



BATTELLE CHLORINATED CONFERENCE 2024

The DNAPL “1 Percent Rule” *Is It Still Relevant?*

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Sustainability is our business

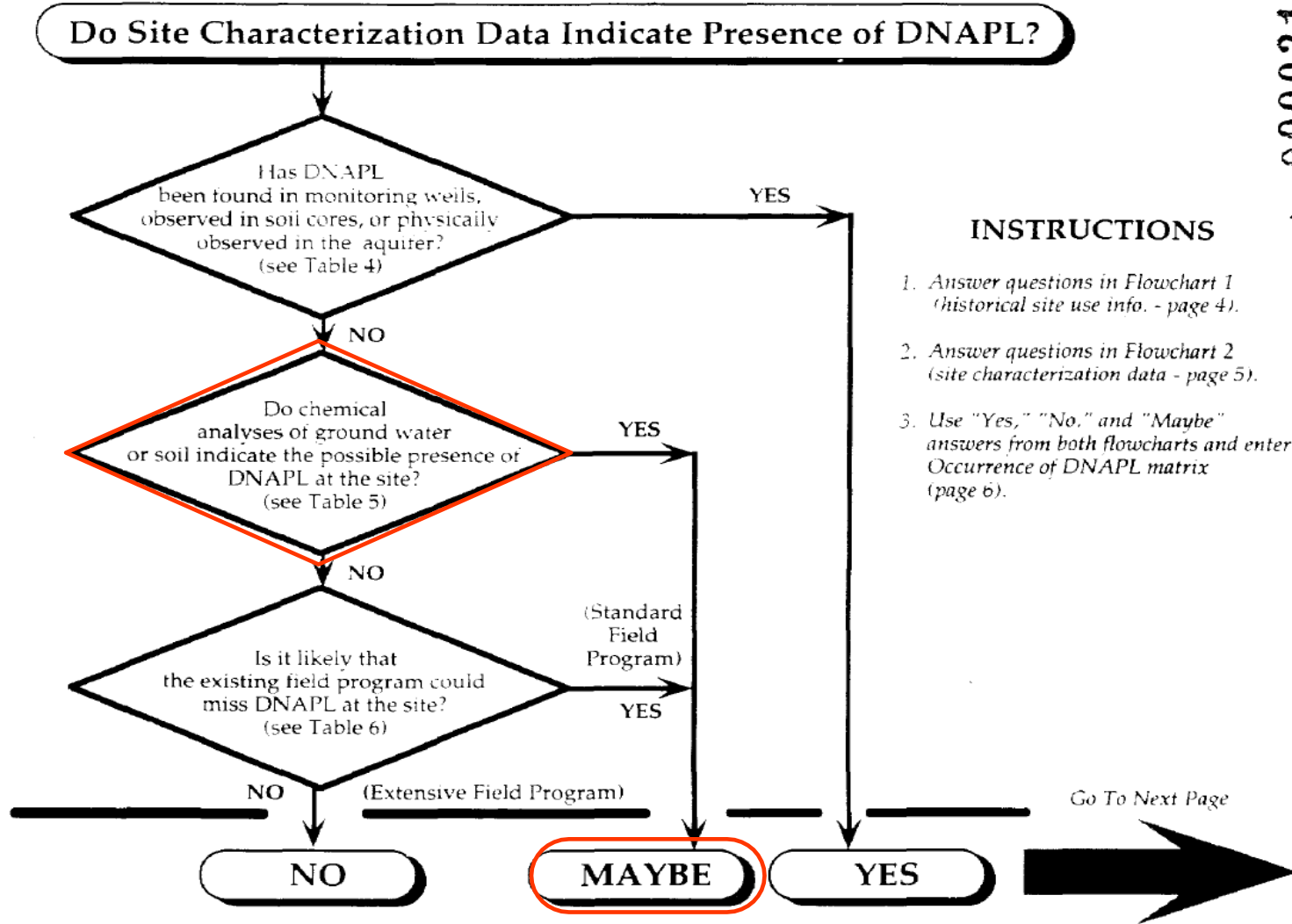
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Outline

- 1 Historical Background
- 2 ERM Experience/Case Studies
- 3 Summary

Evolution from Rule-of-Thumb to Rule



Historical Timeline

1980s: 10% of saturation "rule-of-thumb" proposed

1992: 1% of saturation indicates possible presence of DNAPL

2004: 1% rule of thumb can be used to infer the presence of DNAPL

Source: Newell and Ross, 1992



Cautions

DNAPL. In other words, the 1 per cent 'rule of thumb' should not be used in isolation to establish DNAPL presence at a site, but instead should be used with other converging lines of evidence to both establish DNAPL presence and to delineate the spatial extent of the source zone. Site techniques to

monitoring wells in many, or even most cases of DNAPL contamination. During the mid-1980s, the finding of dissolved concentrations of **10% of saturation** was suggested as a "**rule-of-thumb**" for inferring the presence of a DNAPL phase (Feenstra and Cherry, 1988). Recently, it has been suggested that this rule-of-thumb concentration be reduced to **1% of saturation** (Newell and Ross, 1991). We believe that this is reasonable. This value, however, should not be viewed as strict criterion since, based on the above discussion, we know that the magnitude of the dissolved concentrations observed in a monitoring well will depend on factors other than the presence or absence of DNAPL phase source zones (e.g., well location and well intake length, and size and nature of the source zone). The use of a 1% rule-of-thumb in any assessment of the spatial distribution of DNAPL zones must be performed cautiously, particularly in the downgradient direction.



www.pca.state.mn.us

Dense non-aqueous phase liquids: Site remediation and redevelopment

Site characterization methods and benefits

Historically, a 1% dissolved-phase concentration of chlorinated solvent DNAPLs, based on compound-specific solubility in groundwater, was thought to indicate the potential presence of DNAPL; however, this method is now viewed as unreliable (that is, either falsely positive or falsely negative). See [Appendix F](#) for methods available to evaluate the presence of DNAPL (USEPA 2009).

