

Dynamic Pulsed Injection for In-situ Chemical Treatment

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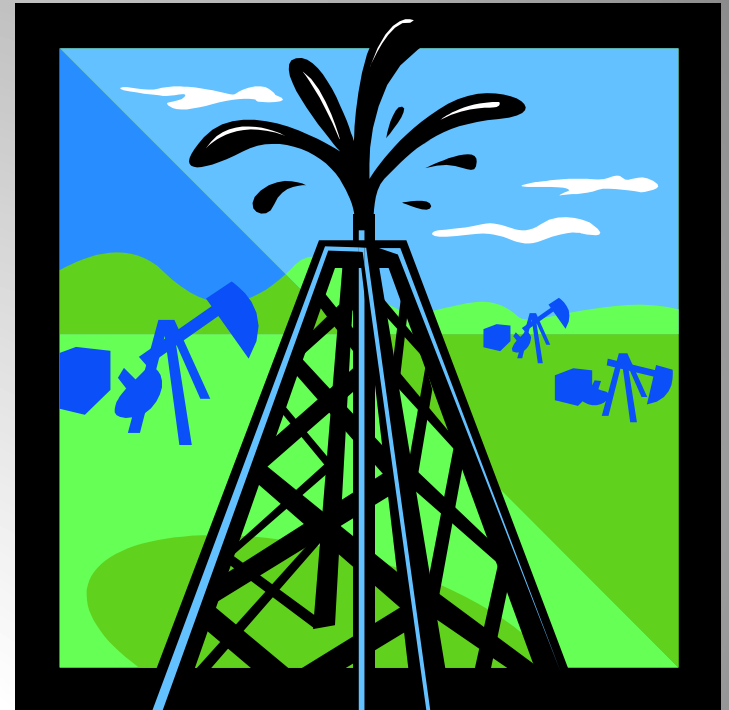


Presentation Outline

- Topic Discussion
- Testing Objective
- Background
- Testing Methods
- Results
- Conclusions

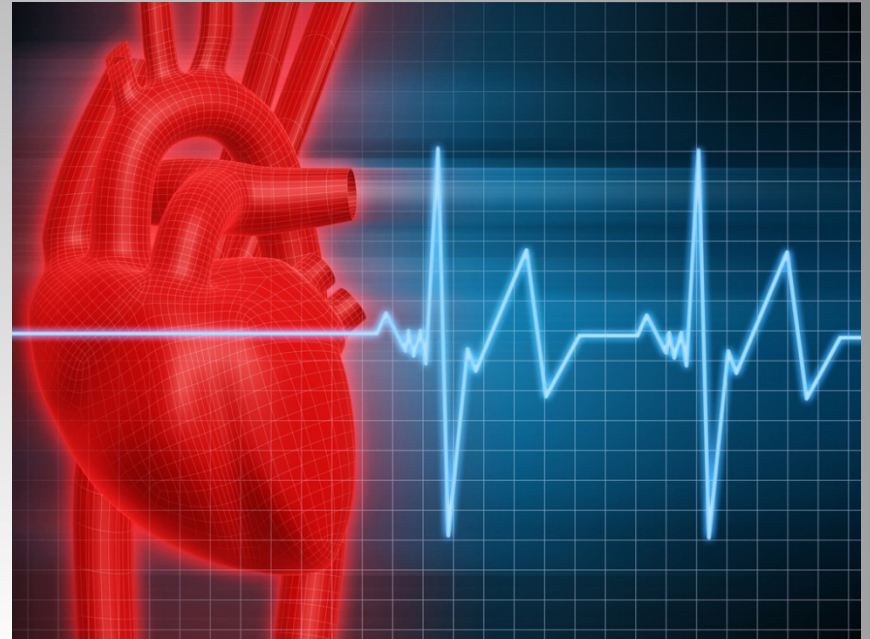
Topic Discussion- Where did this idea come from?

- Soil and groundwater remediation
- In-situ remediation
- Injection systems for in-situ remediation
- Enhanced mechanism of delivery for in-situ remediation treatment technology

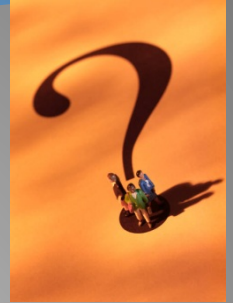


Testing Objective

- To determine if injection by pulsing will have a positive effect on the delivery over more traditional methods.



Why?



- There is a gap in the current data and understanding of contaminant flow under passive and forced conditions.
- Studies that have been done by others have focused on either chemical treatment technology or vertical flow through cells.



Background

- Over the past decade in-situ remediation technology has been gaining more favour.
- Chemical oxidation processes have been used in the treatment of wastewater streams are well understood.
- The understanding of injection of fluid into the subsurface is still a relatively new study.

Background

There are meager resources in published literature and limited research done on the topic of subsurface injection delivery techniques (Christiansen et al, 2010).



