Sources of Ground Water Contamination and NAPL

April 10, 2012

Presenter: Jeffrey Farrell – PS&S

General Intent

- This section of the guidance addresses:
  - Saturated Zone contamination/sources;
  - Unsaturated Zone contamination/sources; &
  - Free Phase Non-Aqueous Phase Liquid (NAPL) or Residual NAPL when Present in either the saturated or unsaturated zones.

Triggers for Ground Water Investigations

- N.J.A.C. 7:26E – 4.4(a) identifies 4-triggers:
  1. GW w/contaminant above GW Remediation Standard;
  2. Soil w/in 2-feet of GW/Bedrock w/contaminant above applicable Soil Remediation Standard (SRS);
  3. Soil w/in the AOC w/contaminant above SRS and no plans to remediate or remove; and
  4. Contaminant w/water solubility>100mg/L @ 20˚-25˚C
     - Soils (between contaminant(s) and saturated zone) are <15% silt and/or clay; OR
     - Any part of AOC w/in 2,000 feet of public supply well.

If NAPL Identified

- Reminder- N.J.A.C.7:26E 1-12(a) & (b)

(a) As a first priority …

1. Identify … any interim remedial measures (IRM) necessary to
   - remove, contain, or stabilize a source of contamination to prevent contaminant migration and exposure to receptors; and

(b) … follow the Department's LNAPL Free Product Interim Remedial Measures guidance

(Regulatory/Mandatory Time Frames Apply)

Delineation Process and Source Identification

- Assess known Hydrogeologic Framework;
- Create/Update Conceptual Site Model;
- Delineate Contaminant Extent:
  - Soil Impacts,
  - Dissolved Constituents,
  - Address NAPL.

Source Identification

- Unsaturated Zone Sources
  - Soil constituents leaching into GW
  - Assess/Develop Site Specific IGW SRS
    - Default Values (very conservative!)
    - Soil Water Partition Equation
    - SPLP (with spreadsheet)
    - Seasonal Soil Compartment Model (SESOIL)
    - SESOIL/AT123D

Source Identification

- Saturated Zone Sources
  - Constituents leaching into GW
  - NAPL or Residual NAPL
  - Source Zone "non-NAPL" layers

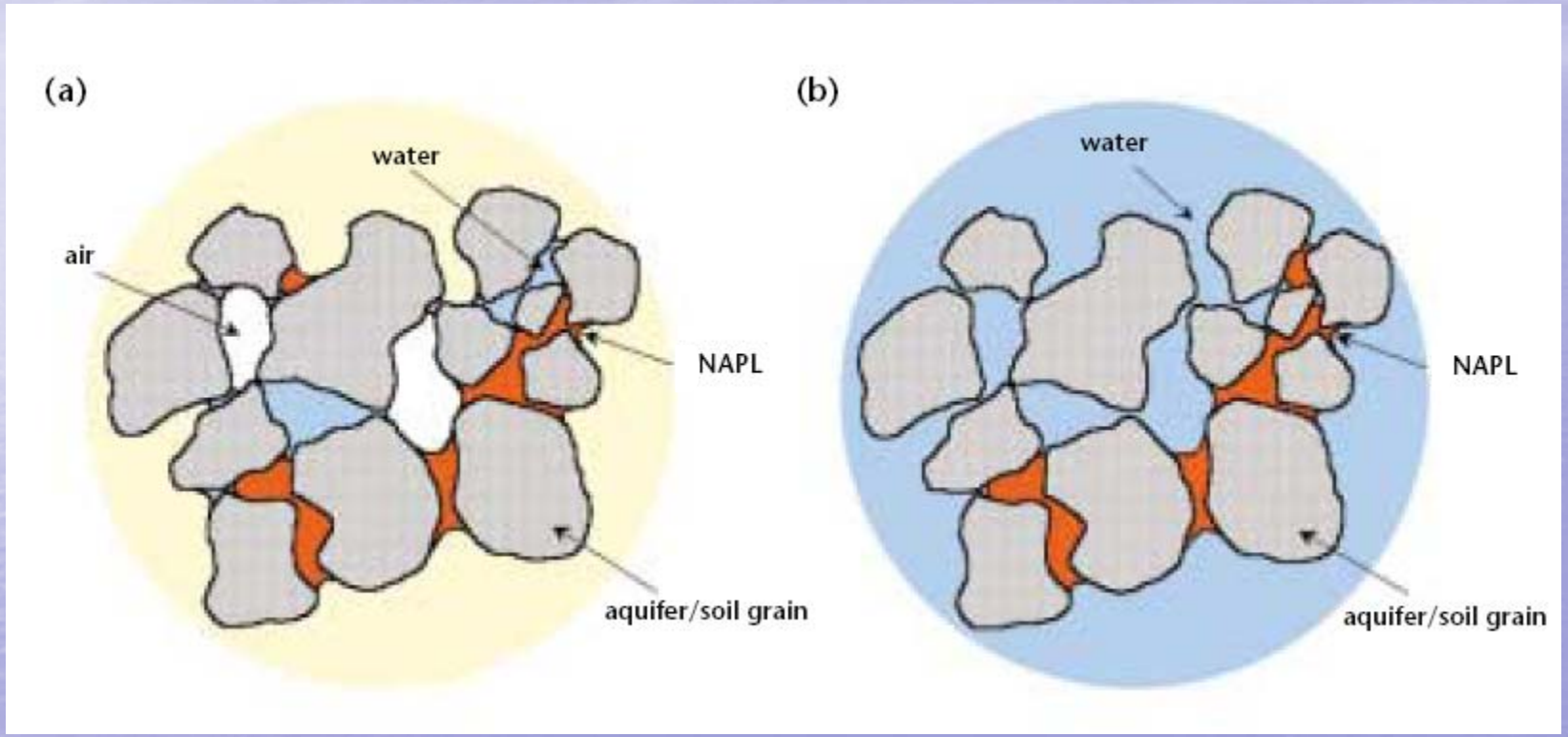
Source Detection Methods

- Method Success Depends On:
  - Geology/Lithology;
  - Degree of Consolidation;
  - Depth to Groundwater; and
  - NAPL Composition

Source Detection Methods

- Soil Gas Surveys Screen For:
  - LNAPL Plumes,
  - DNAPL Release Location,
  - Dissolved constituent source areas
- Constraints for Soil Gas Surveys:
  - Low Permeability soils,
  - Saturated Soils