DENSE CHLORINATED SOLVENTS

and other
DNAPLs in Groundwater

James F. Pankow
John A. Cherry

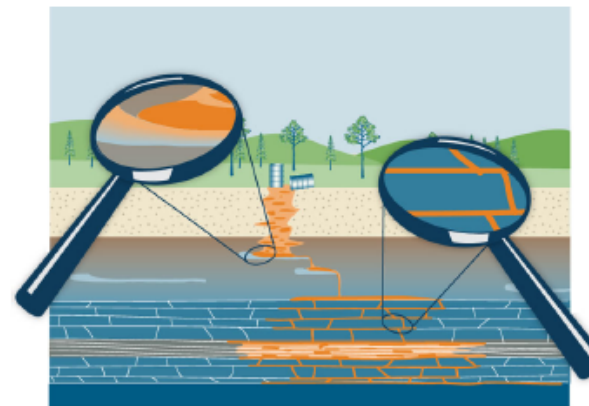
www.environment-agency.gov.uk

An illustrated handbook of DNAPL transport and fate in the subsurface



Guidance Document

Integrated DNAPL Site Characterization and Tools Selection



May 2015

Prepared by
The Interstate Technology & Regulatory Council
DNAPL Site Characterization Team

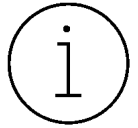
Do not rely on the "1% rule" (a historical viewpoint that if the concentration of a chlorinated solvent DNAPL exceeds 1% of its compound-specific solubility in groundwater, then that compound is likely present as a DNAPL) for the presence or absence of DNAPL. This is not a reliable assumption as it can be falsely positive or falsely negative, and this "rule of thumb" does not provide guidance on how far upgradient the DNAPL source zone is located. Instead, use a multiple methods approach to evaluate DNAPL presence or absence.



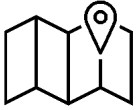
ERM

The DNAPL "1 Percent Rule": Is It Still Relevant?

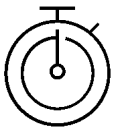
Factors Influencing Groundwater Concentrations



