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Modeling the Movement of Solutes Through the Subsurface: Application to Groundwater Remediation with Oxidant Candles

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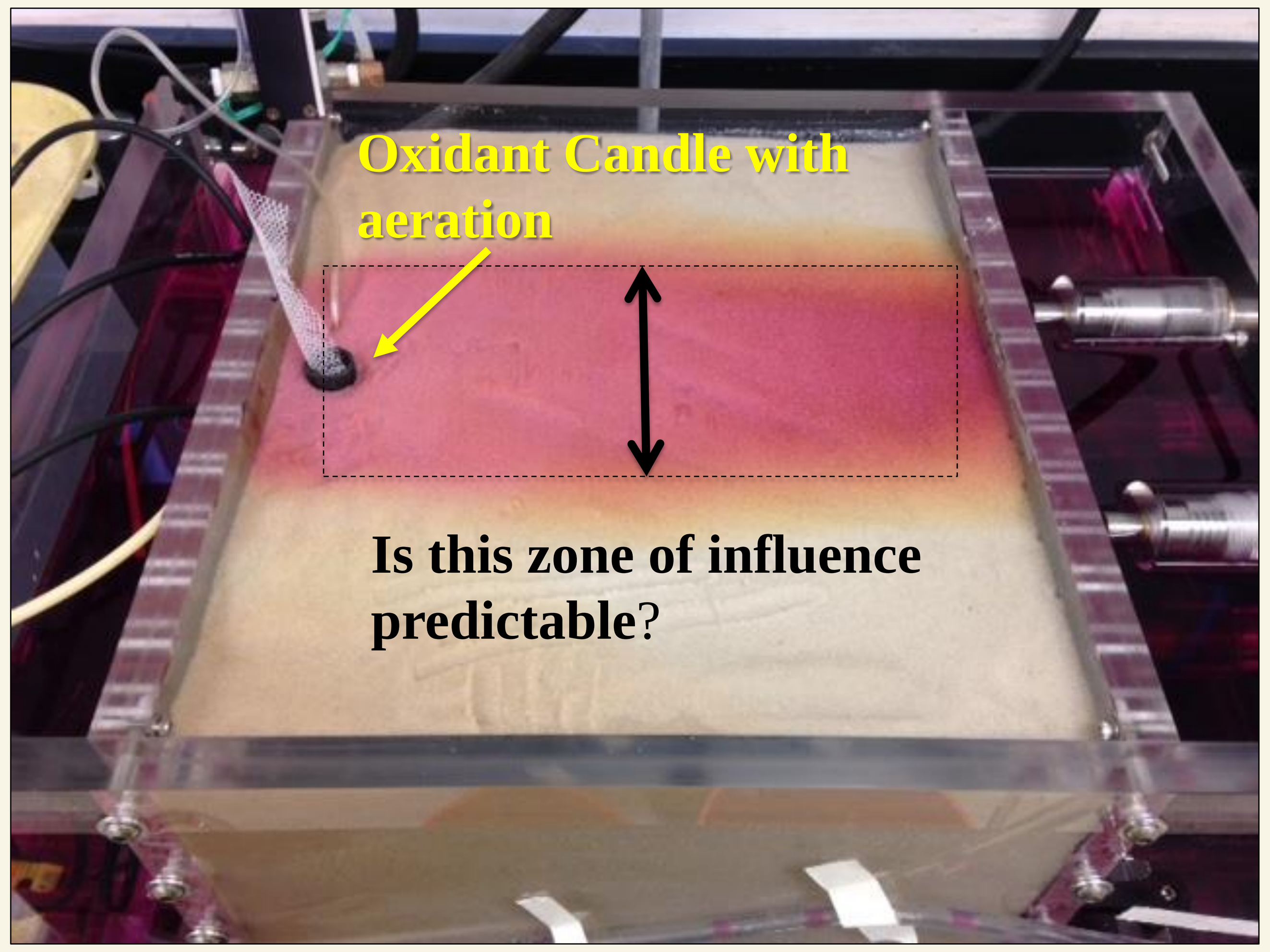
Application to Groundwater Remediation with Oxidant Candles