Soil Gas Constraints



(a) unsaturated zone (b) saturated zone

Modified from: UK Environment Agency "Illustrated handbook of DNAPL transport and fate in the subsurface" (2003)

http://www.clu-in.org/conf/itrc/dnaplpa/dnapl_handbook_final.pdf

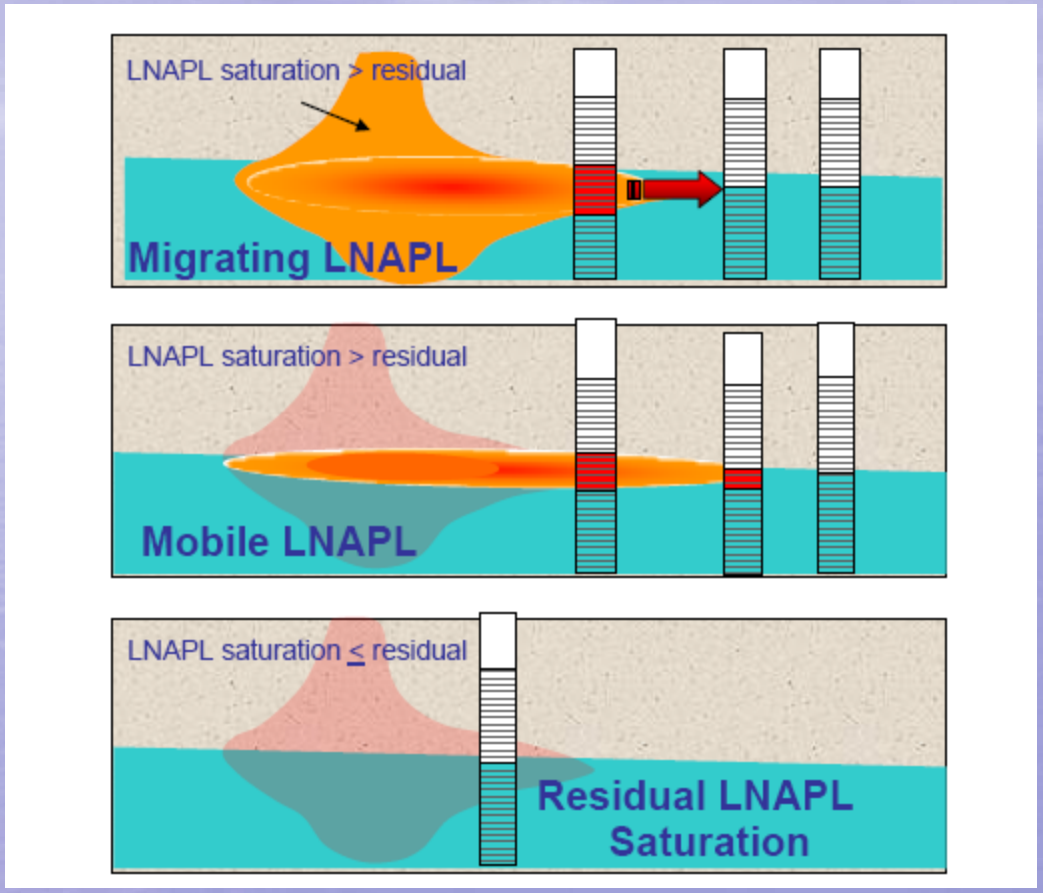
Source Detection Methods

- Direct Push Techniques
  - Membrane Interface Probes (MIPs - both)
  - Cone Penetrometer (both NAPL types)
    - Laser induced Fluorescence - LNAPL

Source Detection Methods

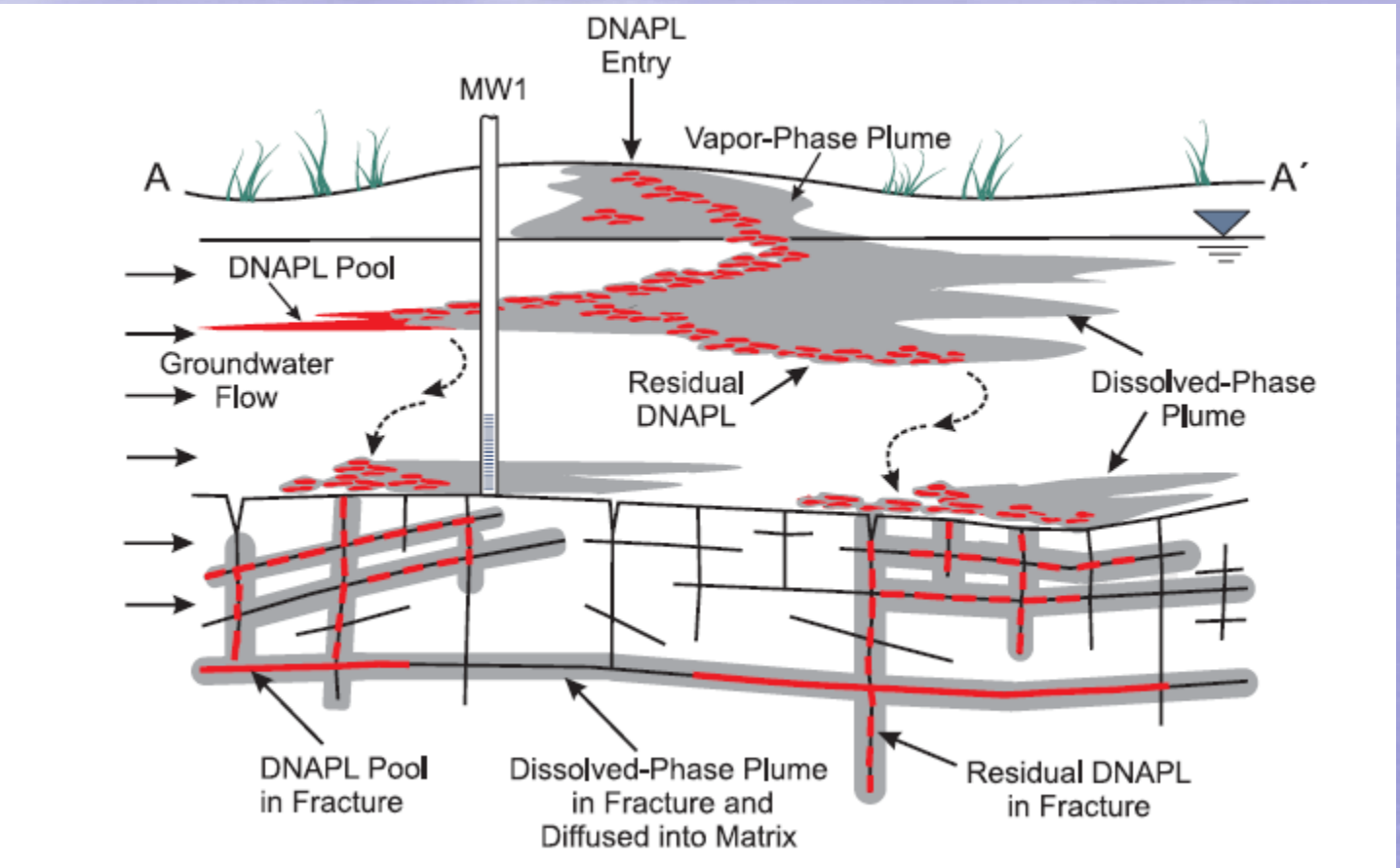
- Geophysical Techniques
  - Acoustic
  - Electrical Resistance
  - Electromagnetic
- Geophysical Constraints:
  - Very Specialized/Expensive
  - Provides Indirect Evidence
  - Requires Confirmatory Techniques