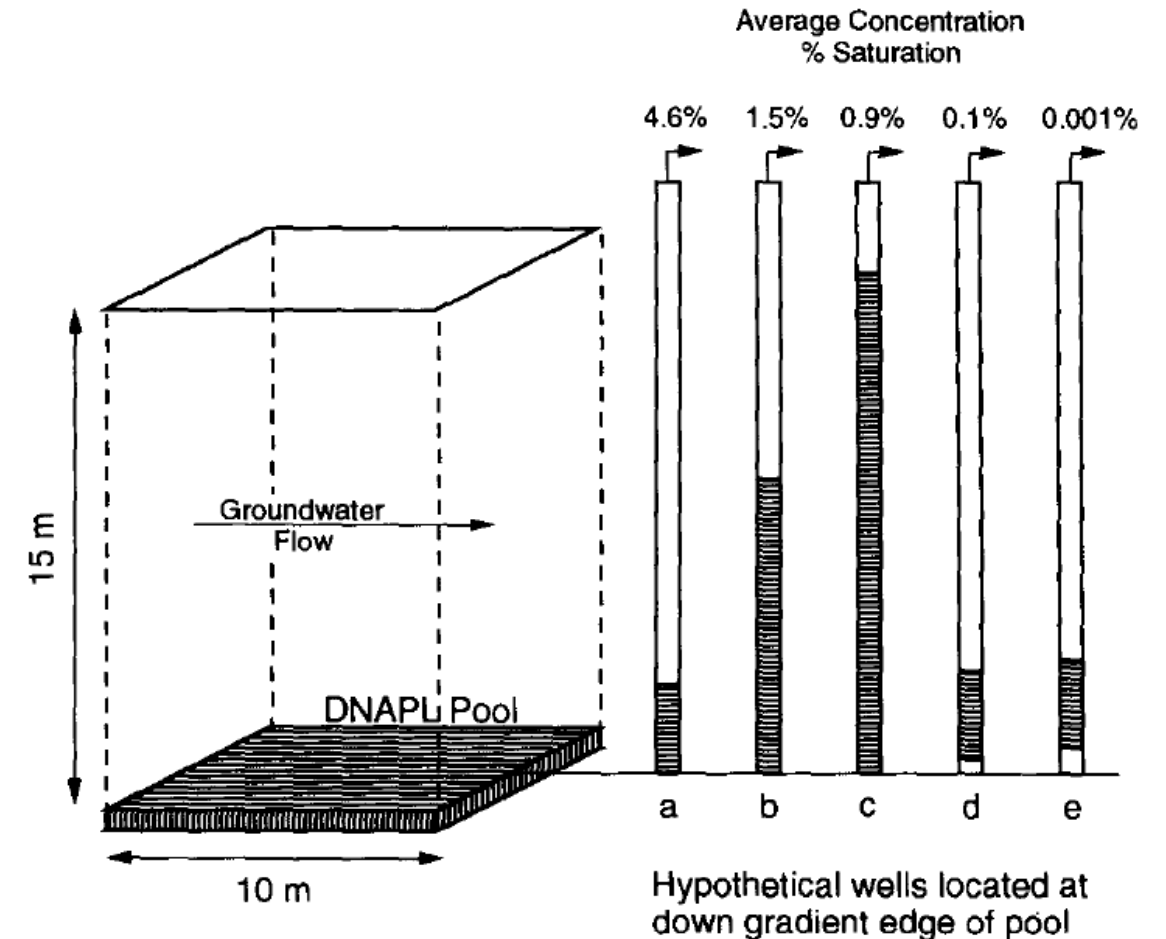
Size and nature of DNAPL zone



Sample location

