Applied NAPL Science Review (ANSR)
Vol 1, Issue 3 - March 2011
*Demystifying NAPL Science for the Remediation Manager*



## Introduction

*Applied NAPL Science Review* (ANSR) is a scientific ejournal that provides insight into the science behind the characterization and remediation of Non-Aqueous Phase Liquids (NAPLs) using plain English. We welcome feedback, suggestions for future topics, questions, and recommended links to NAPL resources. All submittals should be sent to Mike Hawthorne. If you know someone who is interested in NAPL science, please forward this issue to them using the "Forward" link at the bottom of the page.

## Context

Volume 1 (2011) of *Applied NAPL Science Review* (ANSR) is focused on tools and scientific concepts to improve NAPL conceptual site models (CSM). An accurate, detailed CSM will cost-effectively guide risk evaluations, remedial action determinations, technology selection, remedial design, and end point attainment (closure) evaluations.

Beginning with this issue, we have adjusted our terminology describing air, NAPL and water interfaces to be more technically precise. From here forward we will use the following conventions:

**AN**: Air/NAPL interface (previously AOI)

**NW**: NAPL/Water interface (previously OWI)

**CGWS**: Corrected Ground Water Surface (No Change)

**ANT**: Apparent NAPL Thickness (No Change)

**FNT**: Formation NAPL Thickness (No Change)

## Announcements

NEW LNAPL WORKSHOP: *Advances in LNAPL Site Management*. March 14-17, 2011, San Diego, CA. 21st Annual Int'l Conference on Soil, Water, Energy, and Air, AEHS Foundation. Click Here for link to conference web page.

## Coming Up

The next newsletter will discuss baildown test drawdown versus discharge graphs as tools to determine if NAPL is confined or perched.

## Related Links

API LNAPL Resources

ASTM LCSM Guide

Env Canada Oil Properties DB

EPA NAPL Guidance

ITRC LNAPL Resources

ITRC DNAPL Documents

RTDF NAPL Training

RTDF NAPL Publications

USGS LNAPL Facts

## ANSR Archives

ANSR Online

# Hydrostratigraphs
## Flexible CSM Visualization Tools

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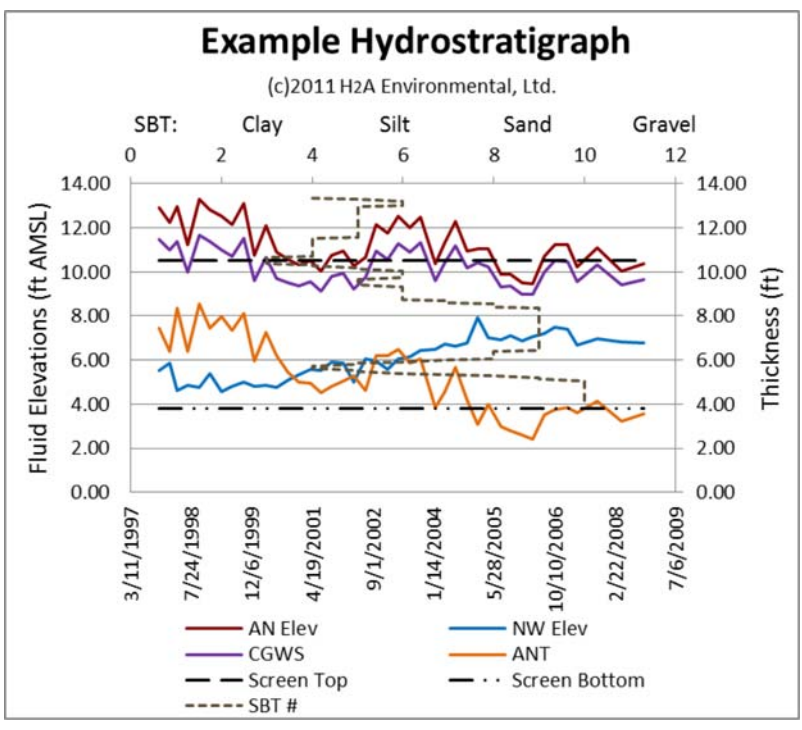
**How can we best visualize complex time-sequential, numeric, single-point conceptual site model (CSM) data? The answer is to take the classic hydrograph and turbo-charge it with stratigraphic and other data to create Hydrostratigraphs.**