NAPL Primer - LNAPL



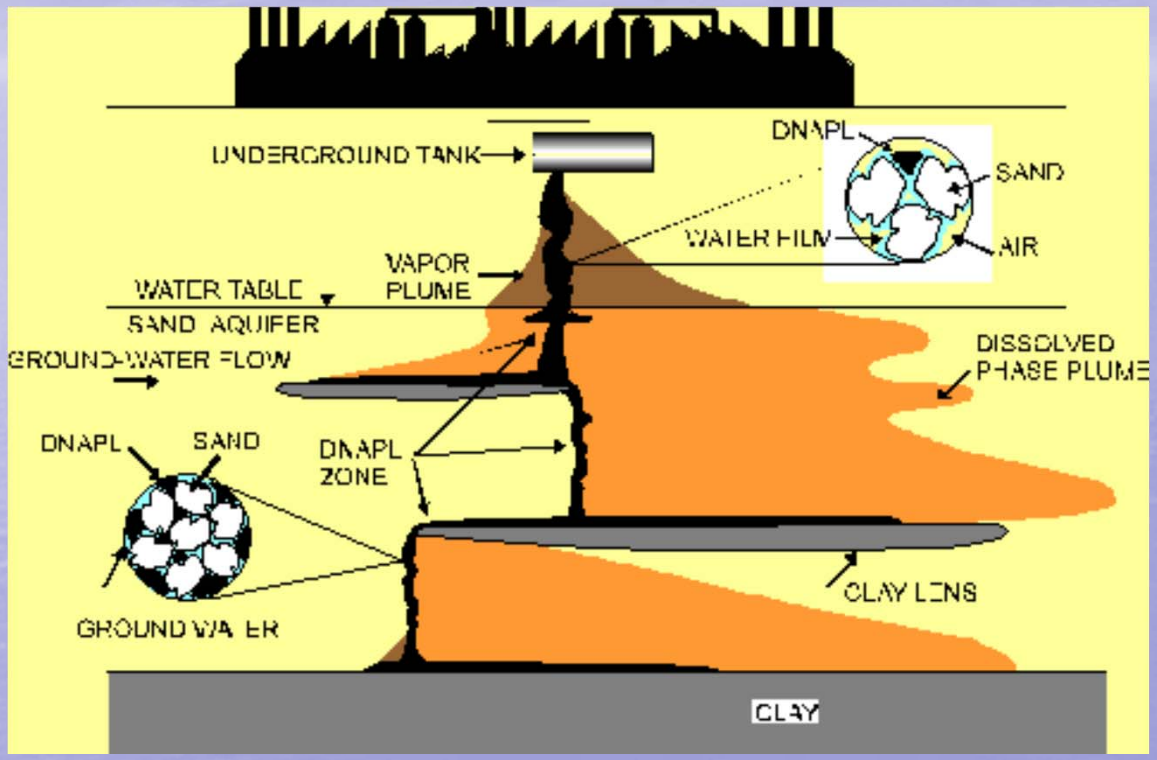
From: ITRC - Evaluating LNAPL Remedial Technologies for Achieving Project Goals (December 2009)

NAPL Primer - DNAPL



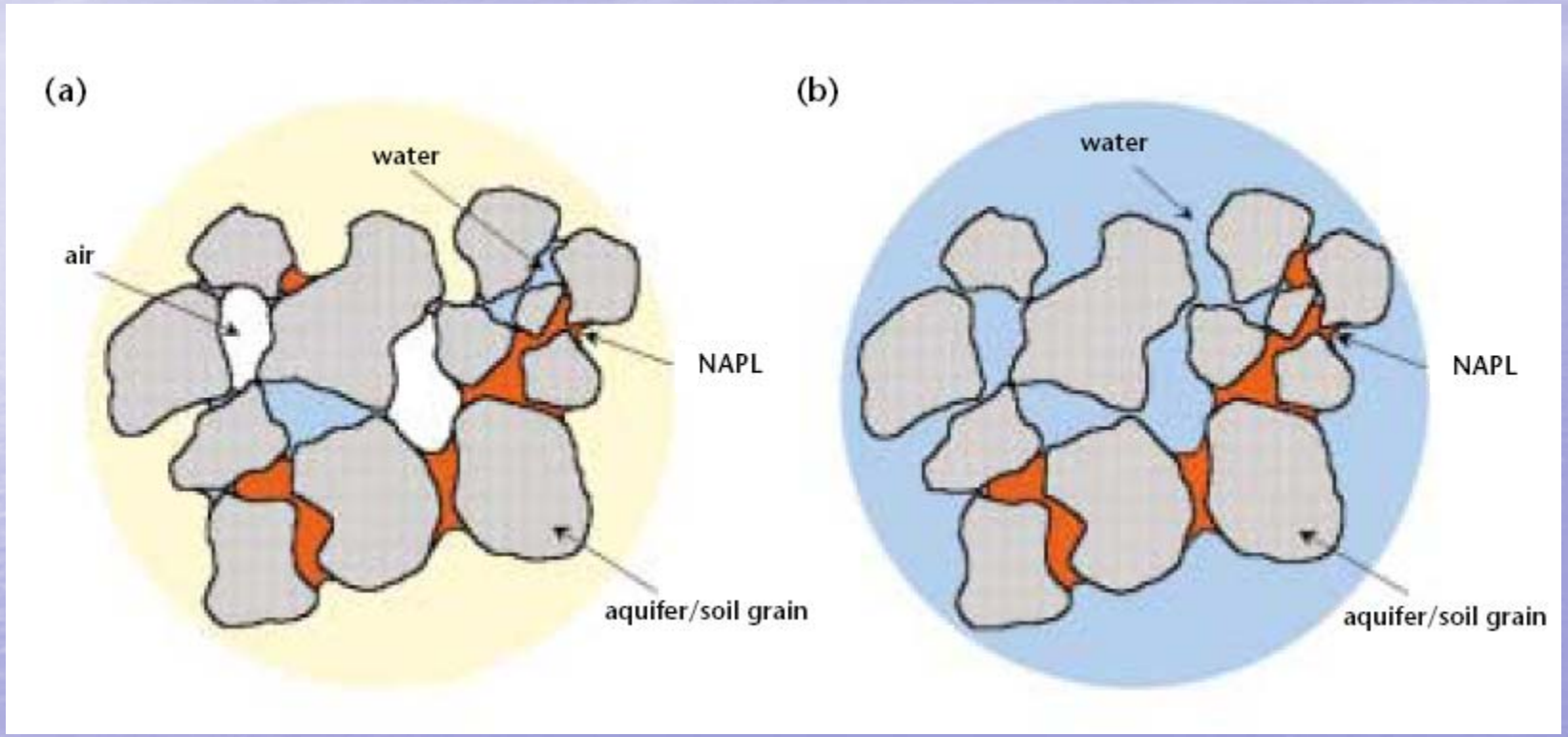
From: EPA - Assessment and Delineation of DNAPL Source Zones at Hazardous Waste Sites (2009)

NAPL Primer - DNAPL



From: ITRC – An Introduction to Characterizing Sites Contaminated with DNAPLs (September 2003)