Christiansen, C.M., Damgaard, I., Broholm, M., Kessler, T., Klint, K.E., Nilsson, B., and Bjerg P.L. 2010. Comparison of Delivery Methods for Enhanced In Situ Remediation in Clay Till. *Groundwater Monitoring and Remediation*. 30, No. 4, Fall 2010. Pp 107-122.

Methodology

- Research current in-situ injection techniques.
- Conduct a field injection pilot test using different injection techniques.
- Develop a new optimal method for injection.
- Test new method within a controlled setting.



Field Test Methods

- Field pilot chemical oxidation injection within two test cells.
- Two different injection techniques used (pulsing and direct injection).
- Data collected from surrounding well network.



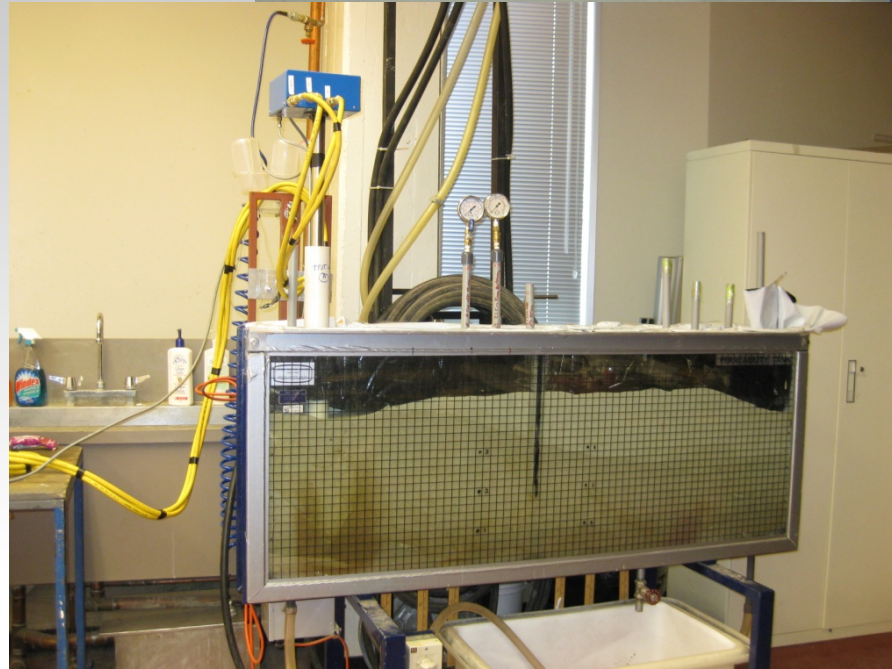
Field Test Methods

- Measured pressure changes with pressure transducers and monitored changes in temperature, pH, TDS and EC in surrounding wells during the injection events.



Lab Test Methods

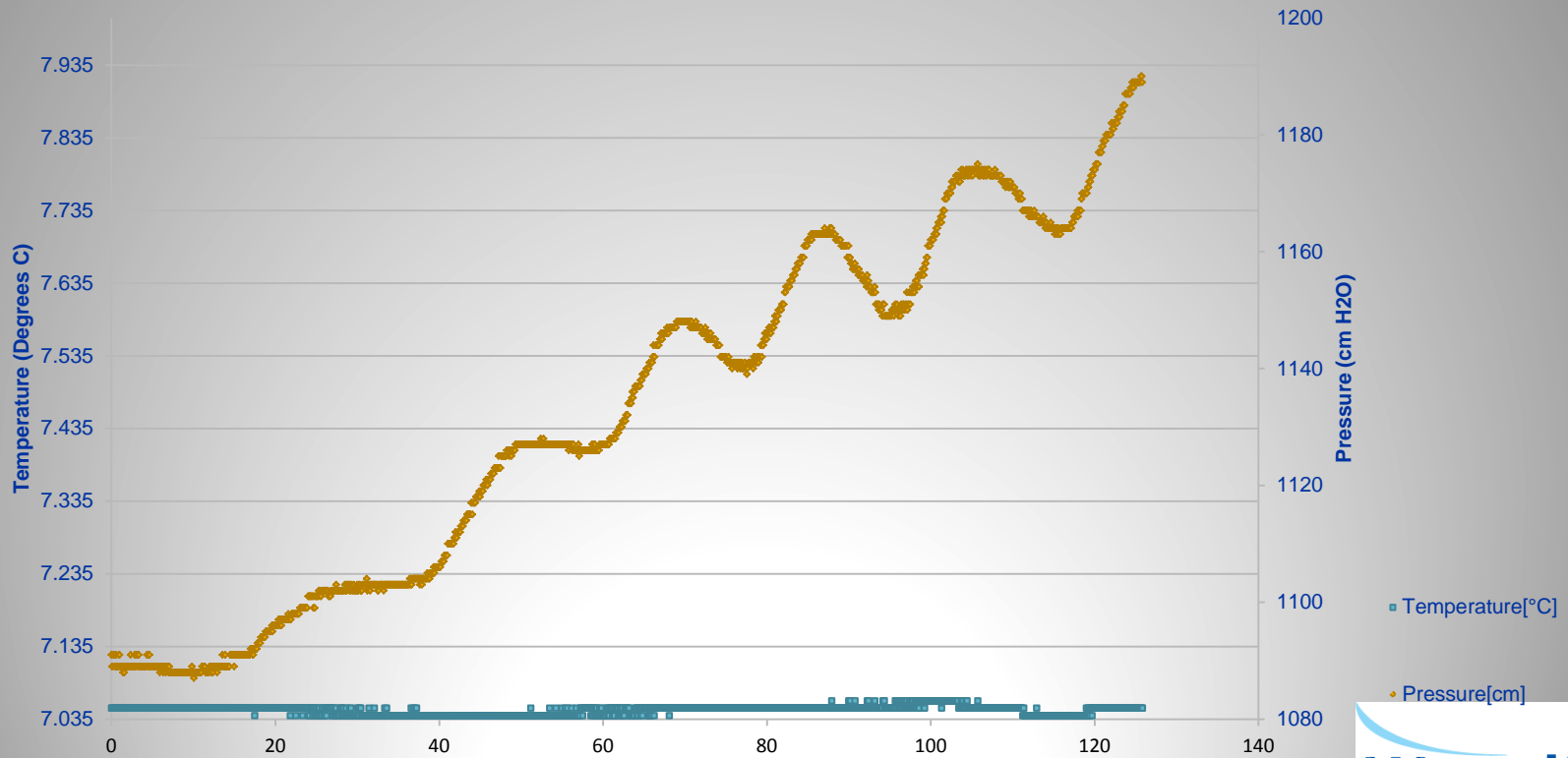
- Lab experiment design to test pulse injection with air and water into a sand filled tank.
- Provide visual data on the injection of pulsing vs. no pulsing of fluid.