Presented by Colin Chatterton Advised by Dr. Steve Comfort

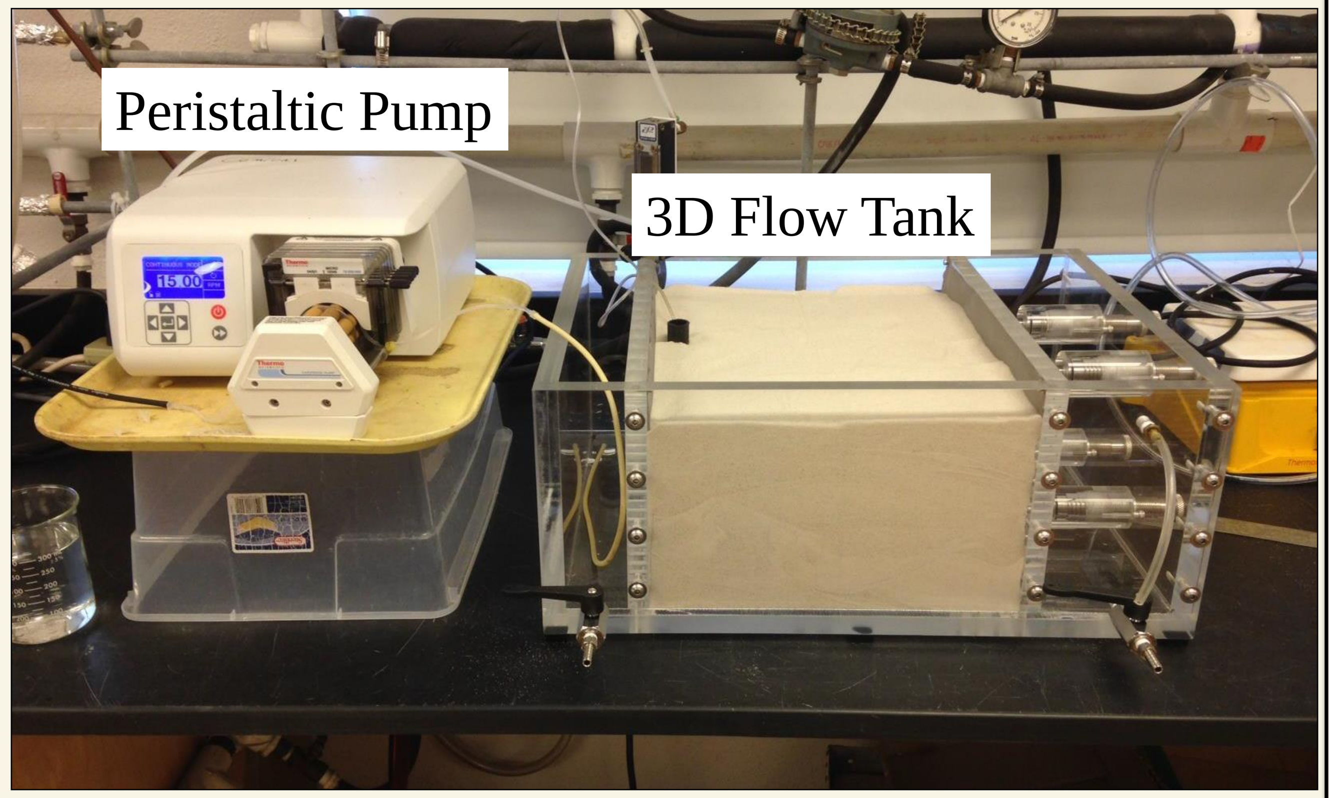
1. The Problem

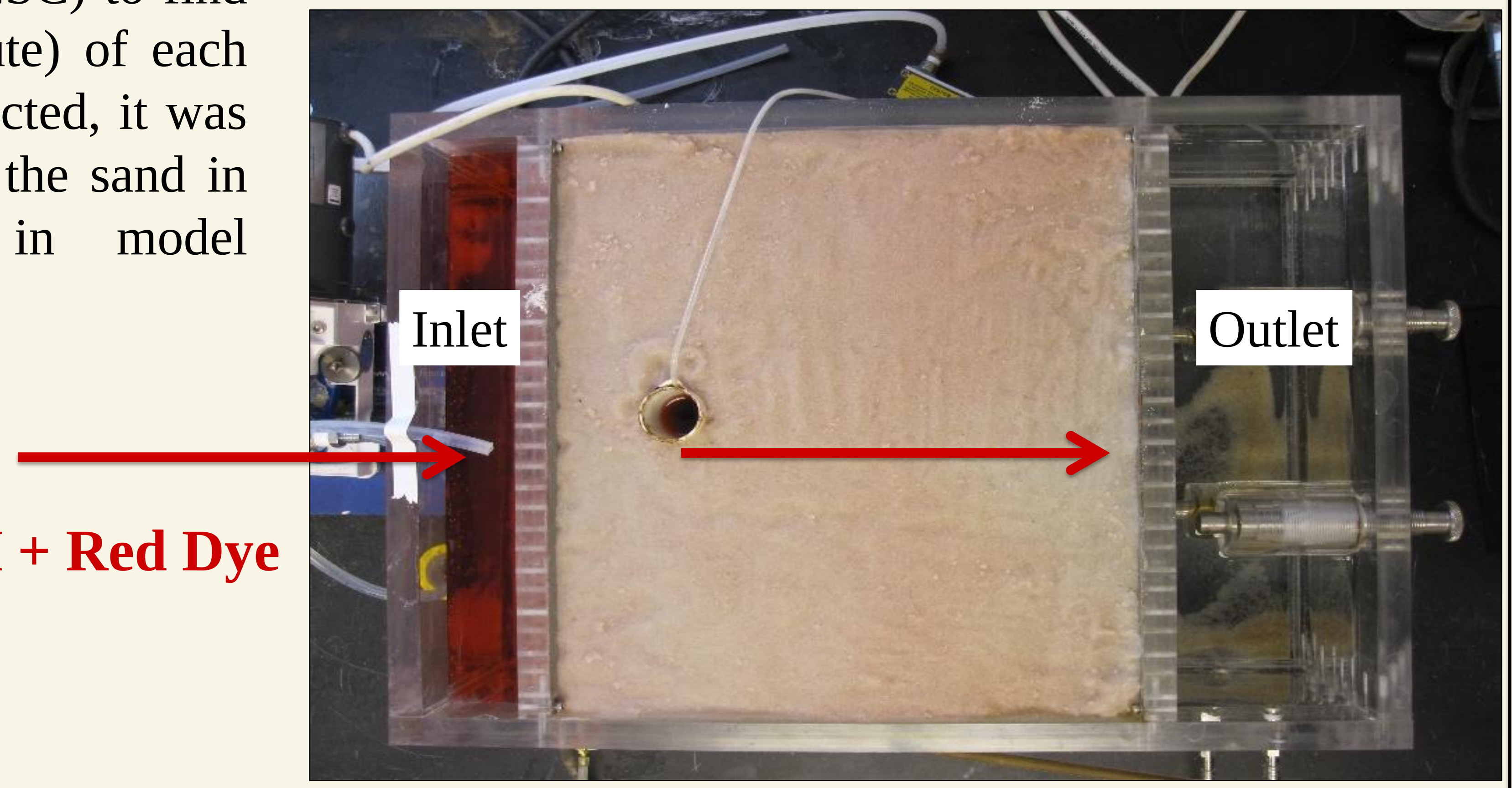
There are many sites across the United Stated where groundwater has become contaminated. In 2012, the National Research Council estimated that there were 126,000 sites in the U.S. in need of remediation (NRC, 2012). Slow-release permanganate candles are a relatively new technique for remediating groundwater contaminated with chlorinated solvents (Christenson, 2011). One practical question limiting candle use is determining how close the oxidant candles should be spaced to effectively treat a contaminant plume. **Our research is addressing this by using 3D modeling techniques to determine the zone influence of the slow-release candles via the dispersion of permanganate.**



2. Methods

A custom-built wide flow tank (12 x 14 x 8 in) was filled with sand and a constant gradient was established using with a peristaltic pump. We then pumped red food coloring into a screened well at a rate of 0.5mL/min. We also pumped in tritiated water as a tracer (^3H_2O) at 10 mL/min and noted the start time. Samples at the outlet were taken every 1 to 4 h by collecting 2 mL of effluent and mixing it with 18 mL of Ultima Gold LSC-cocktail. Samples were then placed into a liquid scintillation counter (LSC) to find the dpms (disintegrations per minute) of each sample. Once all the data was collected, it was graphed to find the dispersivity of the sand in the tank, which was used in model development.