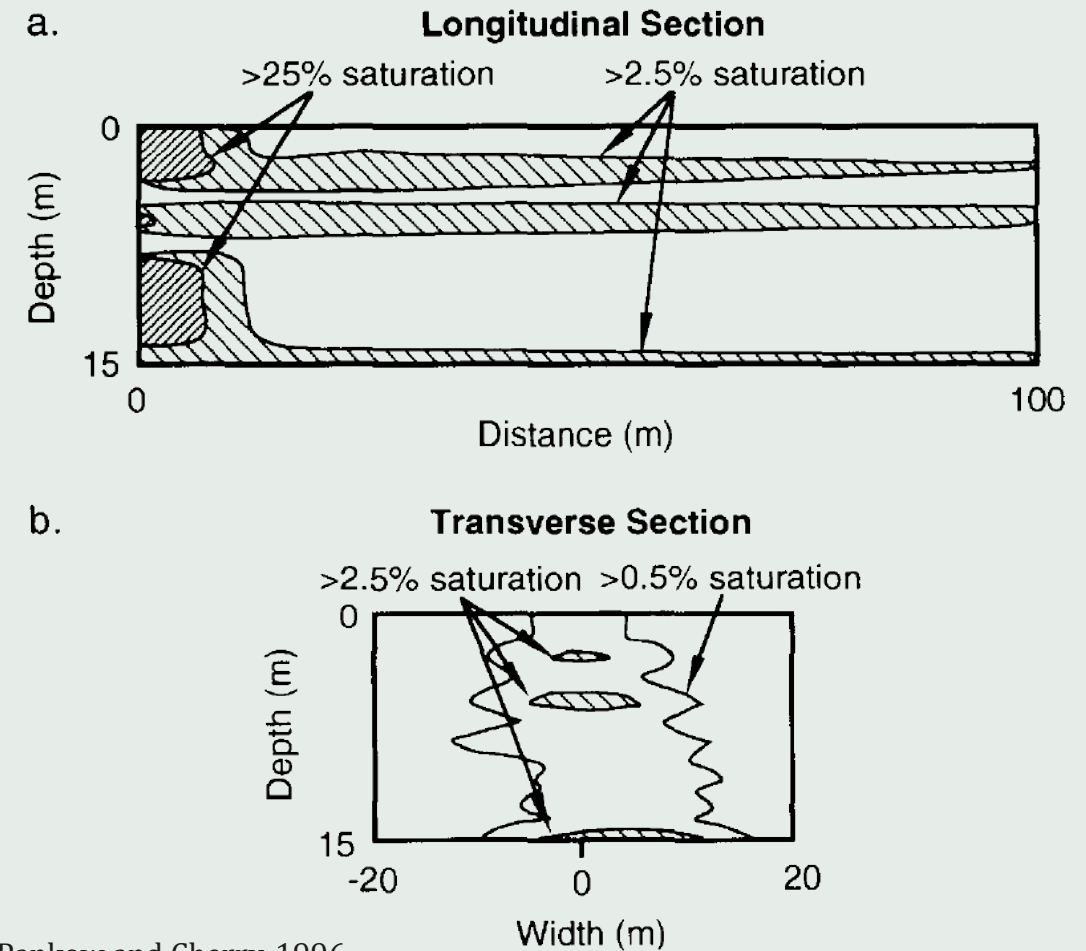
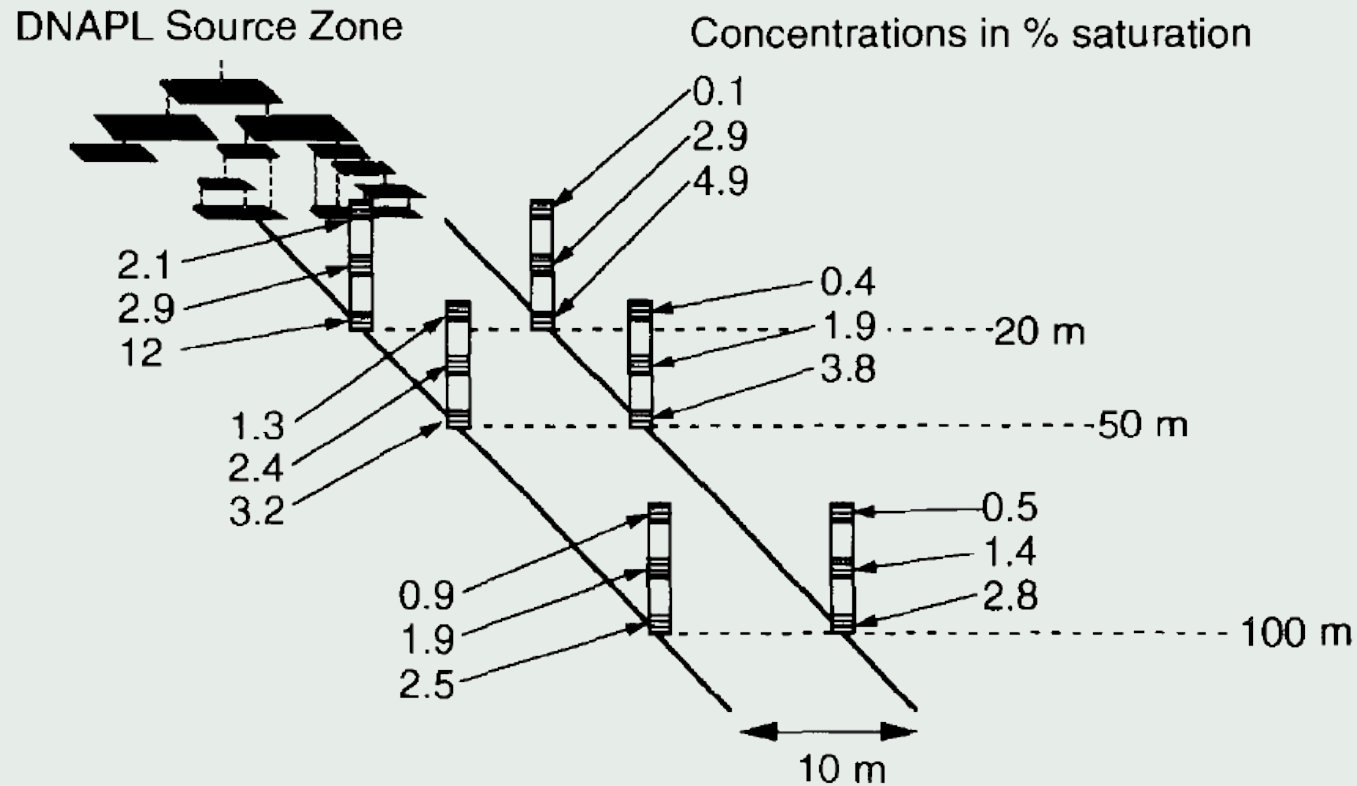


