

Novel Mapping of LNAPL Preferential Flow Pathways at a Rail Yard Using Sequence Stratigraphy Analysis

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Background/Objectives. Sequence stratigraphy analysis was used to develop the current site closure strategy for the former sludge lagoons at the Norfolk Southern Enola Rail Yard in Pennsylvania. This tool is a widely embraced sedimentary basin analysis system for mapping preferential flow pathways and rendering a more concise LNAPL conceptual site model (CSM). The CSM describes source and flow pathways for LNAPL associated with an active seep impacting the Susquehanna River.

The objectives of applying sequence stratigraphy analysis to this project included:

1. Identifying the source and migration flow paths for LNAPL migrating to the Susquehanna River
2. Utilizing existing site data without the need for additional subsurface investigation
3. Establishing a framework for designing interim response actions to stop seepage to the river.
4. Providing a basis for communicating a revised LNAPL CSM to the regulators and facilitating informed discussion and stakeholder acceptance.

Approach/Activities. The multi-scale approach at this site included mapping and preparing cross sections of regional and site-specific features to better define the geologic framework and subsurface “plumbing”. A ridge and trough structure related to bedrock lithology was identified that appears to control the seepage pathways. Recognition of the ridge and trough structure was developed through integration of the detailed cross sections with regional geologic and topographic data using Google Earth™ imagery and historic reports. Visualization across scales provided a compelling explanation for site layout of roadways and lagoon berms, and insight into historic site operations which were not known from existing historical documentation. This existing data evaluation was supplemented by LNAPL forensics analysis and a laser-induced fluorescence (LIF) survey. The detailed information was then entered into environmental visualization system (EVS) software to generate a three-dimensional model displaying the bedrock structure and occurrence of groundwater and LNAPL. The 3-D model was the basis for communicating the revised CSM to stakeholders and the regulators.

Results/Lessons Learned. The results of the sequence stratigraphy analysis and updates to the CSM were presented to the Pennsylvania Department of Environmental Protection (PADEP) in June 2015. The PADEP was very supportive of the approach, particularly the integration of site data with the regional “big picture” to understand the geology and the 3-D presentation of the bedrock surface. More importantly, the live presentation of the 3-D model allowed the regulators to manipulate the graphics themselves and obtain a “hands on” understanding of the CSM. Interim action implemented based on the revised CSM was installed in February 2017. The flow path identified by the sequence stratigraphy analysis was confirmed by conditions encountered during excavation of the interim remedy, an interceptor trench.