NAPL Source Comparison



(a) unsaturated zone (b) saturated zone

Modified from: UK Environment Agency "Illustrated handbook of DNAPL transport and fate in the subsurface" (2003)

http://www.clu-in.org/conf/itrc/dnaplpa/dnapl_handbook_final.pdf

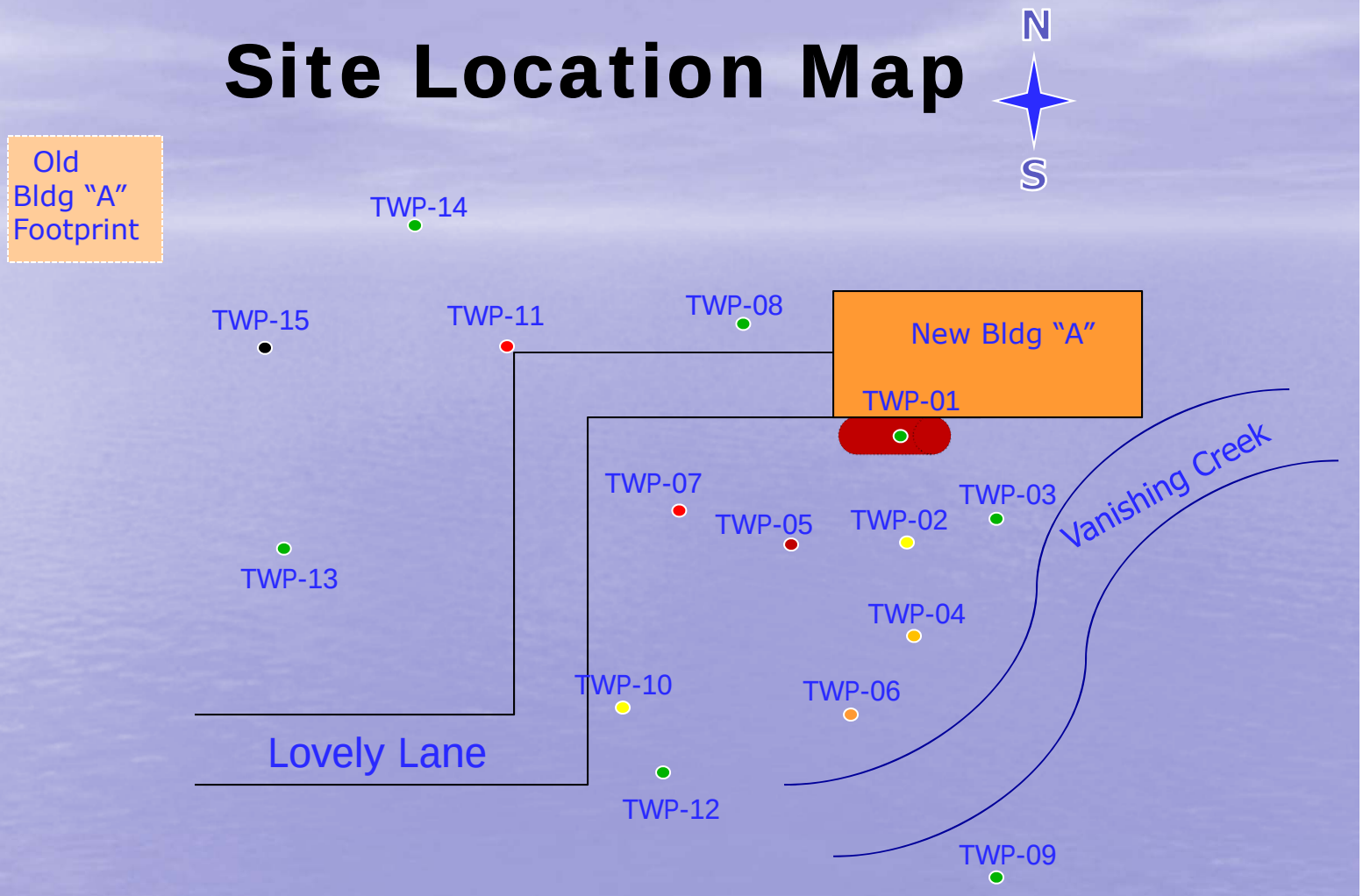
NAPL Source Delineation

- Delineation is an Iterative Process
  - Evaluate what you Know
  - Develop or Modify your Conceptual Model
  - Collect Additional Data
  - Repeat until done

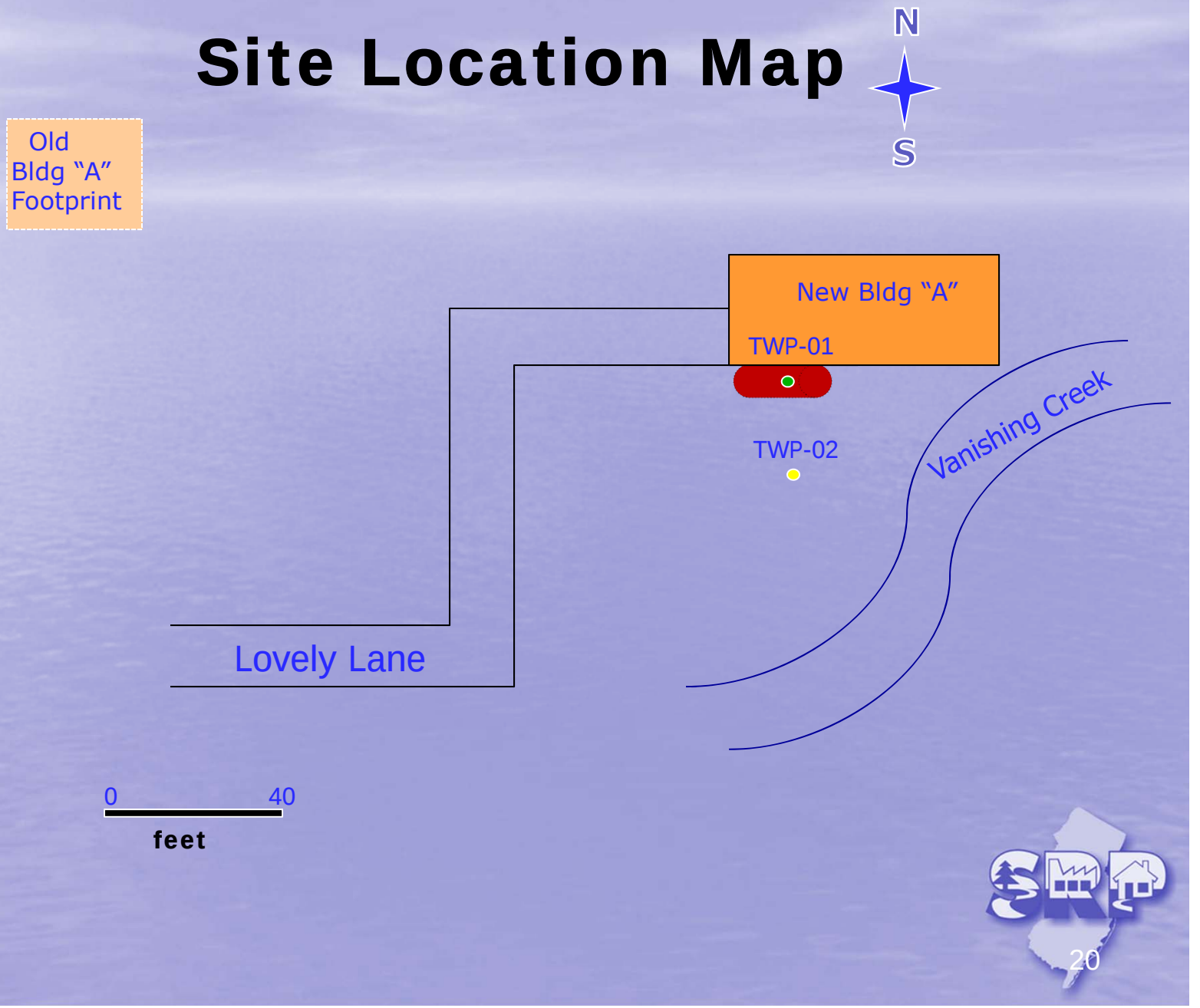
NAPL Source Delineation

- Use outside-in approach
- Start delineation at the expected “clean” zone and find a clean perimeter;
- Move in to “dirty” zones;
- As data is known, refine.

