LNAPL Transmissivity
Acceptance and Use by the Regulatory Community

October 2017
LNAPL TRANSMISSIVITY ($T_N$) ACCEPTANCE AND USE BY THE REGULATORY COMMUNITY

→ Kimball, C.G., Hawthorne, J.M., Menatti, J.A., Rousseau, M.

→ Historically, apparent NAPL thickness (ANT) gauged in wells has been utilized as the threshold metric for determining when LNAPL recovery was needed and the shutdown metric to signify the end-point to LNAPL recovery.

→ LNAPL transmissivity ($T_N$) is an improved metric over ANT to quantify LNAPL recoverability and provides a reliable metric to define when LNAPL has been removed to the “Maximum Extent Practicable” (MEP), and may also be used to determine when hydraulic recovery of LNAPL may be a feasible LNAPL mass reduction technology.
SURVEY GOALS AND METHOD

How is the $T_n$ being used in the regulatory decision process, to determine:

1.) the feasibility of or regulatory requirement for hydraulic LNAPL removal
2.) the ability to cease hydraulic LNAPL recovery based at least in part on $T_n$ values while LNAPL is still present at a site

10 question internet survey
- United States, Canada, Australia and New Zealand

26 of 50 US State Regulators responded

US response is the primary focus, international comparison where appropriate
STATE ACCEPTANCE OF $T_N$ AS A METRIC

- 26 responses
- (blue) 18 (69%) accept $T_n$ as a metric
- (orange) 8 (31%) do not accept $T_n$ as a metric
- International 67% accept $T_n$: Canada 60%, Australia 100%, New Zealand 0%
WHEN DOES YOUR REGULATORY AGENCY ACCEPT LNAPL TRANSMISSIVITY AS A METRIC TO DETERMINE IF LNAPL HYDRAULIC RECOVERY IS FEASIBLE OR REQUIRED?

- leading metric 31%
- lagging metric 35%
- additional line of evidence 11%
- track the ongoing progress of recovery 11%
- contingent on site specifics 12%

When asked specifically about using $T_n$ to support that LNAPL has been removed to the “Maximum Extent Practicable”, 50% indicated that it is accepted as a line of evidence.
WHAT $T_N$ VALUE DOES YOUR REGULATORY AGENCY ACCEPT AS A THRESHOLD FOR MAKING DECISIONS?

For those accepting $T_n$:

- 11% (two states) have set a numeric threshold value below which hydraulic recovery is not effective or efficient (0.5 ft$^2$/d and 0.8 ft$^2$/d).
- 50% have numeric guidelines of 0.1 to 0.8 ft$^2$/d (ITRC 2009 guidelines)
- 39% have not offered numeric guidelines but consider it to be negotiable dependent upon site conditions
WHAT OTHER METRICS DOES YOUR AGENCY ACCEPT TO DETERMINE WHEN LNAPL HAS BEEN REMOVED TO THE "MAXIMUM EXTENT PRACTICABLE"?

**Figure 4**
Accepts Other Metrics for Determining Maximum Extent Practicable Removed

- Asymptotic trend in LNAPL recovery rate or decline curve: 89%
- Demonstrate remaining LNAPL is largely at residual saturation (e.g., via soil core petrophysical testing): 61%
- Specific de minimis recovery threshold (e.g., 3 gallons per quarter): 39%
- Financial threshold (e.g., dollars per gallon): 28%
- Oil/water ratio threshold (e.g., 0.001 oil to water ratio): 22%
- Percentage of expected ultimate recovery (e.g., 90% of expected ultimate recovery): 17%

Legend:
- Blue: Accepts Tn as Metric
- Orange: Does Not Accept Tn as Metric
WOULD YOU CLOSE A SITE WITH LNAPL? WOULD IT REQUIRE INSTITUTIONAL CONTROLS?

**Figure 5**
Would you Close a Site with Mobile, Not Migrating LNAPL

- Yes: 31%
- No: 11%
- Maybe: 58%

89% consider it a possibility

**Figure 6**
Would you Require Institutional Controls to Close a Site with LNAPL

- Yes: 46%
- No: 29%
- Maybe: 25%

71% want Institutional Controls
DOES THE AGENCY REQUIRE $T_n$ TESTING PER ASTM?

DOES THE AGENCY ACCEPT THE API WORKSHEET?

**Figure 7**
Require ASTM Guidance for $T_n$ Testing

- Yes: 30%
- Recommended (Not Required): 25%
- No: 45%

**Figure 8**
Accept API Worksheet to Calculate $T_n$

- Yes: 75%
- Likely: 25%
HAS YOUR REGULATORY AGENCY WRITTEN LNAPL TRANSMISSIVITY_THRESHOLDS INTO RULES OR GUIDANCE DOCUMENTS?

- 12% (two states), have written guidance that includes $T_n$ thresholds
- 15% indicated that there could be written thresholds on a site specific basis: some had procedures but no thresholds, others would consider a lagging threshold depending on the site conditions
- 27% of the responding states are planning to propose written $T_n$ thresholds as rules or guidance
- 46% do not have plans to incorporate $T_n$ thresholds into rules or guidance documents
A regulatory framework exists. $T_n$ has been accepted in most states in official state correspondence as a remedy start-up metric, progress metric, remedy shutdown metric, and/or to represent MEP.

Several states have also included LNAPL transmissivity metrics in regulations and/or official guidance documents. 

Modified after Hawthorne et al (2016)
COMPARED TO 2009

→ The ITRC 2009 guidance document (Evaluating LNAPL Remedial Technologies for Achieving Project Goals, Technical/Regulatory Guidance) included the results of a survey of all 50 states
  ▪ 38 states responded

→ Using LNAPL thickness as a basis to determine if remediation is required dropped from 18% in 2009, to approximately 3% in 2016

→ Considering the conditions needed to terminate active remediation systems: In 2009 40% responded that all measurable LNAPL must be remediated, in 2016 approximately 8% of respondents indicated that LNAPL thickness is a primary factor for ending remediation
CONCLUSIONS

The determining factor for the feasibility of LNAPL hydraulic recovery continues to move away from using measurable thickness in a monitoring well (ANT) as the primary factor. Remediation efforts and site closure are considering site specific geologic conditions, receptor health risks and a growing acceptance of $T_n$ as a way to quantify the recoverability of LNAPL. For most, $T_n$ is primarily a line of evidence, but some regulatory agencies are beginning to establish thresholds for when hydraulic LNAPL recovery could be initiated or may be terminated.