Dense nonaqueous phase liquids (DNAPLs) are immiscible groundwater contaminants that are denser than water (e.g., trichloroethylene). When a spill occurs, DNAPLs can migrate deep into the aquifer and become trapped in pores. The trapped DNAPL globules can be removed from the aquifer by injecting fluids into the aquifer through injection wells, similar to waterflooding and other techniques developed by the petroleum industry to enhance the recovery of oil and gas from natural reservoirs. Cosolvent flooding, which consists of injecting alcohol solutions and other miscible solvents into groundwater, has been shown to be an effective in situ method for remediating DNAPL contaminated sites. For this research, we are designing and assembling a two-dimensional laboratory model to investigate effects of “mobility ratio” and horizontal well patterns on residual DNAPL removal efficiency.

The laboratory model for this research will look much like a window mounted in a teacart (see below). The top plate of the model will be framed with aluminum to support beveled glass panes. The bottom plate of the model will consist of a single sheet of glass supported by an aluminum frame. The two plates will be bolted together allowing space in between (2.5cm) for packing with porous materials (e.g., sand). The sand (or other porous media) will be saturated with water and the DNAPL contaminant. Equally spaced ports will be drilled through the frame on the top of the model to simulate injection and recovery wells. The dimensions of the model are 58cm wide x 144cm long x 3.5cm thick. Lightweight aluminum was selected for the frame to facilitate maneuvering and re-positioning of the model, which is needed to simulate various aquifer dip angles. Glass was selected for the panes to observe and monitor flow patterns during cosolvent injection and DNAPL recovery experiments. The model must be able to withstand corrosion associated with water and contact with various DNAPLs and solvent solutions. Given these constraints, the materials for this model need to be appropriately selected and designed to support the weight of the model, withstand corrosion, and contain fluid pressures for all possible experimental conditions.

For this poster presentation, we will describe our prototype and discuss our final laboratory model design. The prototype was made with an aluminum frame and Lexane, which is a high-strength translucent polymer material that we were planning to use instead of glass. As evidenced during our preliminary studies, the Lexane material was not able to withstand the DNAPL contaminants and the alcohol cosolvents. We therefore refined the design of our model to facilitate our operational needs while still providing flexibility. We will also provide detailed information regarding the final design of our two-dimensional laboratory model apparatus.