Sample interval length



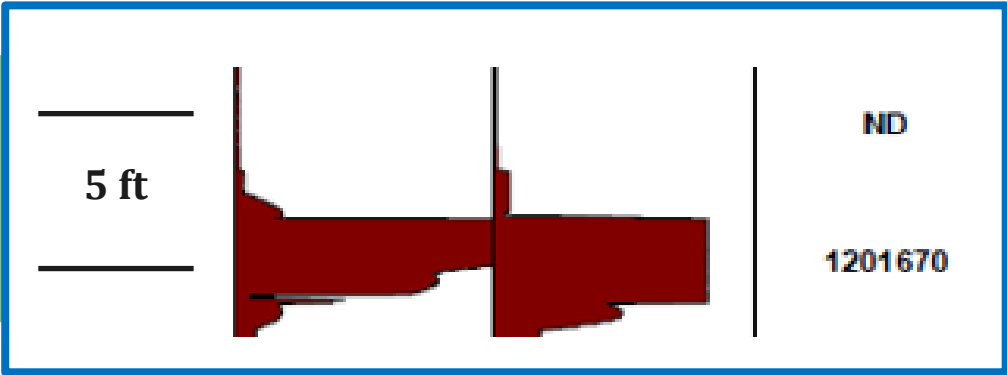
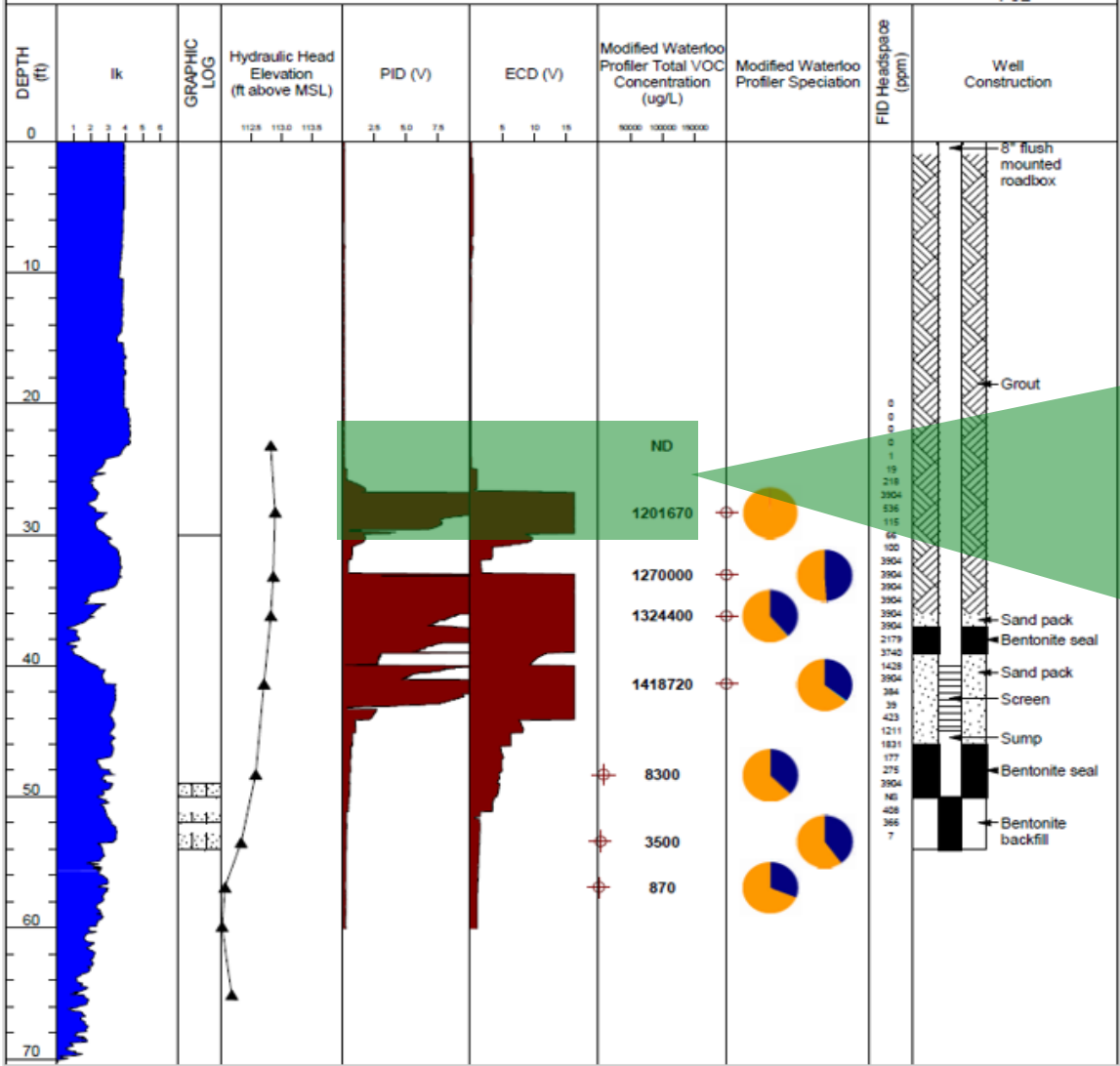
Source: Pankow and Cherry. 1996

