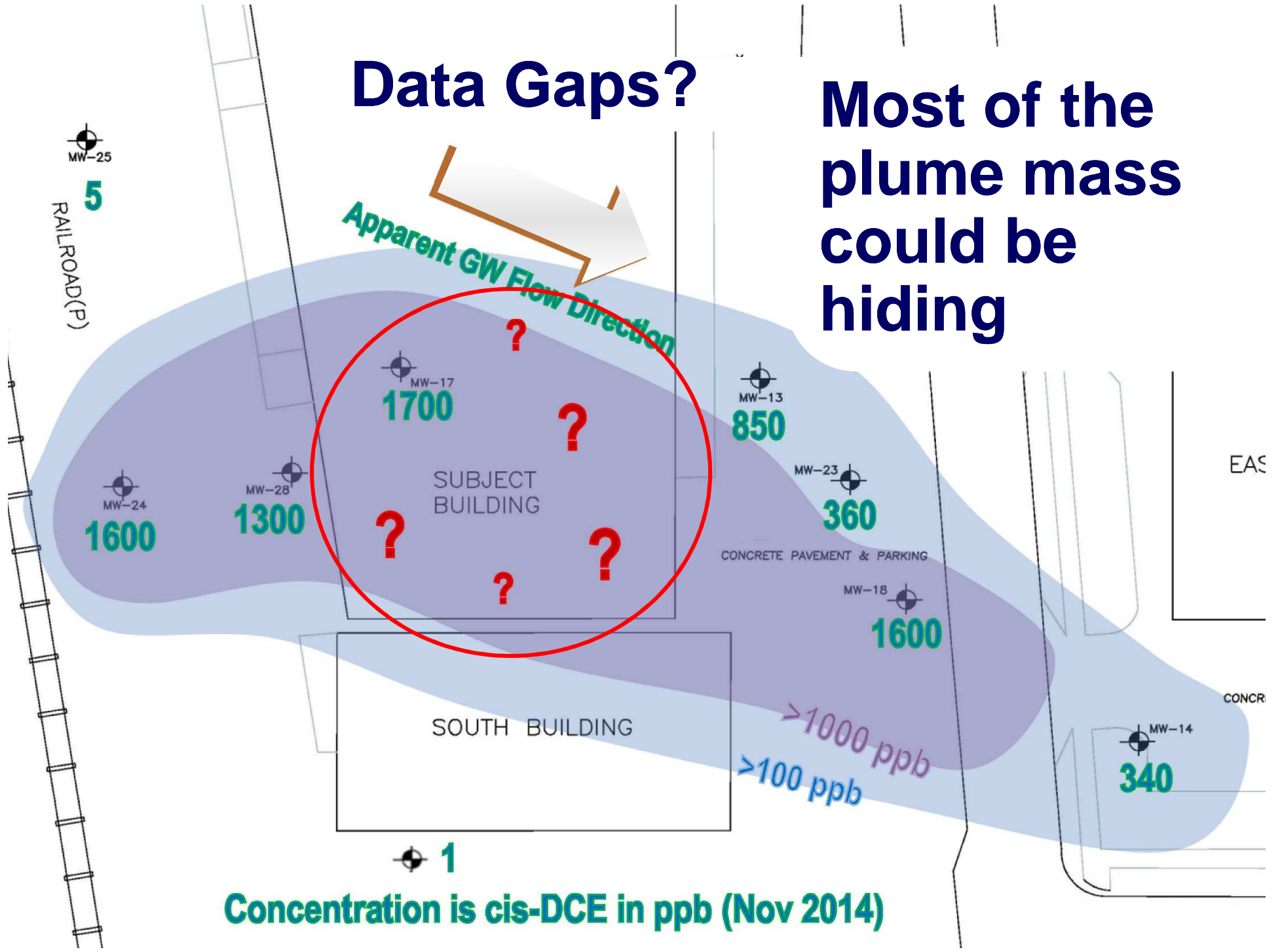
Case Study

- Lithology – silty sand.
- Clay confining unit at approximately 17 ft. bls.
- Water Table is at 3-5 ft.bl.



