

## Interactive Visualizations of 5 Million Sensor Measurements of the Capillary Fringe Lead to an Optimized Soil Remedy

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**Background/Objectives.** Concerns of contaminated groundwater impacting clean soils through capillary rise, and the appropriate mitigation measures to address them, were a point of contention between numerous site-stakeholders. To help address concerns, a study was undertaken to characterize capillary rise in site materials, as well as test some candidate mitigation technologies.

**Approach/Activities.** A year-long high-resolution field study was undertaken with approximately 200 soil and groundwater sensors collecting hourly measurements. Sensor data was paired with an on-site meteorological station recording weather conditions in 15-minute intervals. The study focused on understanding the range of elevations where contamination from groundwater may be present in the future. Findings from the high-resolution year-long field study were then integrated with a complementary analysis of the relatively sparser historic site dataset going back 14 years, as well as meteorological data over the past century.

The datasets were too large to analyze using conventional techniques, and consequently custom analytics and visualization software was developed to perform the analysis and communicate findings from the data. The R environment was used to develop a custom data-analysis pipeline which featured novel visualizations and statistical workflows, and heavy use of automation and report reproducibility. Additionally, custom interactive data visualization and reporting tools were built, allowing the project team to interactively explore visualizations of up-to-date data through a web-browser based “data explorer.”

**Results/Lessons Learned.** The results of the study were used in remedial design to determine an appropriate final ground surface elevation, and to identify site areas where construction of a mitigation measure for capillary rise was appropriate. The interactive data visualizations facilitated communication among the stakeholders, which led to greater understanding and ultimately, consensus about the best path forward. The outcome of the study was a highly data-driven, optimized, and efficient site remedy.