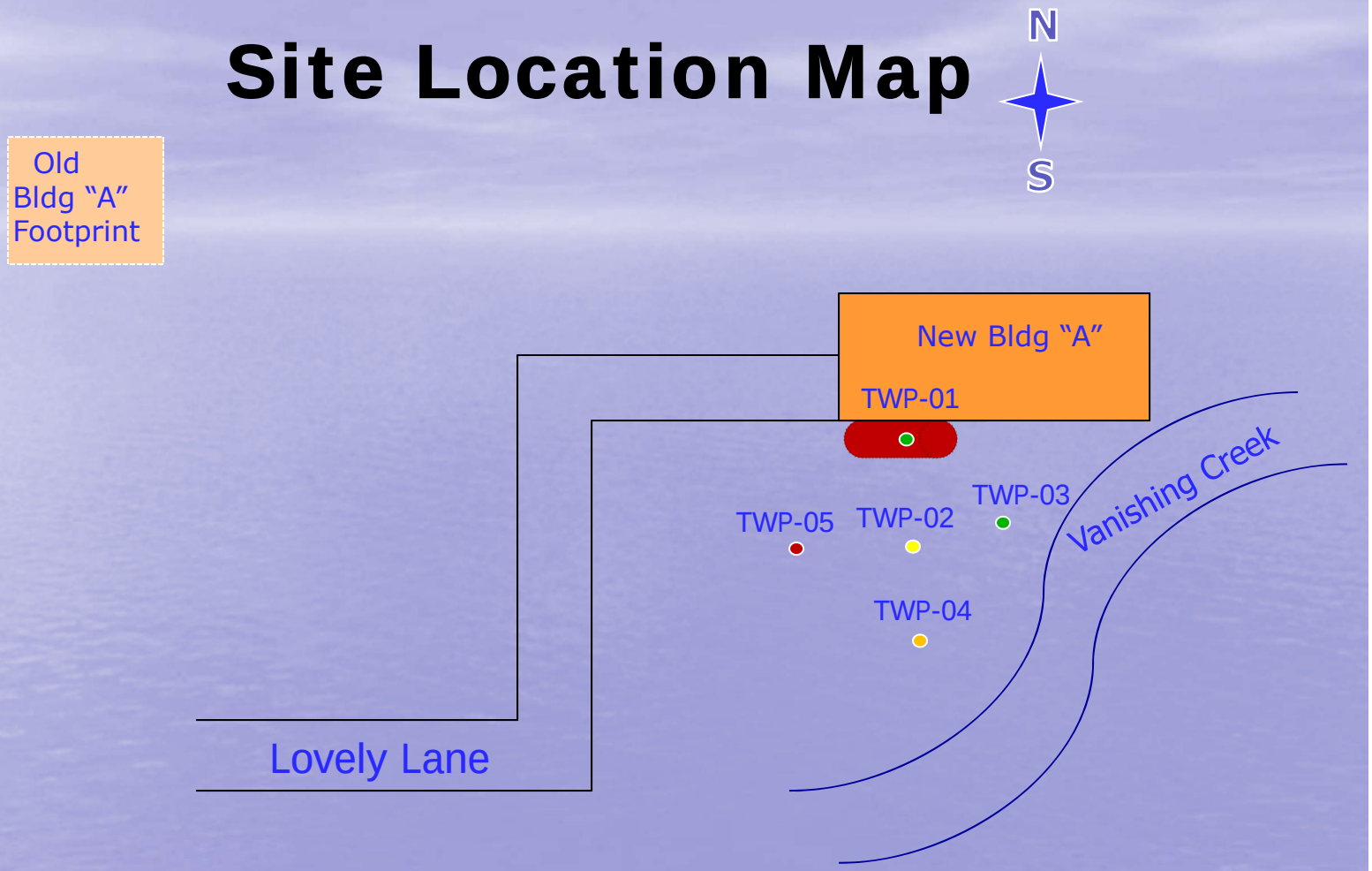
Site Location Map



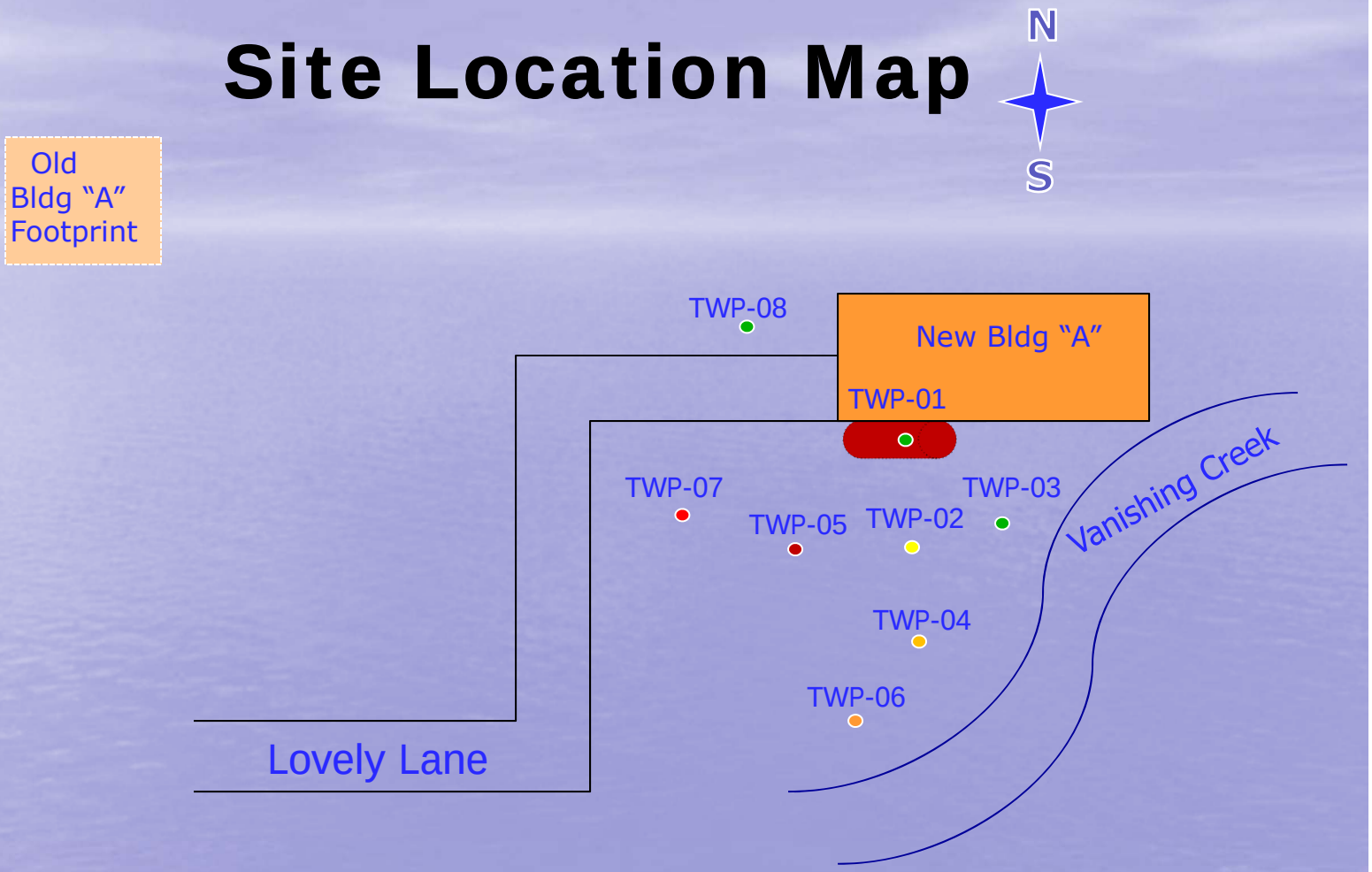
Site Location Map



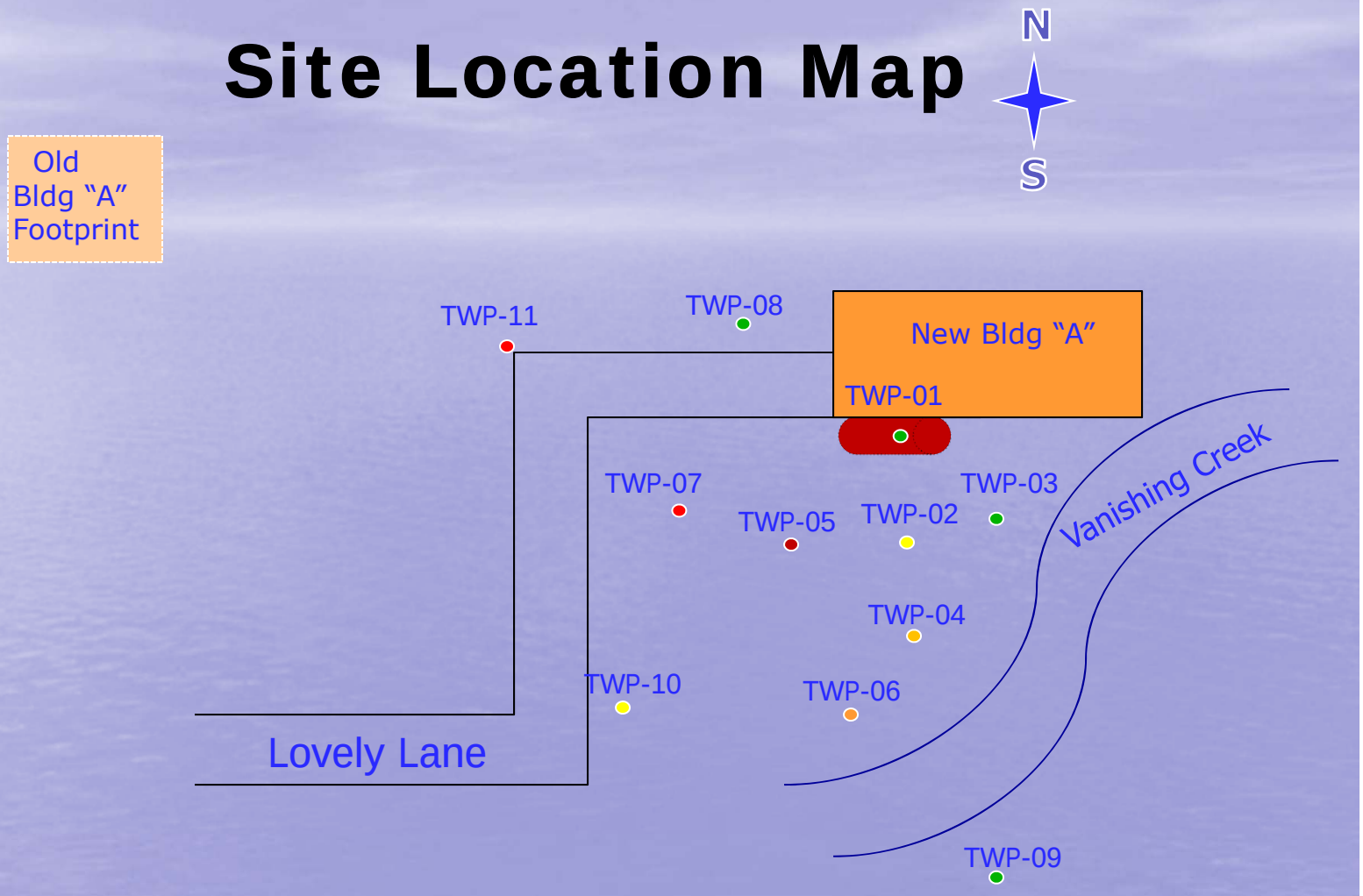
Site Location Map



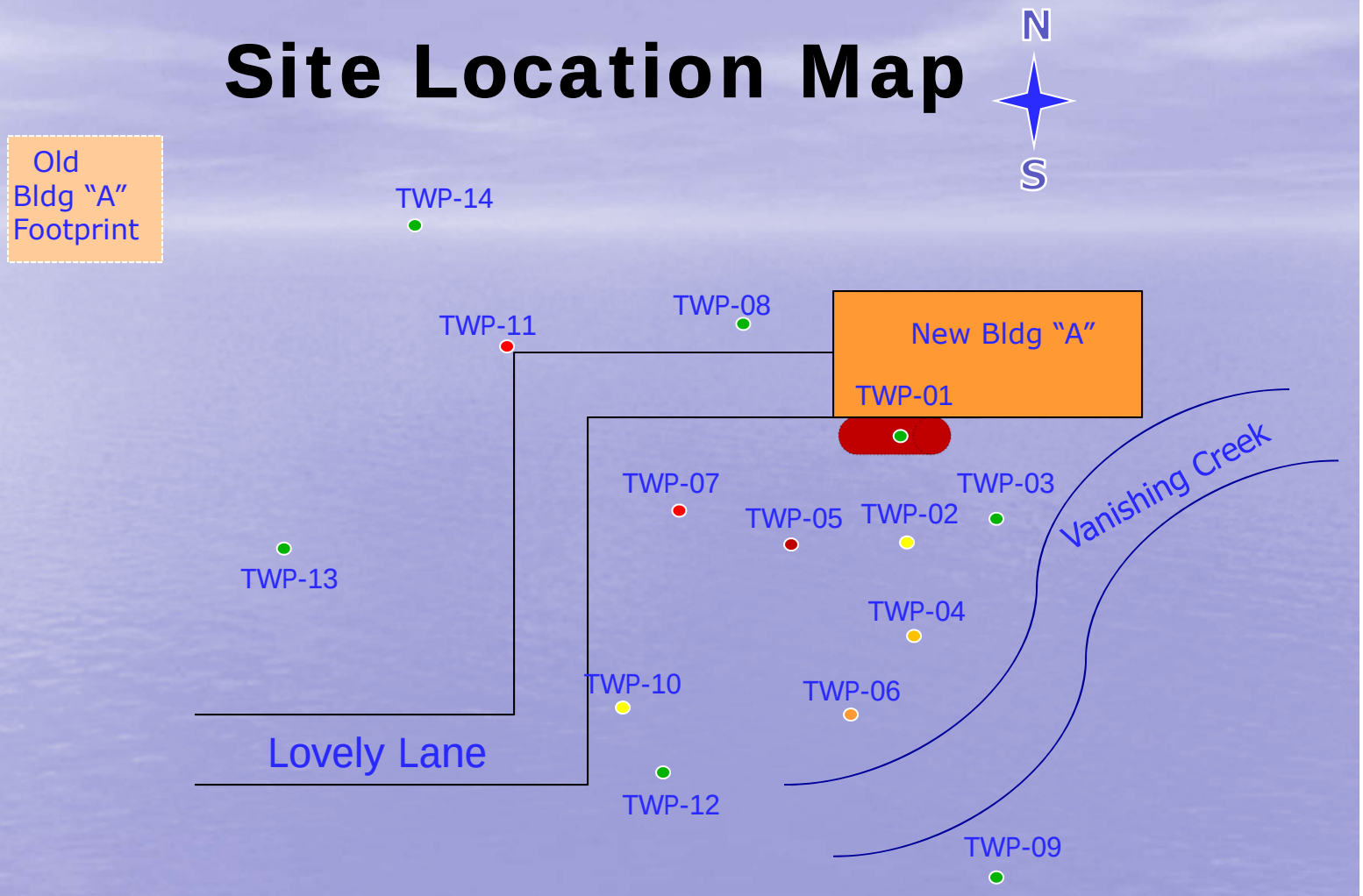
Site Location Map



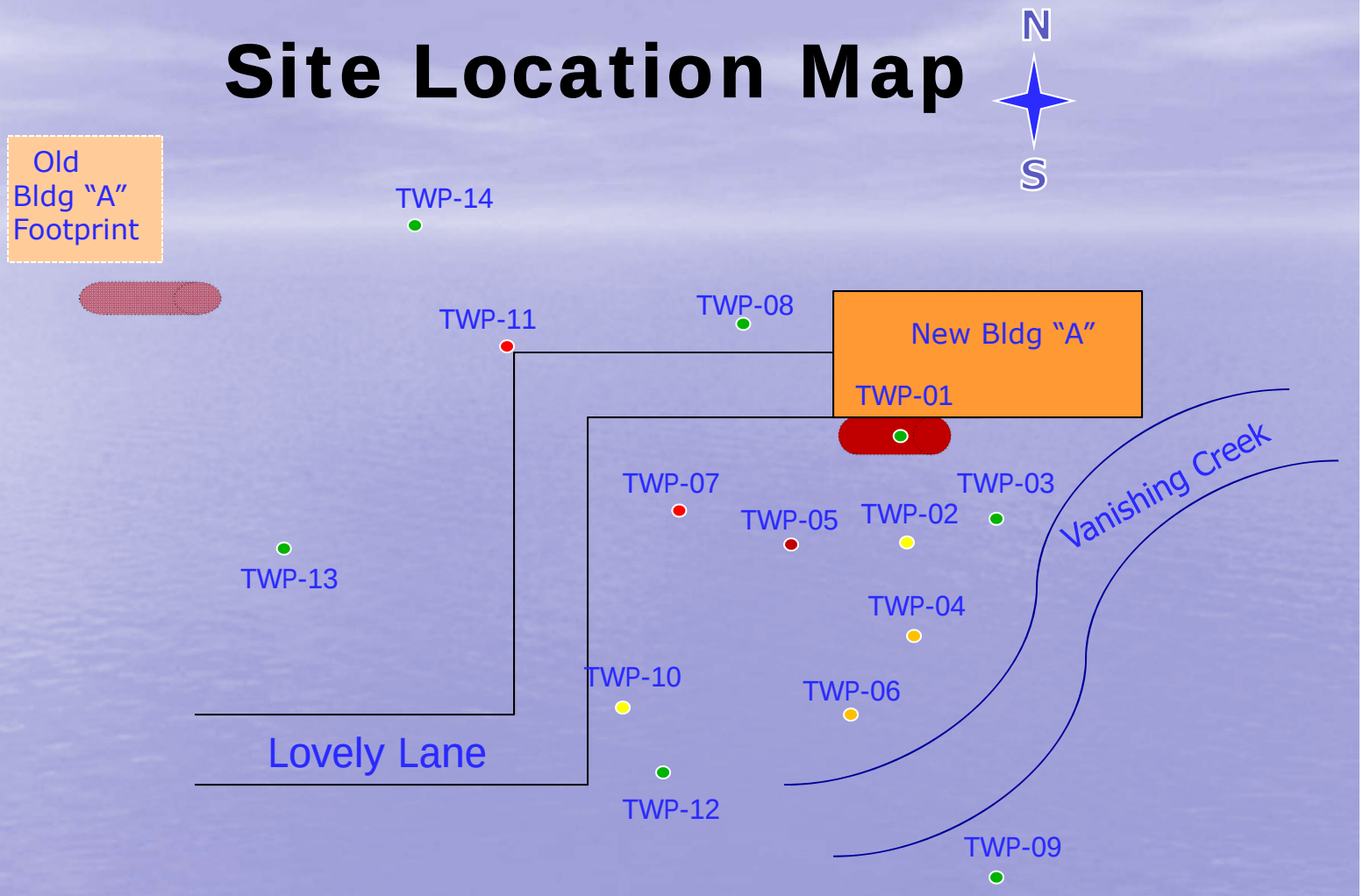
Site Location Map



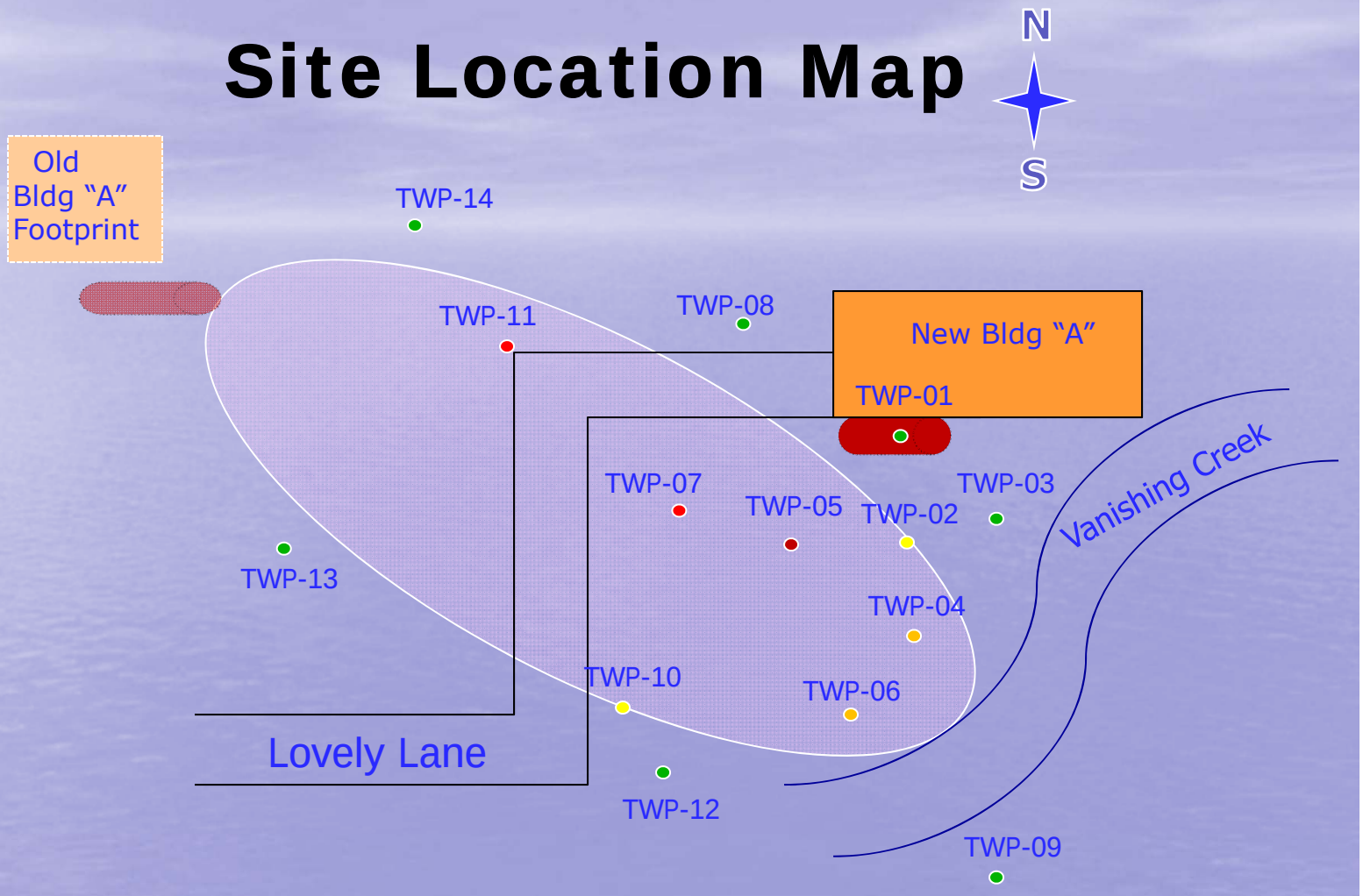
Site Location Map



Site Location Map



