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AECOM

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

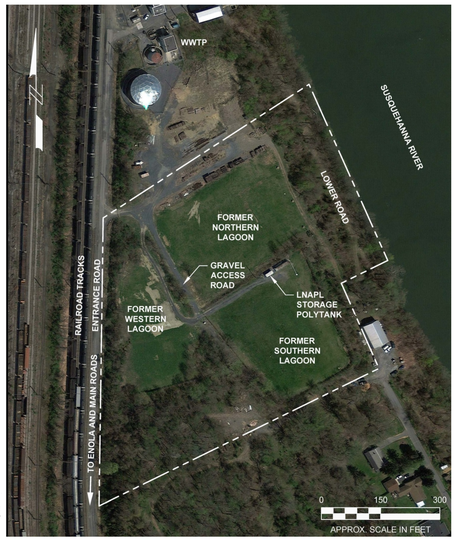
Suzie du Pont (AECOM, Mechanicsburg, PA) | Scott Pittenger (Norfolk Southern Corporation, Atlanta, GA)

Introduction

Mapping the subsurface distribution of light non-aqueous phase liquid (LNAPL) in fractured rock mass is challenging because LNAPLs behave very differently in fractured and bedded rocks than they do in porous media.

The geometry and migration of LNAPL in fractured rock is largely a function of the fluid properties of the LNAPL, the architecture of the fracture and bedding network, weathering and other physical properties of the parent bedrock, and groundwater hydraulics. One key component to unraveling LNAPL behavior in fractured rock is mapping of flow pathways.

Here we present the use of Sequence Stratigraphy Analysis (*Catuneanu, O. 2002. Sequence Stratigraphy of Clastic Systems: Concepts, Merits, and Pitfalls. Journ. African Earth Sci. Pg 1-43.*), a widely embraced sedimentary basin analysis system, for use on an environmental project, mapping preferential flow pathways and rendering a more concise LNAPL conceptual site model (CSM).



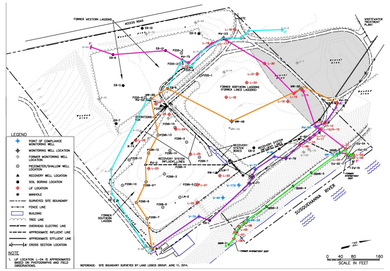
***LNAPL Sludge Lagoon Site**, showing former waste water treatment lagoons. The site abuts the Susquehanna River to east, providing a wealth of depositional and stratigraphic data for analysis.*

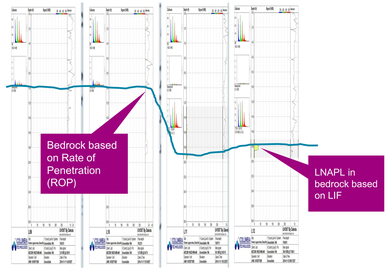
CSM Objectives

ELUCIDATION	Identify the source and migration flow paths for LNAPL migrating to the Susquehanna River
EFFICIENCY	Utilize existing site data without the need for additional subsurface investigation
DESIGN	Establish a framework for designing interim response actions to stop seepage to the river
COMMUNICATION	Provide a basis for communicating a revised LNAPL CSM to the regulators

CSM Components

- Developed cross sections parallel and perpendicular to depositional setting, using existing lithological logs, Laser-Induced Fluorescence (LIF) logs, and geotechnical logs.

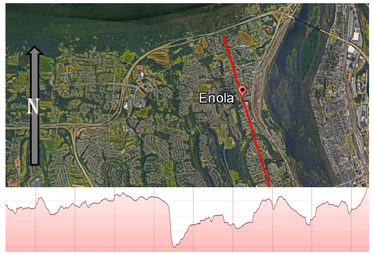


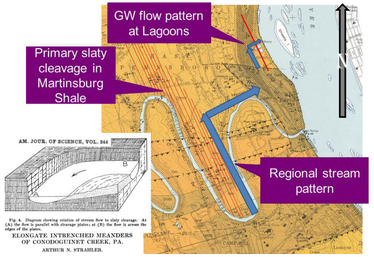


- Integrated information about regional and local geology and topography to understand the underlying structure controlling flow paths.

Regional Aspects

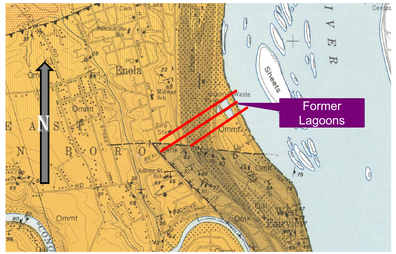
Hummocky terrain identified, suggesting "ridge and trough" bedrock topography.





Local Aspects

Roads and berms of lagoons parallel to strike of formation (on ridges).



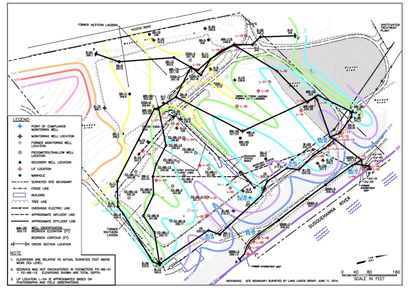
Geomorphology

- Stream flow patterns in bedrock formation support subsurface flow pattern at site (north along cleavage then east)
- Groundwater flow parallel to cleavage planes of Martinsburg Shale bedrock.
- LNAPL migration flow path along bedrock cleavage planes.

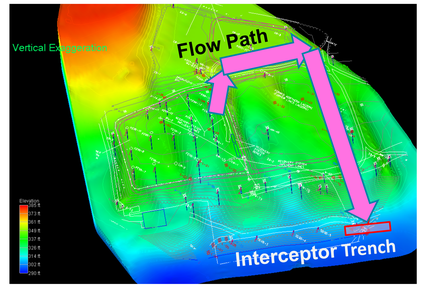
LNAPL Flow Pathway Interpretation

3-D Visualization in EVS

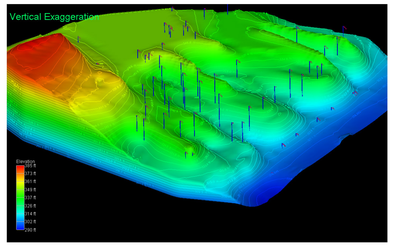
Generated 3-D bedrock contour map using EVS illustrating ridge and trough bedrock structure.



Step 1 - Top of bedrock elevations plotted on the site map and contoured



Primary flow along ridge structure ultimately determined location of LNAPL interceptor trench.



Step 2 - Bedrock surface elevations entered into the EVS system to generate model

Communication

Hand over the mouse - let the regulator "rotate the bus". Live presentation of CSM using the 3-D EVS model provides better perspective during presentation to the regulator.

Confirmation

LNAPL Interceptor Trench

Installed in February 2017, incised the bedding plane of bedrock, and encountered LNAPL seepage at the sandstone/ shale contact identified through Sequence Stratigraphy Analysis.

On-going fluid recovery will provide additional understanding of LNAPL behavior in fractured bedrock and fluvial systems.

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