Factors Influencing Groundwater Concentrations

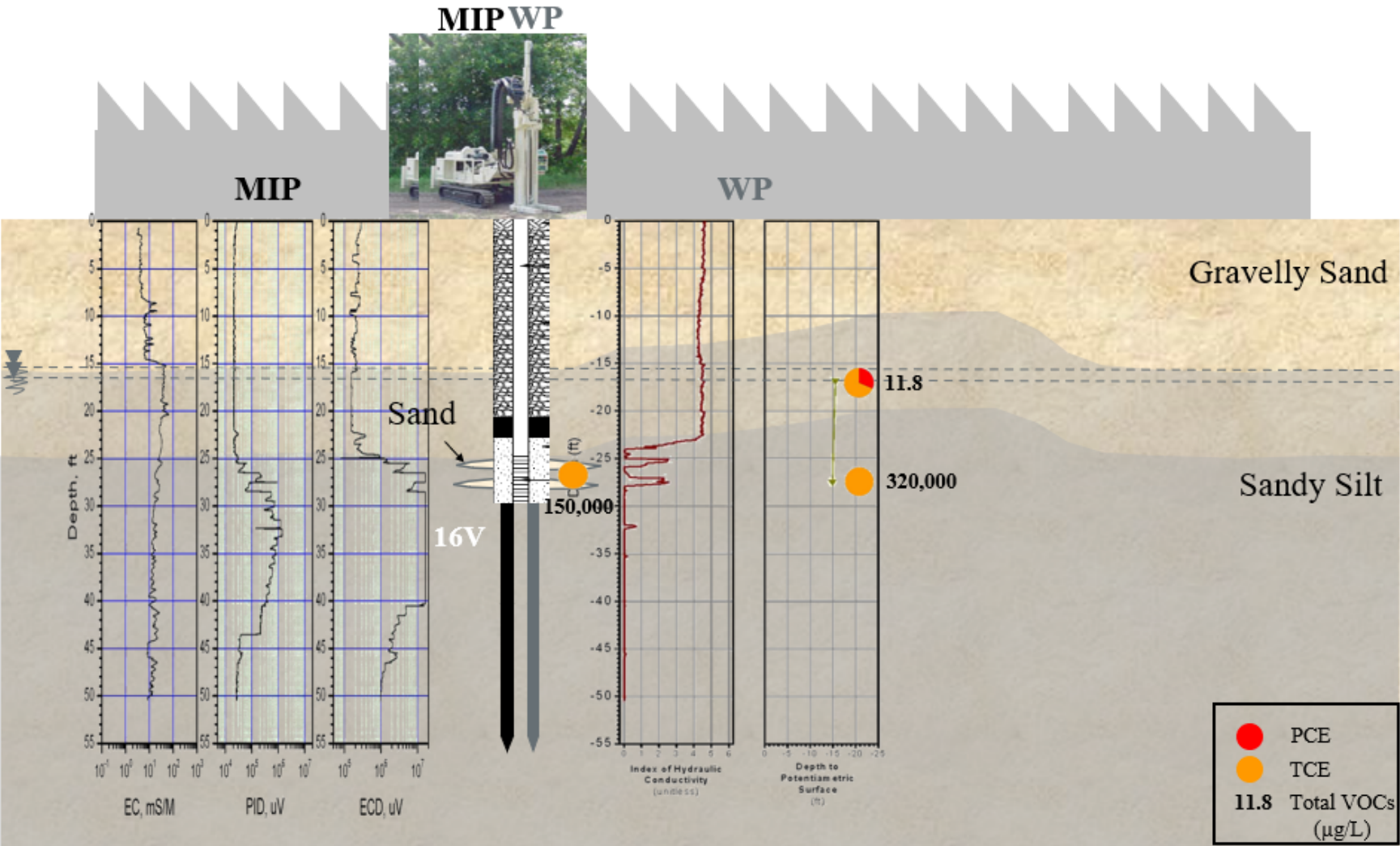


Source: Pankow and Cherry. 1996

Case Study 1

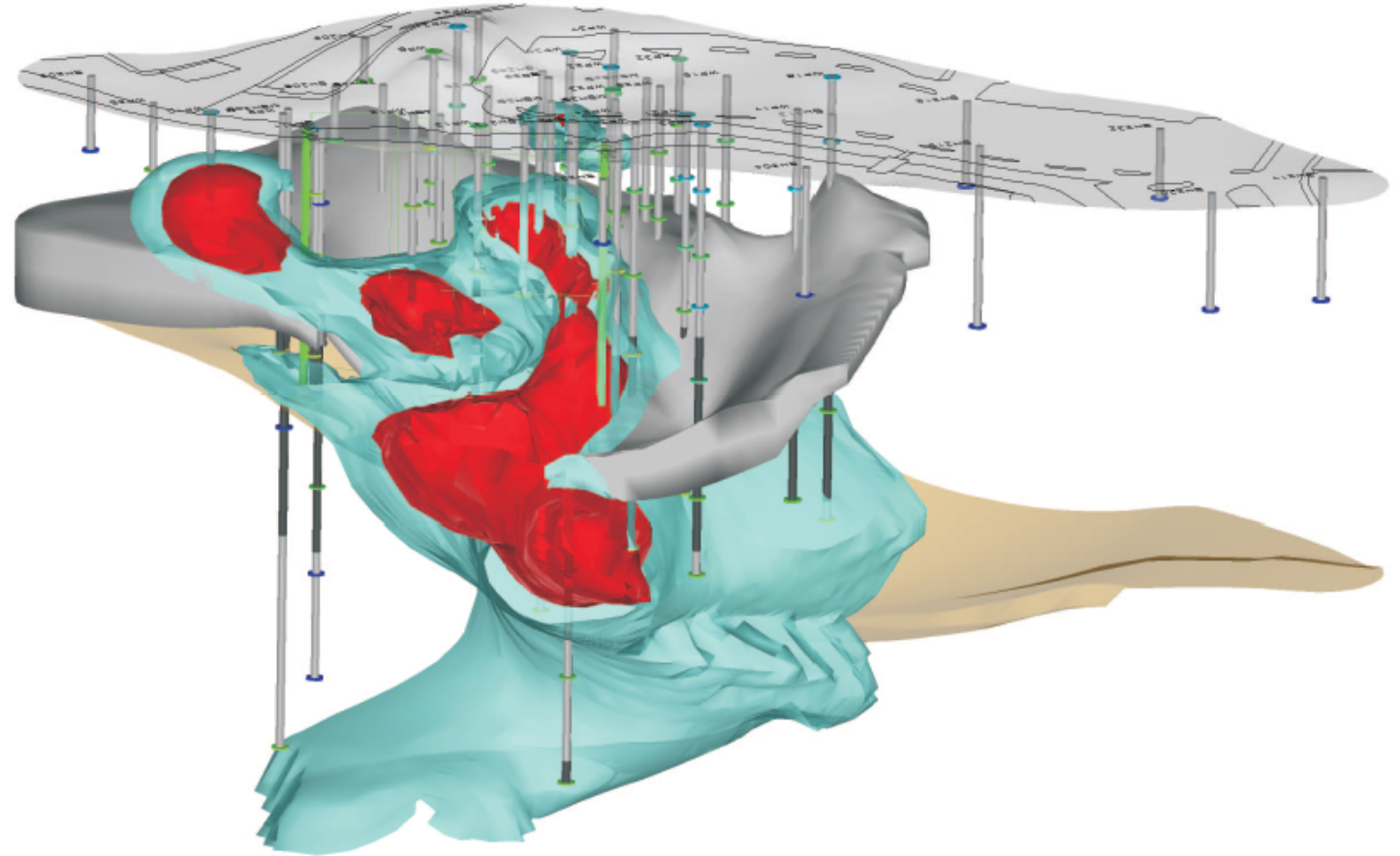


Case Study 2



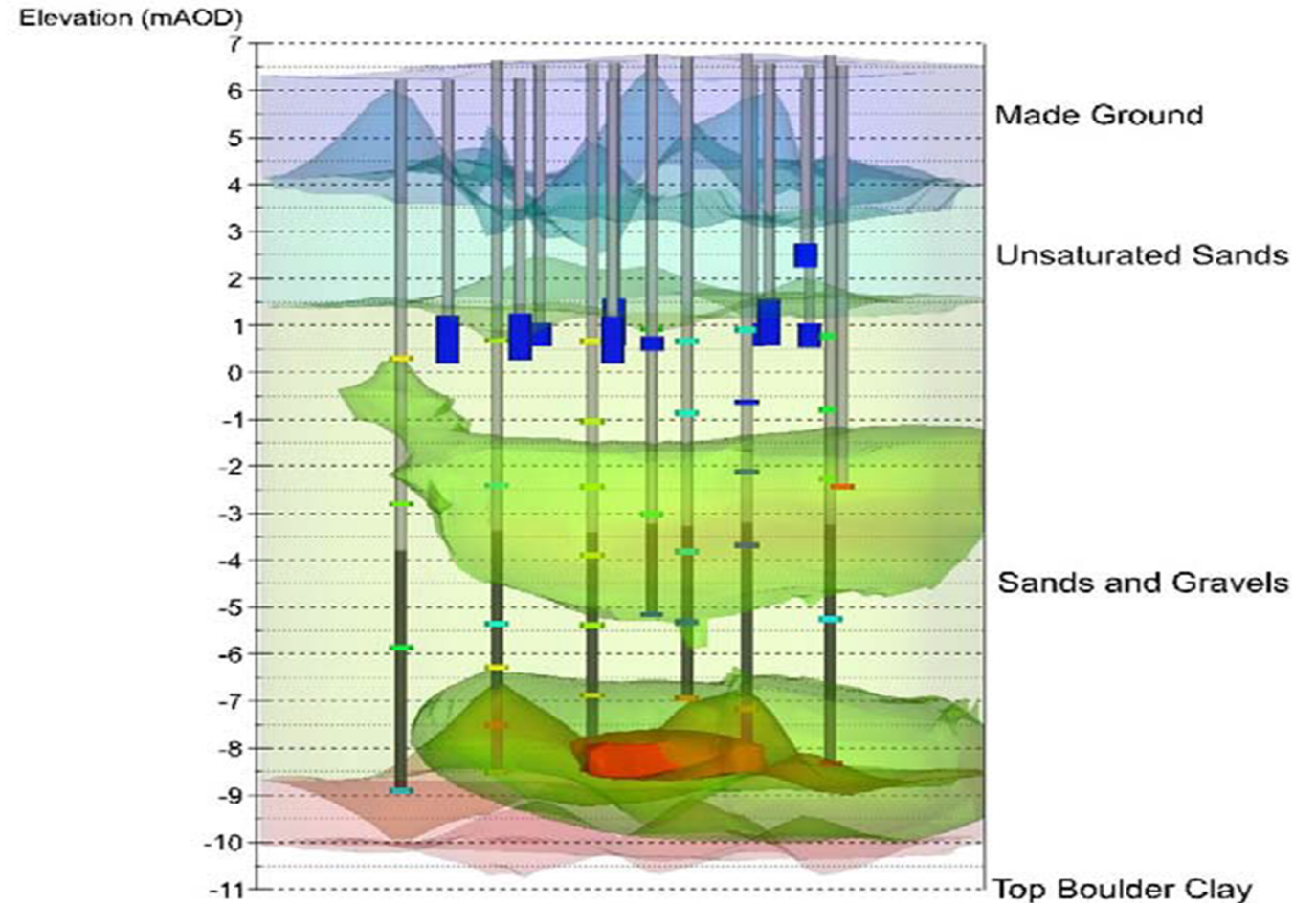
Case Study 3

- Groundwater concentration in monitoring wells less than 0.1% of TCB solubility.
- DNAPL visually identified next to monitoring wells using Waterloo Profiler.
- Substantial impact to groundwater remedy design.