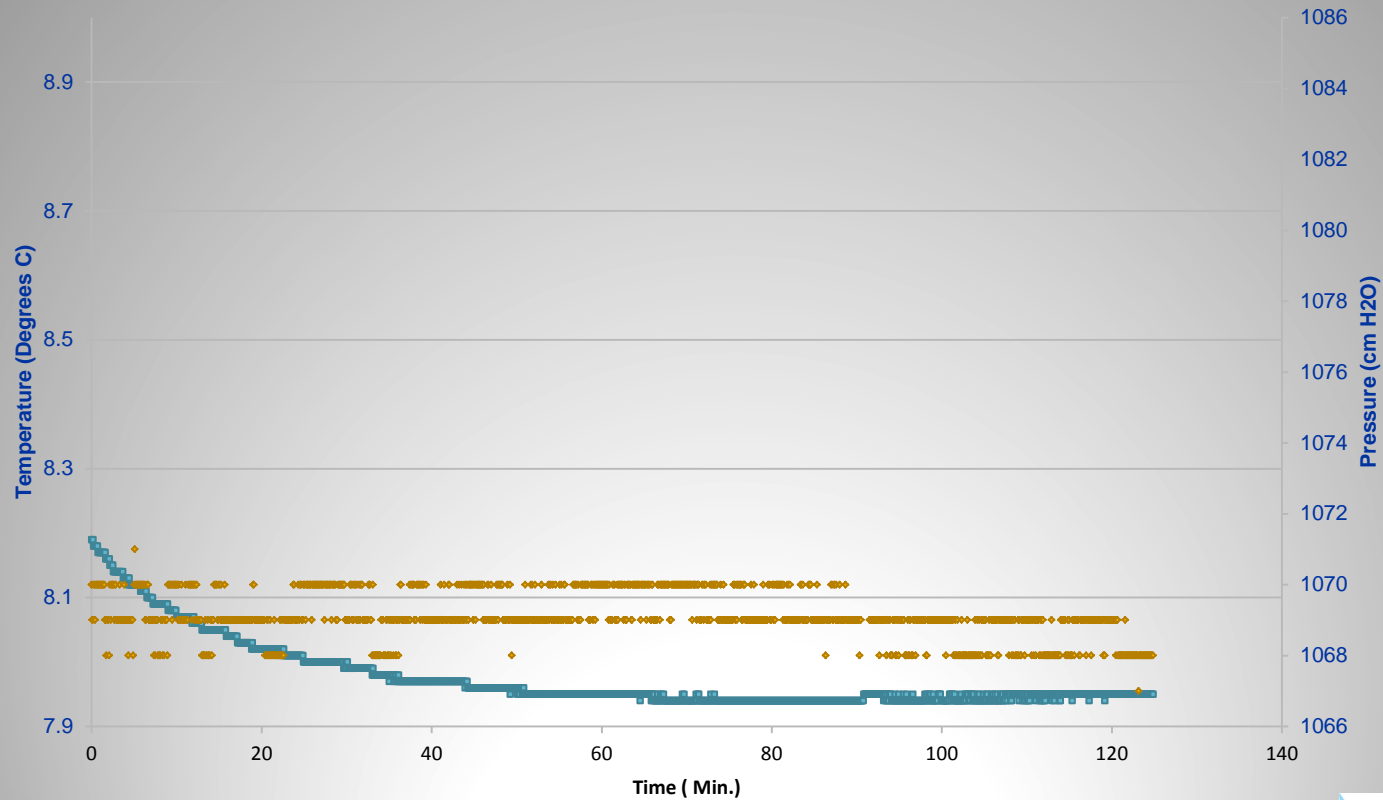
Results

- The field results indicated the pulsed injection pressures were observed at surrounding monitoring well locations.
- Field data indicated that chemical reactions were occurring through fluctuations in pH and temperature during the pulse injection event.
- The Lab results showed the pulsed fluid travelled farther in the horizontal direction than the direct injected fluid.