**BACKGROUND**: In the preceding issues of ANSR we discussed Light Non-Aqueous Phase Liquid (LNAPL) thickness and Diagnostic Gauge Plots as Conceptual Site Model (CSM) tools. One simple yet powerful vehicle to place these tools in context for a site is the Hydrostratigraph. Hydrostratigraph is a term first coined by the author in 2005 to describe diagrams created by combining hydrograph elevations over time with stratigraphic contact elevations to graphically depict and evaluate the distribution and mobility of LNAPL over vertically varying piezometric conditions.

**DEFINITION**: Three data sets define basic Hydrostratigraphs:

- Elevation vs. Time: Elevation-related data such as LNAPL hydrograph and well screen elevations are graphed on the primary horizontal (time) and primary vertical (elevation) axes regardless of whether that data is static or dynamic over time.
- Thickness vs. Time: With the addition of a second vertical axis, apparent LNAPL thickness (ANT) at a vertical scale sufficient to identify trends over time is plotted on the primary horizontal time axis.
- Stratigraphy vs. Elevation: Lithologic contacts are plotted on the primary horizontal (time) and vertical (elevation) axes.

In addition, advanced Hydrostratigraphs may be constructed by adding a second horizontal axis (any data type or scale) that may be matched to the primary or secondary vertical axis. Advanced Hydrostratigraphs incorporate a broad range of data such as laser induced fluorescence (LIF), hydrocarbon production, or cone penetration testing (CPT) soil behavior type (SBT) data.




**INTERPRETATION**: Basic Hydrostratigraphs incorporate Air/NAPL (AN), NAPL/Water (NW), Corrected Ground Water Surface (CGWS) and stratigraphic contact (e.g., confining layer) elevations as well as apparent NAPL thickness (ANT) trends. These trends can be useful in identifying periods of unconfined, confined or perched LNAPL. The ANT for unconfined LNAPL will approximate the formation NAPL thickness (FNT). The FNT for confined or perched LNAPL may be estimated based on the difference between the key stable interface (see Table) and the respective confining or perching layer elevations.

Advanced Hydrostratigraphs (e.g., production Hydrostratigraphs, CPT Hydrostratigraphs, LIF Hydrostratigraphs) provide a vehicle to visualize and interpret microstratigraphic impacts on LNAPL distribution and recoverability.

**SUMMARY**: Hydrostratigraphs are a blend of hydrographs and stratigraphic cross-sections, making them ideal time-sequential single-point conceptual site model (CSM) visualization and analysis tools. Hydrostratigraphs and Diagnostic Gauge Plots (ANSR v1i2) are superb co-analysis tools.

### Key to Hydrostratigraph Analysis

| Hydro Geology | *Stable Interface | Key Interpretive Boundary | Dynamics |
|---|---|---|---|
| Unconfined | None | No confining or perching boundary in AN/NW range | ANT increases as AN, NW and CGWS elevations decrease, and vice versa |
| Confined | NW | AN interface above confining boundary | ANT increases as AN and CGWS elevations increase, and vice versa |
| Perched | AN | AN interface above perching boundary | ANT decreases as NW and CGWS elevations increase, and vice versa |

*constant equilibrium interface elevation ©2011 H2A Environmental, Ltd.

**REAL WORLD LIMITATIONS:** A word of caution – vertical gradients, non-equilibrium conditions, and other factors can affect the results of a Hydrostratigraph analysis. For example, confined or perching conditions may exist as a result of relatively minor grain size variation and the resulting capillary contrast rather than the presence of a sharp stratigraphic contact. Of particular concern, true equilibrium conditions may only rarely, if ever, be attained at a site. Complex stratigraphic sequences across screened intervals can mask ideal trends. Multiple lines of evidence should be used.

*Next month we will explore drawdown versus discharge (DvD) plots as tools to identify confined and perched NAPL. DvDs are useful NAPL Conceptual Site Model (CSM) tools to augment Diagnostic Gauge Plot and Hydrostratigraph analyses.*

Until then, feel free to call or email us with any questions about how Hydrostratigraphs can be used in modern day NAPL science to minimize your site remediation costs.



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