Case Study 4

- Dichloromethane and chloroform concentrations exceed 1% solubility during Waterloo Profiler survey.
- No DNAPL was ever encountered or recovered during subsequent investigation and remediation.



What does exceeding 1% solubility represent?



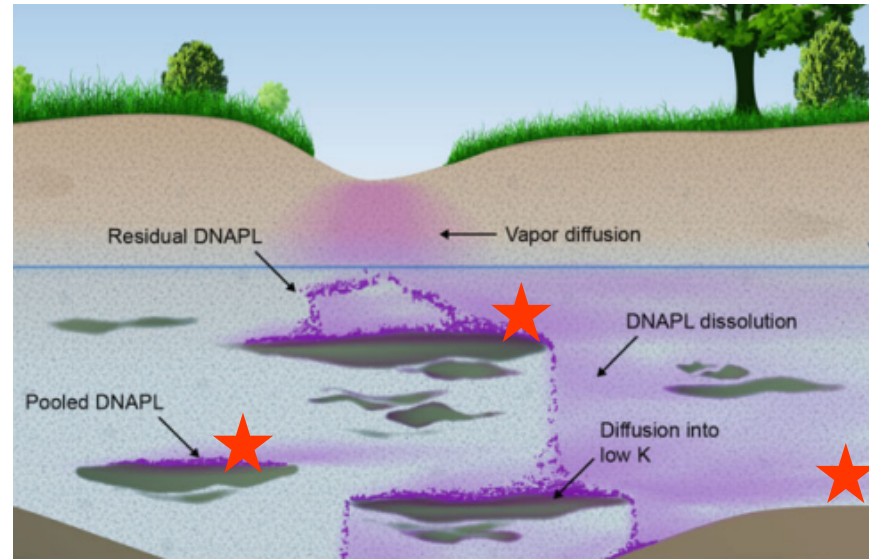
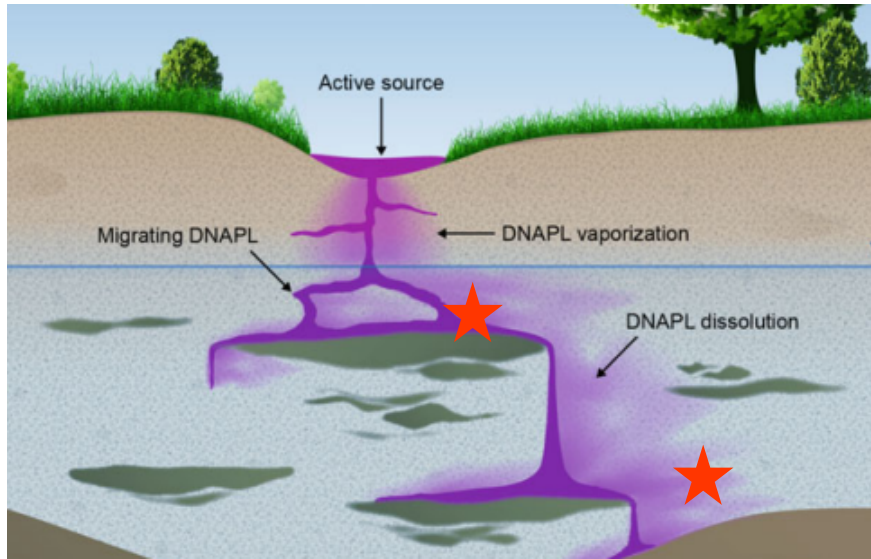
The sampled groundwater may have come in contact with DNAPL at some point along its flow path. (Kueper et al. 2014)