Data Gaps?

Most of the plume mass could be hiding



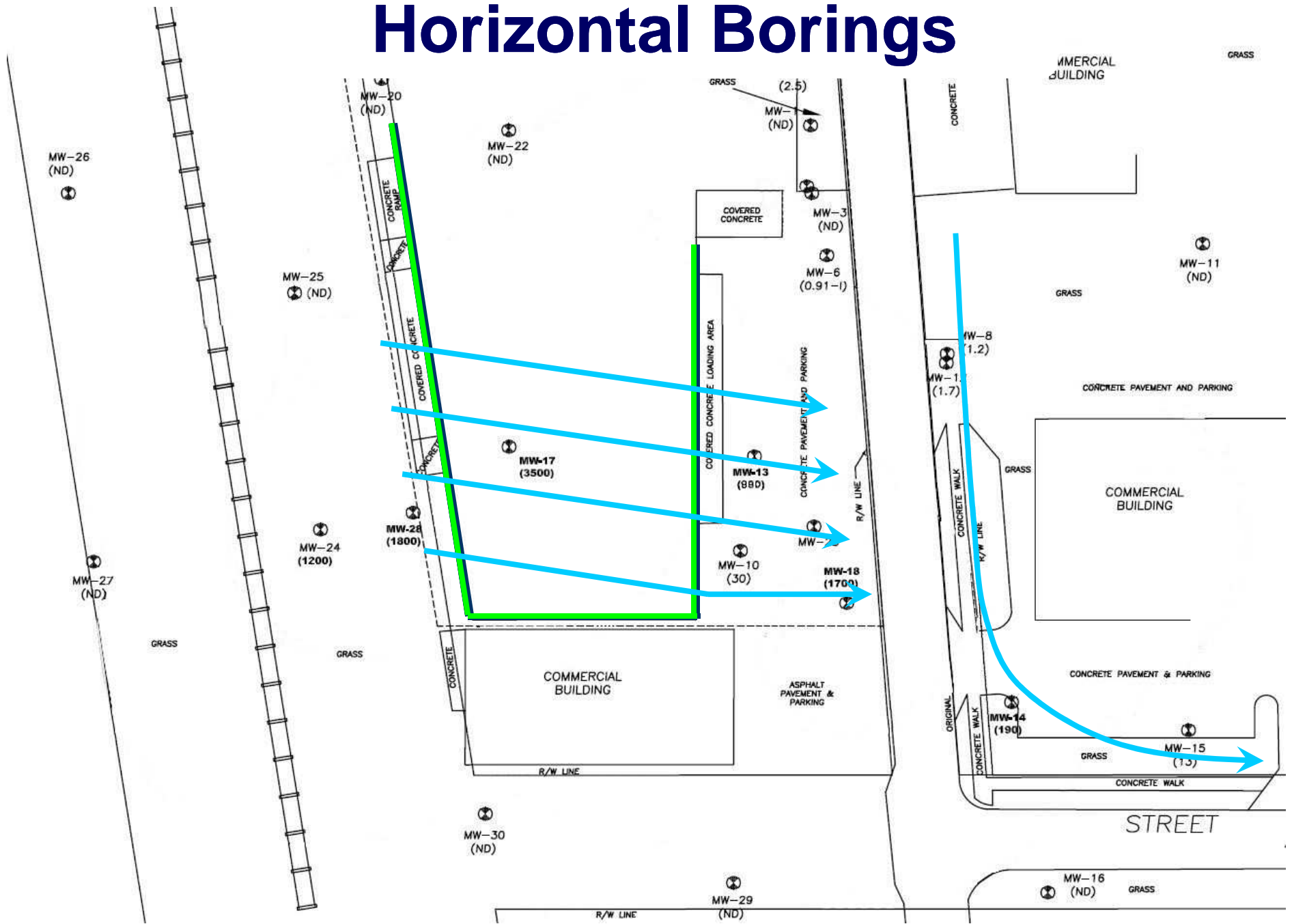
Concentration is cis-DCE in ppb (Nov 2014)



Vertebrae™ Installation

- 4 Vertebrae™ were completed in 8 days.
- 26 individual well segments were installed.
 - 6, 6, 8, 6
- Wells were installed 1-3 ft. above the clay unit.
- Wells were terminated in one location to be plumbed to a treatment system.
- Wells were developed until clear.