Results from the field- Pulsed Injection Method

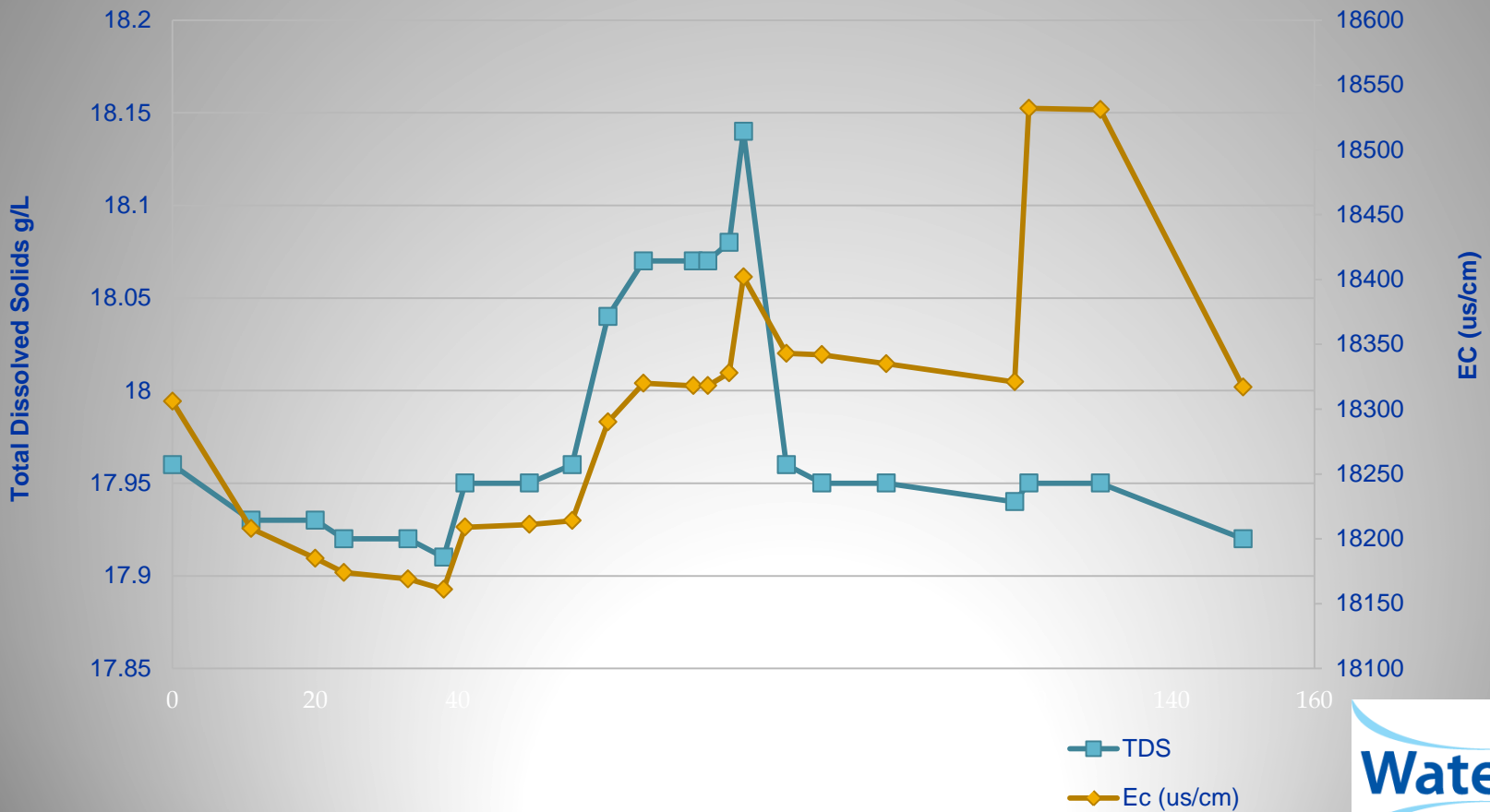


Results From the Field Direct Injection Method

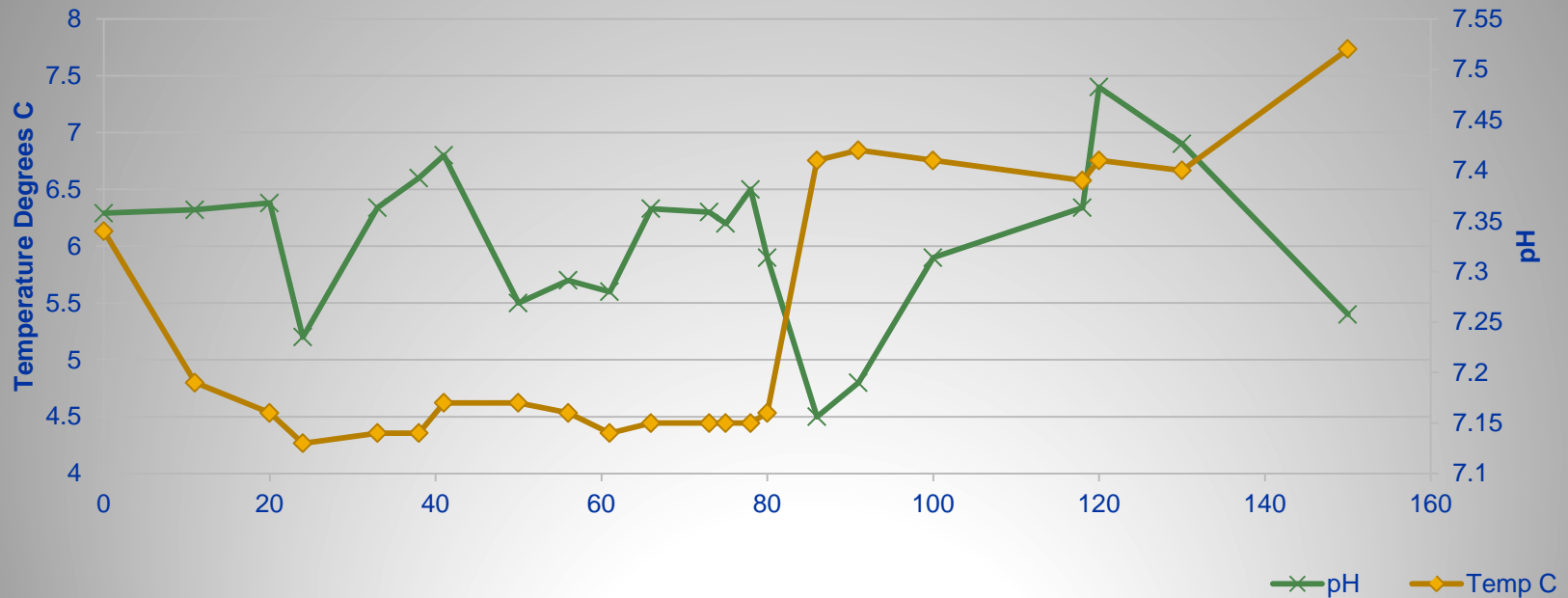


■ Temperature[°C] ◆ Pressure[cm]