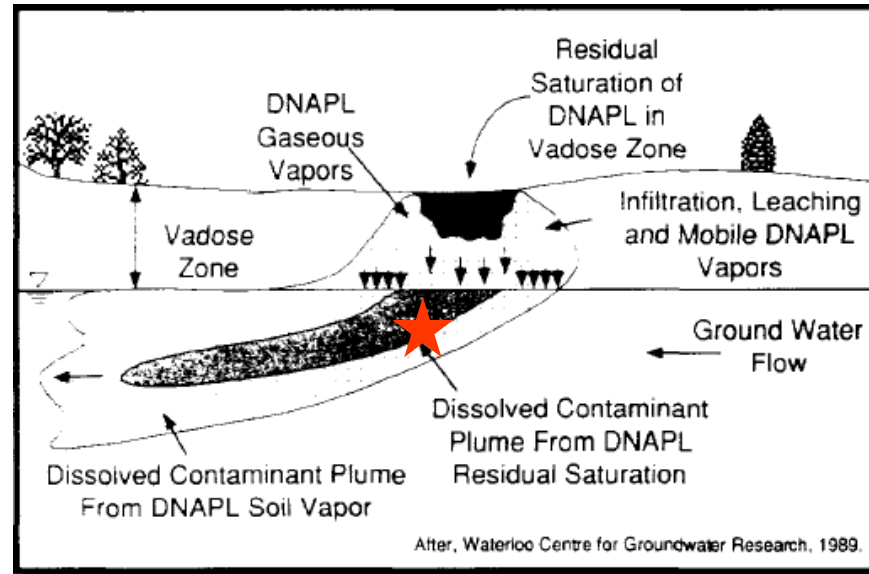
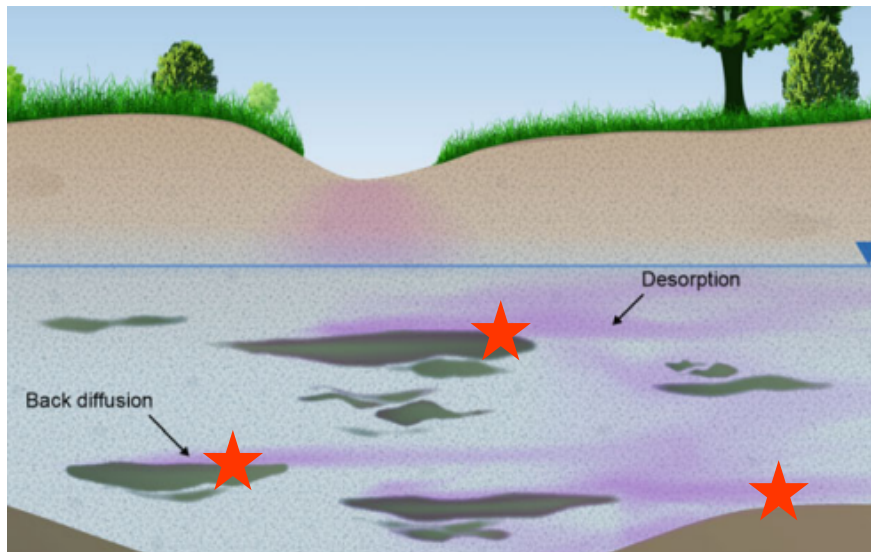
Exceedance of 1% solubility can occur

- Inside DNAPL source zone – **Presence** of DNAPL
- Downgradient of DNAPL source zone – **Impact** of DNAPL
- Sites where DNAPL never existed below the water table – **Phantom** of DNAPL
- Sites with totally depleted DNAPL – **Memory** of DNAPL

What does exceeding 1% solubility represent?



Source: Kueper et al. 2014



Source: Newell and Ross 1992



Thank you

FOR FURTHER INFORMATION,
PLEASE CONTACT:

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