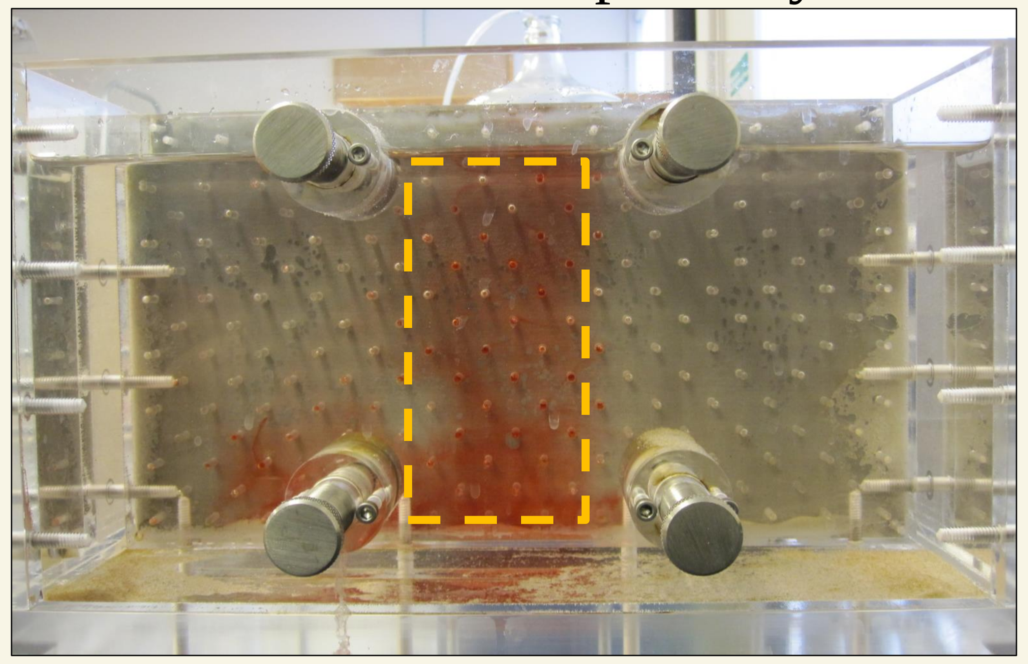




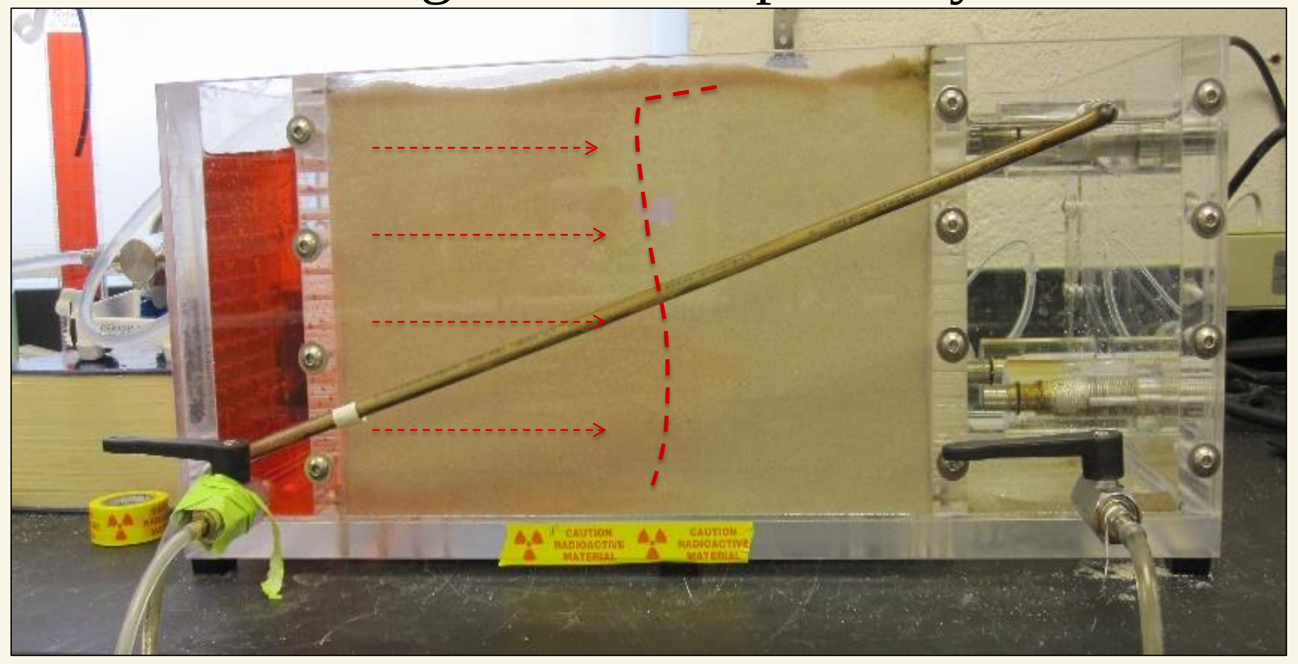
^{3}H + Red Dye

3. Results

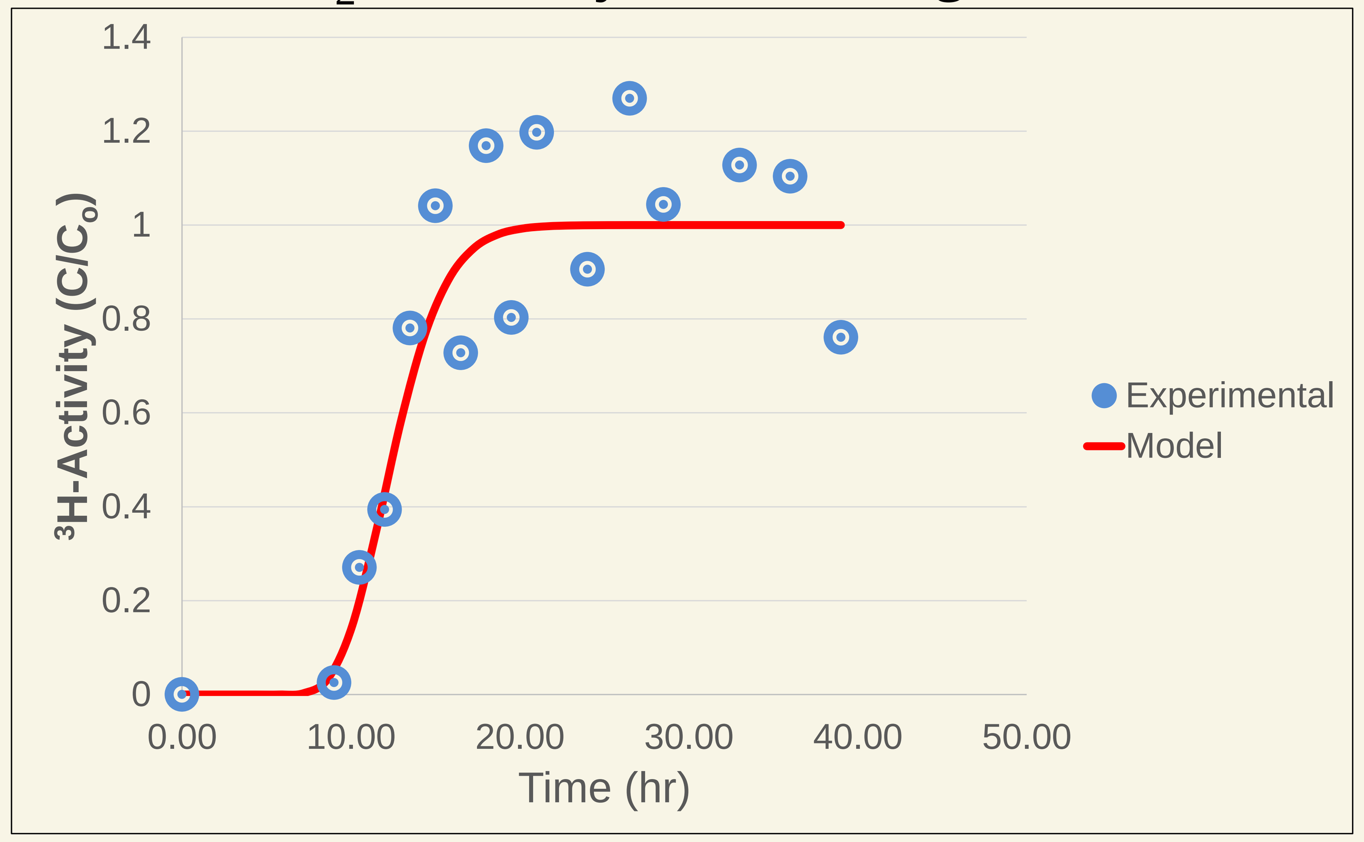
Transverse Dispersivity



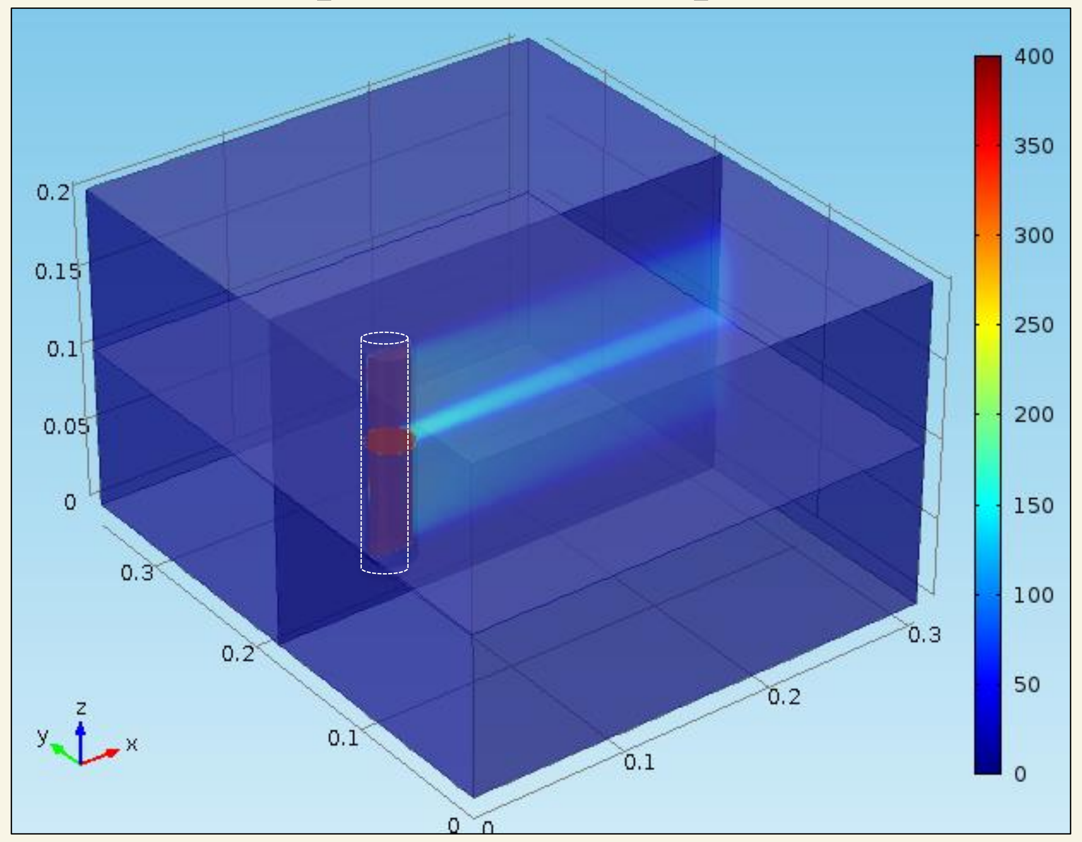
Longitudinal Dispersivity



^3H_2O Activity Breakthrough curve



Example Model Output



This experiment helped to determine certain flow-altering characteristics of the medium within the flow tank. It took 11 h to see a concentration rise in the effluent, and there was a steady climb in concentration until around 18 h. The data in the curve was manipulated via a multitude of different methods to accurately estimate the longitudinal dispersivity of the medium within the tank. The longitudinal dispersivity was found to be around 0.5 cm. This dispersivity will be entered into the model to create more accurate estimates. An example of this 3D modeling is shown above.

4. Discussion and Conclusion

Groundwater remediation is a process that is heavily dependent upon the properties of the subsurface. Dispersion is a huge factor that controls the spread of a chemical's mass from its center, which directly controls the volume of subsurface material affected (Pepper, Gerba, & Brusseau, 2006). Quantifying the dispersivity of the medium in the flow tank will help immensely in trying to accurately predict the zone of influence of the slow-release oxidant candles.

Sources

Christenson MD. 2011. Using slow-release permanganate to remove TCE from a low permeable aquifer at a former landfill. Chemosphere 89: 680-7.

National Research Council. *Alternatives for Managing the Nation's Complex Contaminated Groundwater Sites*. Washington, DC: The National Academies Press, 2012.

Pepper, I. L., Gerba, C. P., & Brusseau, M. L. (2006). *Environmental and Pollution Science* (second). Burlington, MA: Elsevier Inc.

Acknowledgements

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