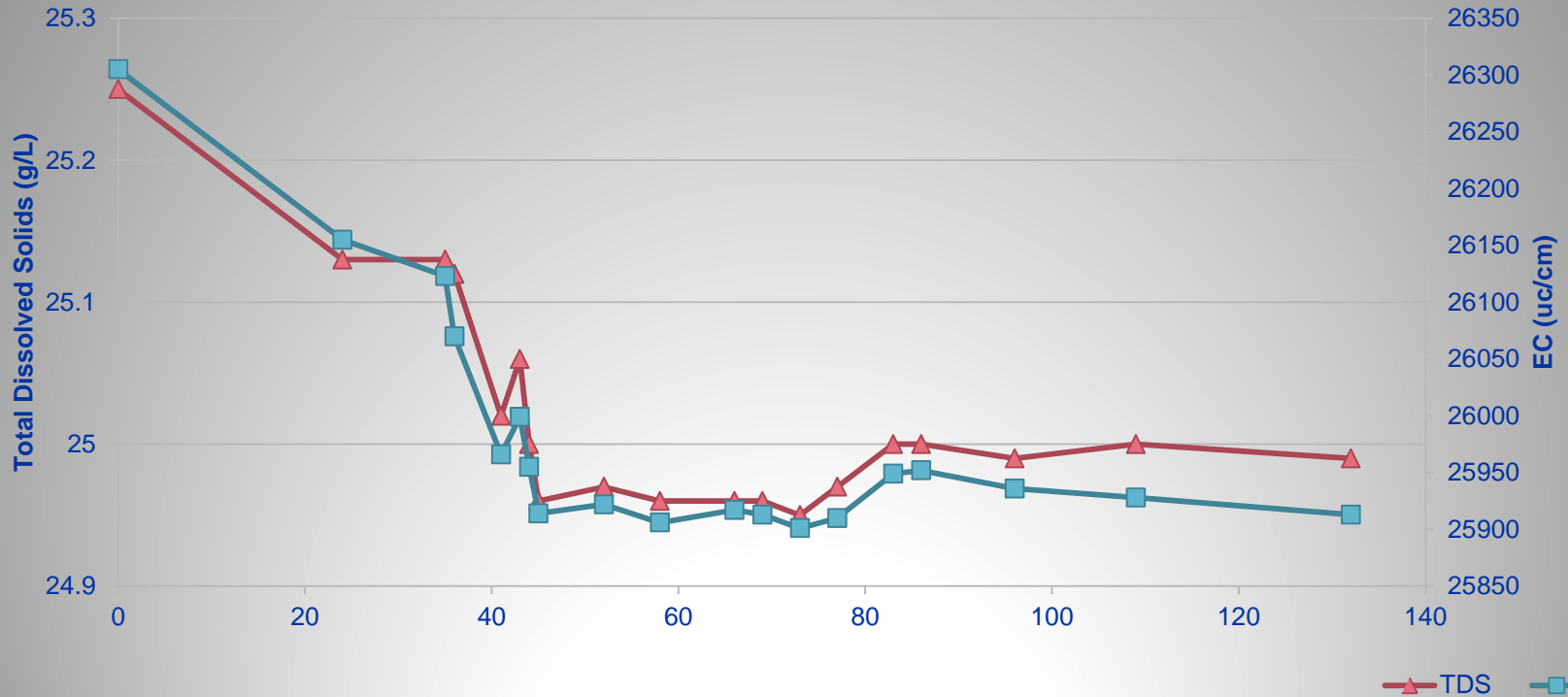
Field Test Results- Pulsed Injection Method