Horizontal Borings



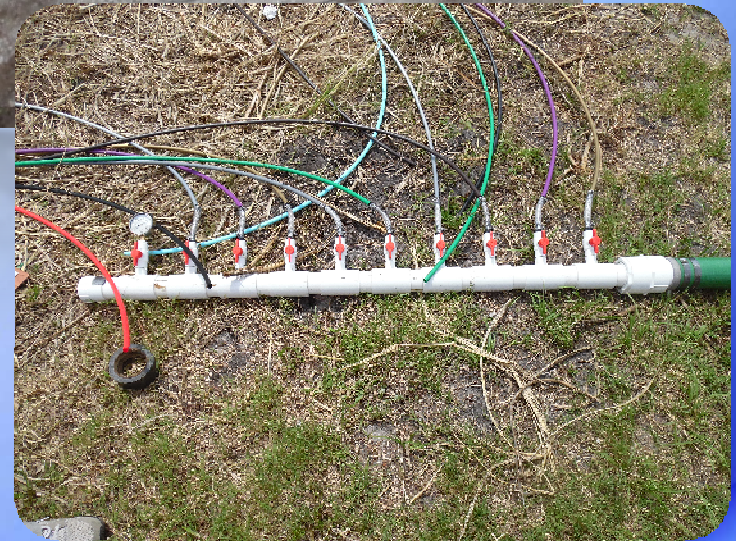


Quick Installation

4 Vertebrae™ Well Systems were installed - 8 Days



Less than half the Time
Better Coverage





Vertebrae™ Sampling

- 4 Weeks later the wells were purged using standard stabilization techniques.
 - YSI, Turbidity Meter, (no DTW tape)
- Data indicated the maximum concentration may be 4 times higher than previously known.
- Data indicated highest concentrations were southeast of the southern interior building well.

Sampling Conclusions

- Data gap coverage.
- Well density for Hi Def iso-contours.
- Provides a cost effective solution.
- Provides many other benefits including
 - Less business disruption.

Case Study - Treatment

- **Feedback Optimized Continuous Injection System**
 - A self-contained, solar-powered, un-manned, communication-ready, remediation platform capable of injections. **(FOCIS)**
 - Slow down the injection rate to collect data and ensure efficient use of reagent
- Injection of 0.5 gpm of water mixed with EN Rx activated hydrogen peroxide.
- One segment at a time is used for injection.
- Pressure for injection remained below 3 psi for all the well segments.
- Reagent is place precisely where it is needed.
- Work is on-going at the site.



