Applying Environmental Sequence Stratigraphy (ESS) to Optimize Monitoring and Remediation Design for Groundwater Contamination in Glaciated Settings: A Former Nike Missile Site

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This case study documents a groundwater site representative of many contaminated groundwater sites in glaciated areas of the Midwest and Northeastern USA and Canada. Dissolved TCE is exiting the site into agricultural areas via groundwater migration. Agricultural operations necessitate expensive semi-annual installation and abandonment of temporary monitoring points.

To evaluate the monitoring efficiency of off-site contamination we updated the conceptual site model (CSM) by focusing on the geologic conditions resulting from repeated cycles of glacial advance and retreat. Existing site data including boring logs from well installation and MIP data formed the dataset for interpretation of glacial stratigraphy and hydrostratigraphic units. This formed an updated CSM for groundwater flow and contaminant flux away from the site.

In addition to multiple till units, a coarse-grained glacial outwash unit was identified in the subsurface data. Careful mapping of the outwash showed that the unit pinches out onto bedrock highs and also till units, as well as being truncated to the south by a younger till unit. Hydrogeologic (water level) and analytical data were analyzed in the context of the distribution of the outwash unit and showed that the outwash unit represents the preferential pathway for groundwater contamination to leave the site. A revised CSM was developed, consisting of the following: Rainfall events fill the abandoned missile silos, releasing a slug of contaminated groundwater into the outwash unit. Upon exiting the silo area excavation (non-native fill), geochemical change occurs in the native glacial strata and degradation of dissolved TCE begins almost immediately. Because the pathway for contamination is now understood and validated with contaminant concentration data, the monitored natural attenuation (MNA) monitoring network can be significantly reduced as sampling outside of the outwash sand pathway is not necessary. Significant cost savings will be achieved without sacrificing confidence in monitoring effectiveness.