Field Test Results- Pulsed Injection Method

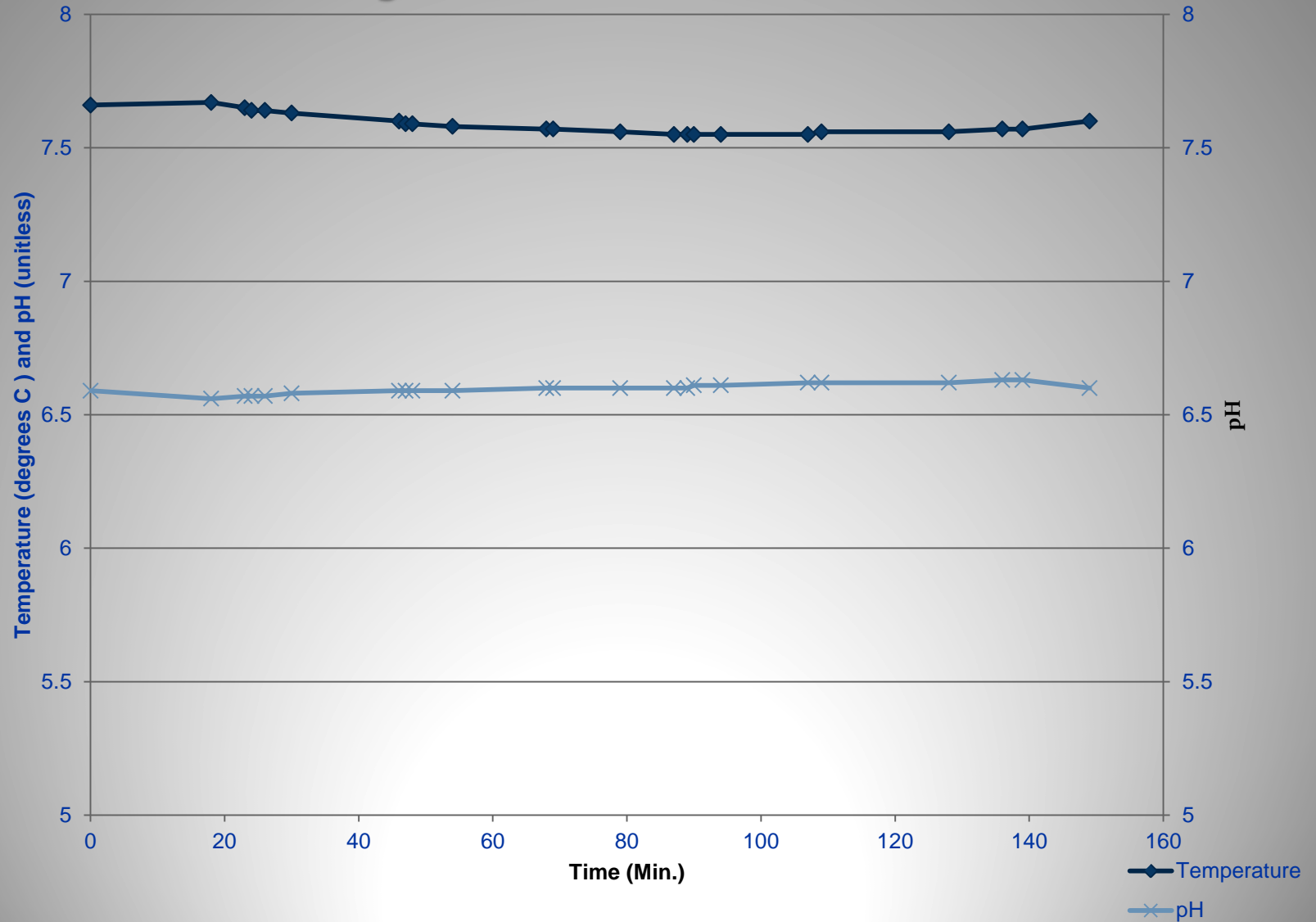


Field Test Results- Direct