Site Location Map



NAPL Detection

So you have completed GW delineation of the dissolved phase. What questions should you ask?

- Does my data indicate that a NAPL source exists?

NAPL Detection

- Review Field Data (N.J.A.C. 7:26E 3.6(a); 7:26E 4.4(g))
  - Soil Screening Results during Well Installation:
    - Visual Observations;
    - FID/PID;
    - Hydrophobic Dyes;
    - Ultraviolet Fluoresence

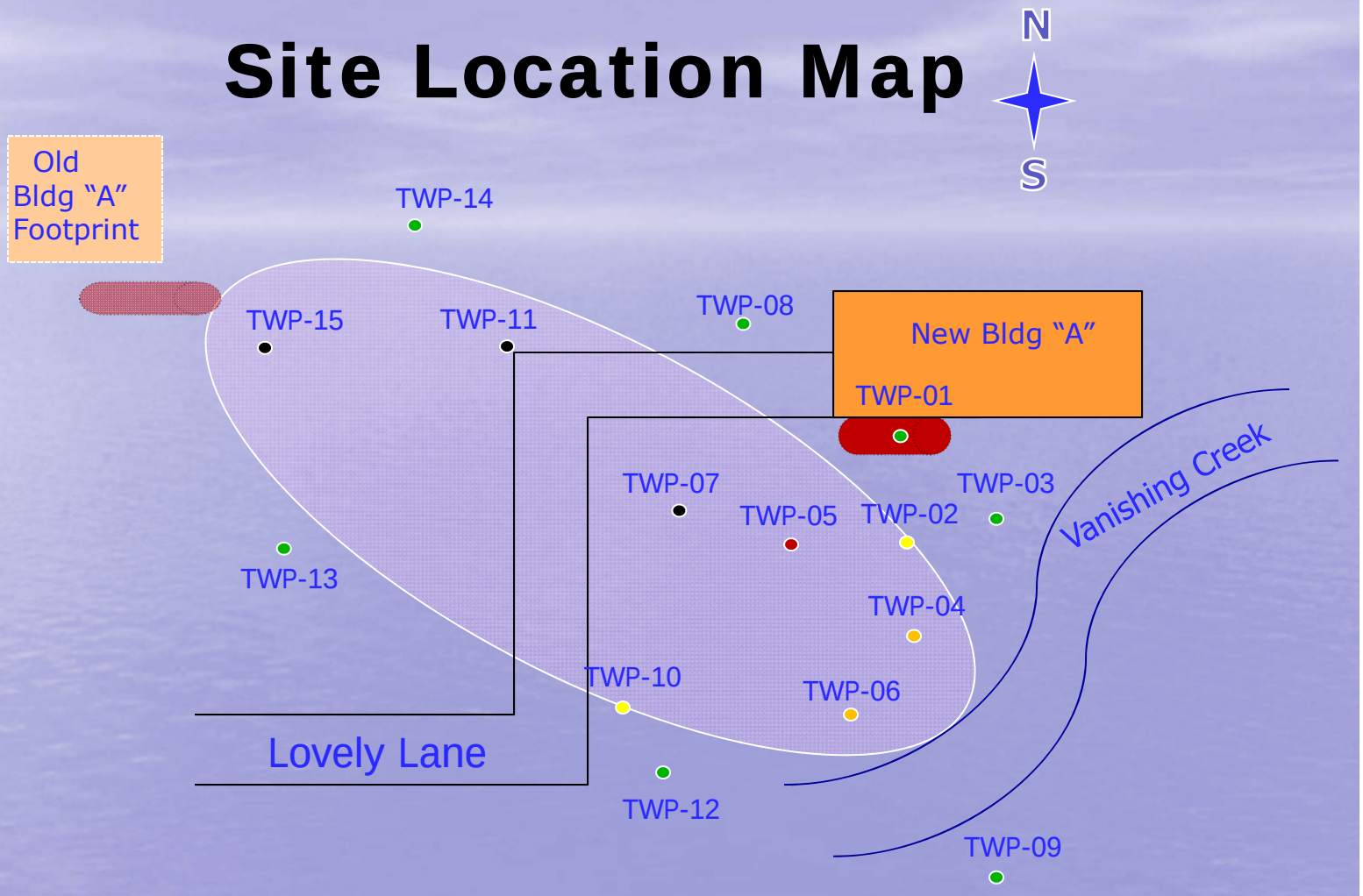
NAPL Detection

- Review GW Data:
  - 1 % rule for DNAPL
  - Threshold DNAPL Saturation Calculation
  - Soil Saturation Limit (LNAPL/DNAPL)

1% Solubility Rule

- Tetrachloroethylene (PCE) has an approximate pure phase solubility of 150 mg/L and an effective solubility of approximately 133 mg/L.
- 1% of the effective solubility = 1.33 mg/L or 1,330 ug/L (1,330 ppb).
- GW concentration of PCE ≥ 1,330 ppb infers that DNAPL may be present.

Site Location Map



Conclusion

- There are many tools available to identify source and delineate impacts
- Understanding the tools and picking the right one will save time/$$
- References, including the Guidance Documents, are resources to help you – use them!