Sampling or Treatment

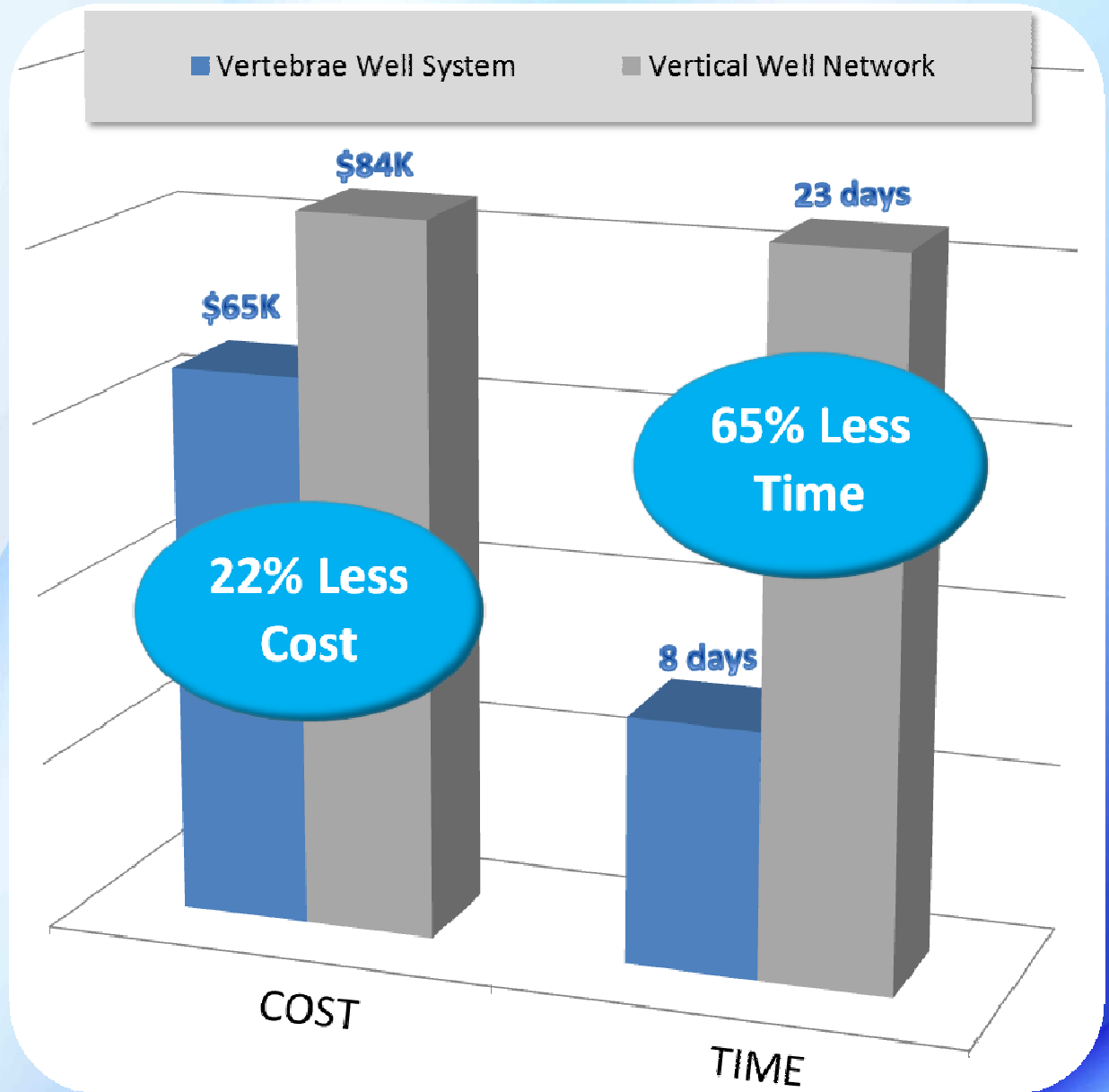
- Not all the well segments have to be used for treatment. Preserved segments can be sampled as they are independent seals wells.

Segment	Pre Pilot	During	Post Pilot	Reduction
HIC-GR4	9390	4580	458	95%
HIC-BK6	3640	3760	870	76%
MW-17	2390	1300	1510	37%

Vertebrae™ Case Study

Cost estimates compared to a traditional plumbed injection or ozone system review significant saving.

In part to speed.





Conclusions

- Daps gaps can now be filled by a horizontal tool
- Higher sample density on a horizontal plane provides a better understanding of the plume.
- This data is cost effective under the HRSC proven concept that a better understanding leads to more precise cost effective remediation, even if the HRSC is relatively expensive during the assessment phase.
 - ie. the assessment costs go up while remediation cost go down.
- Other sampling benefits include:
 - Safety
 - Minimal business disruption
 - Cleaner installation, less site work



Conclusions (continued)

- The Vertebrae™ has two qualities beyond other HRSC tools.
 - Reuse for sampling.
 - Reuse for treatment.
- Treatment occurs in the plume with greater contact and efficiency.
- Using Vertebrae™ for treatment allows the increased density to increase the treatment control unlike other horizontal tools.
- The combined features of sampling and treatment give additional value added.

Conclusions

Thanks



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