Injection Method

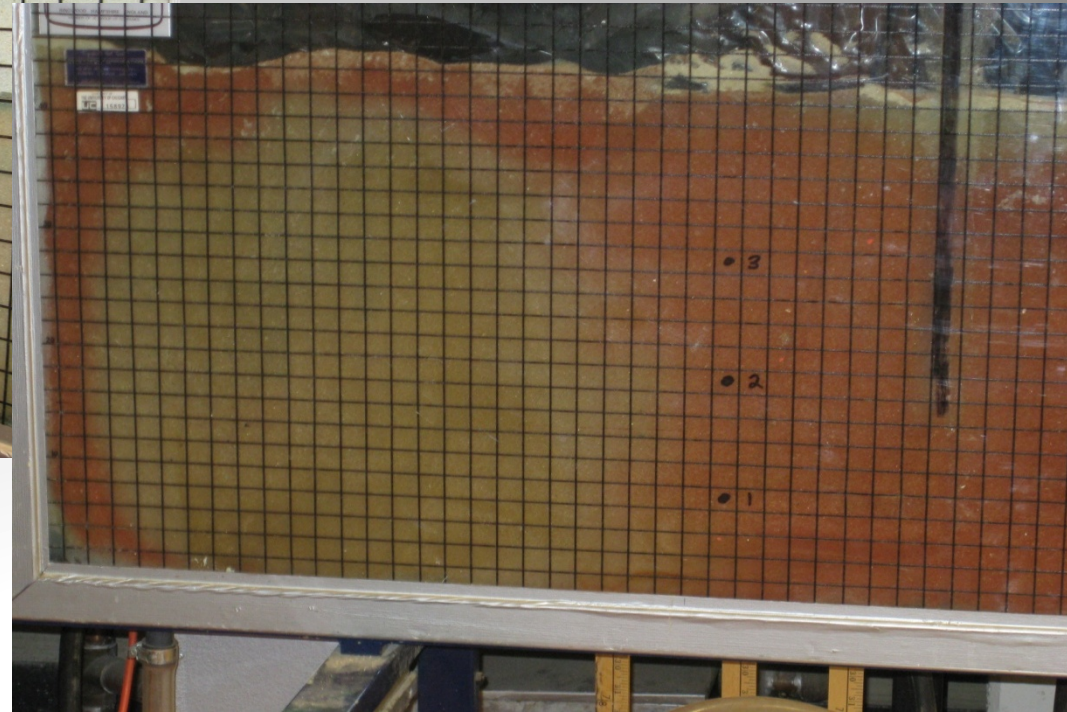
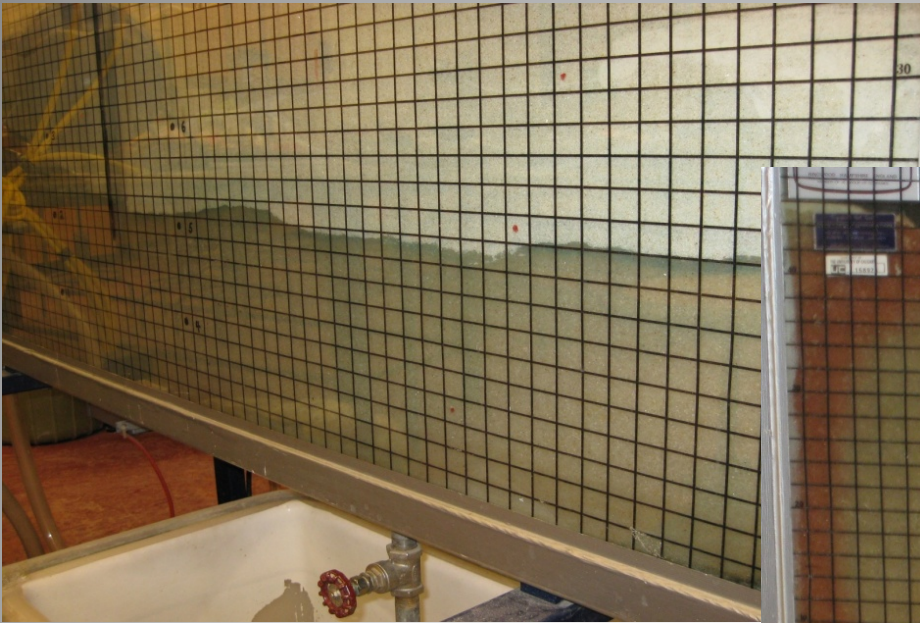


▲ TDS ■ Ec

Field Test Results- Direct Injection Method

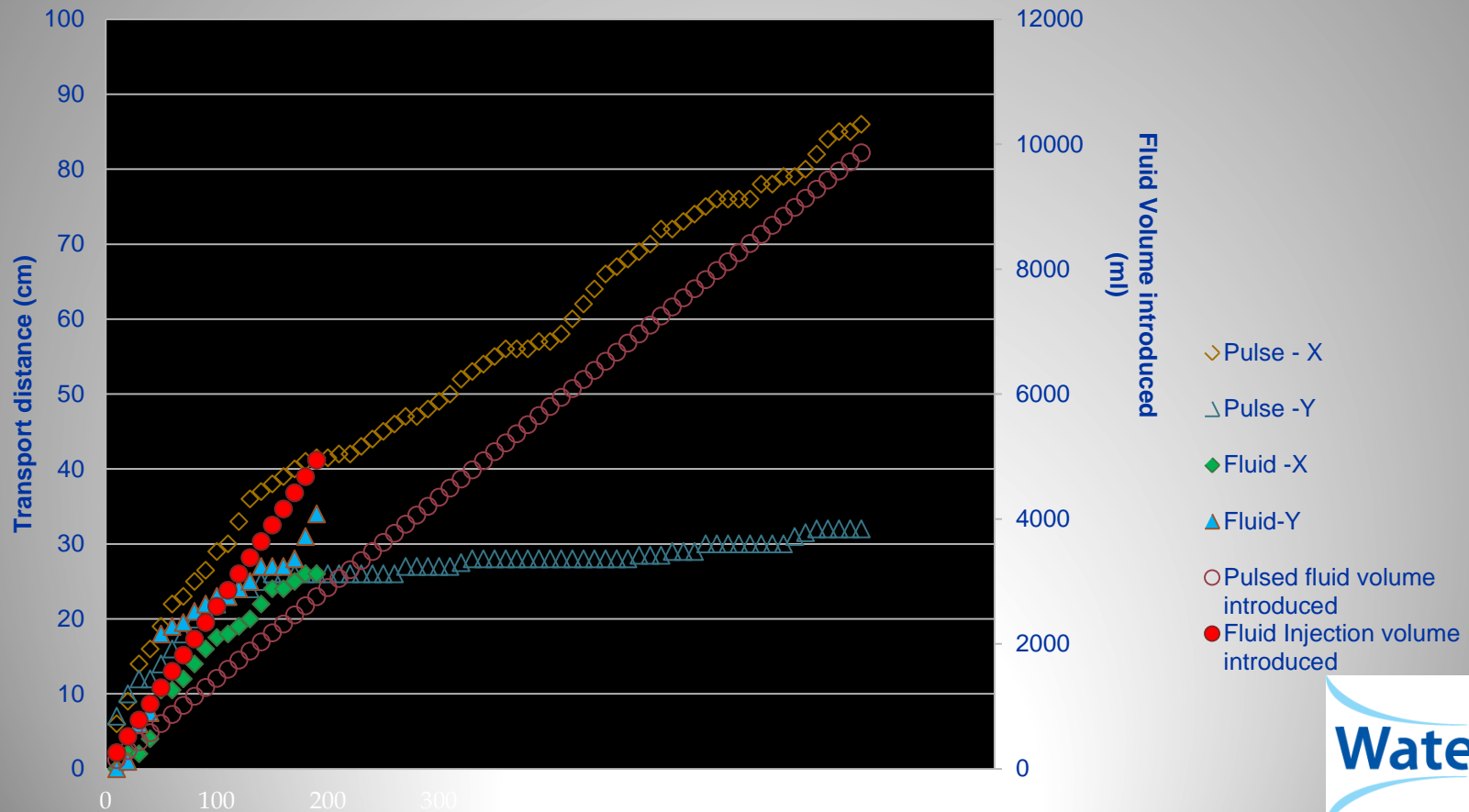


Lab Test Results



Lab Test Results

Fluid distribution and Volume Vs Time for direct Injection and Pulsed Injection



Conclusions

- Results of the field and lab indicate pulsed delivery techniques have a positive effect on treatment delivery and overall remediation efficiency.

Thank You

