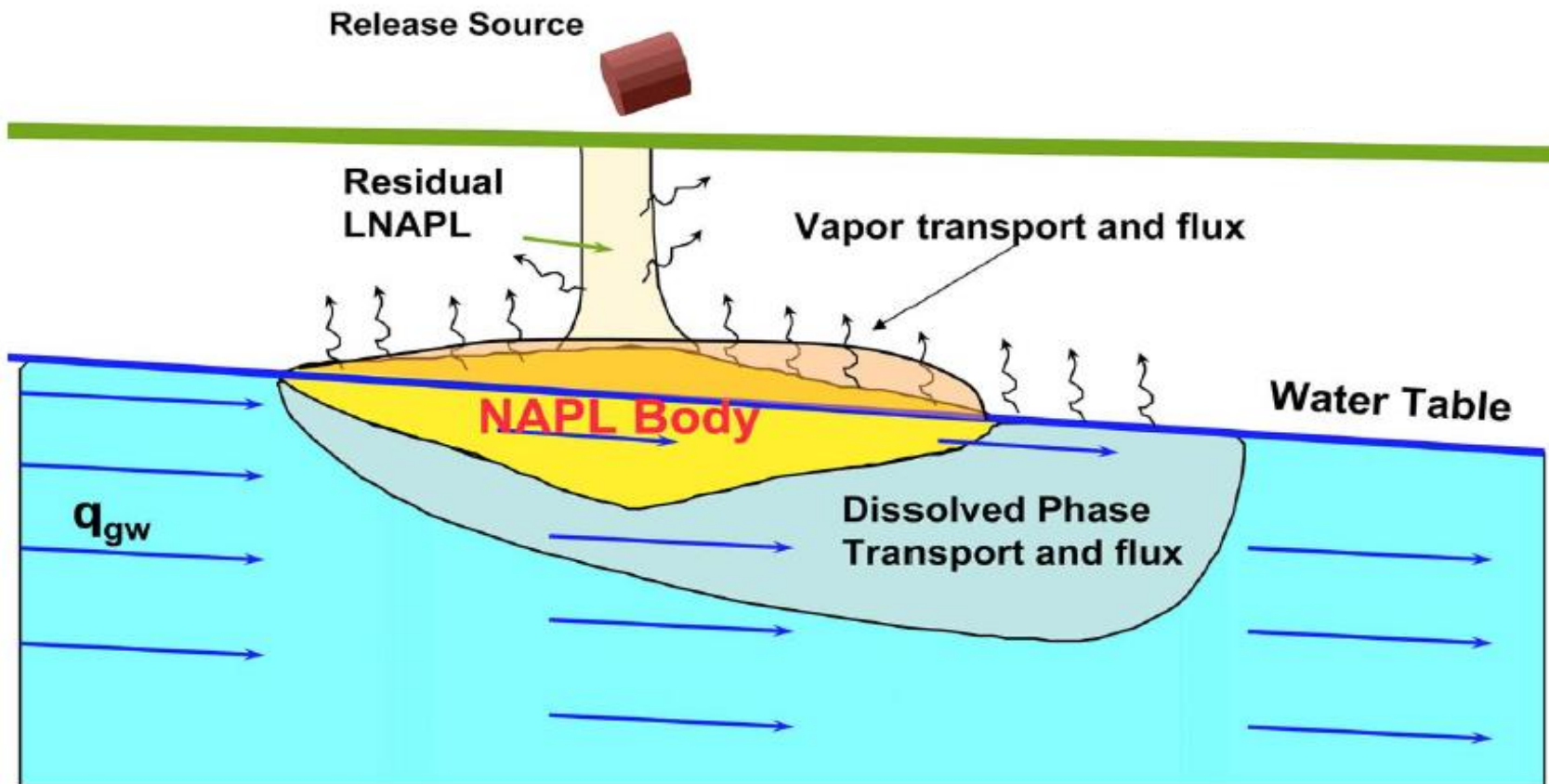


# Evaluating Risk of Heritage LNAPL Bodies

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International Petroleum Environmental  
Conference  
10/14/14

# Evaluating Risk



# What is a Heritage LNAPL Body

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- One or many of the following:
  - Significantly aged LNAPL body
  - Inherited LNAPL site with no prior remediation
  - Prior remediation but no source reduction data

# What is a Heritage LNAPL Body

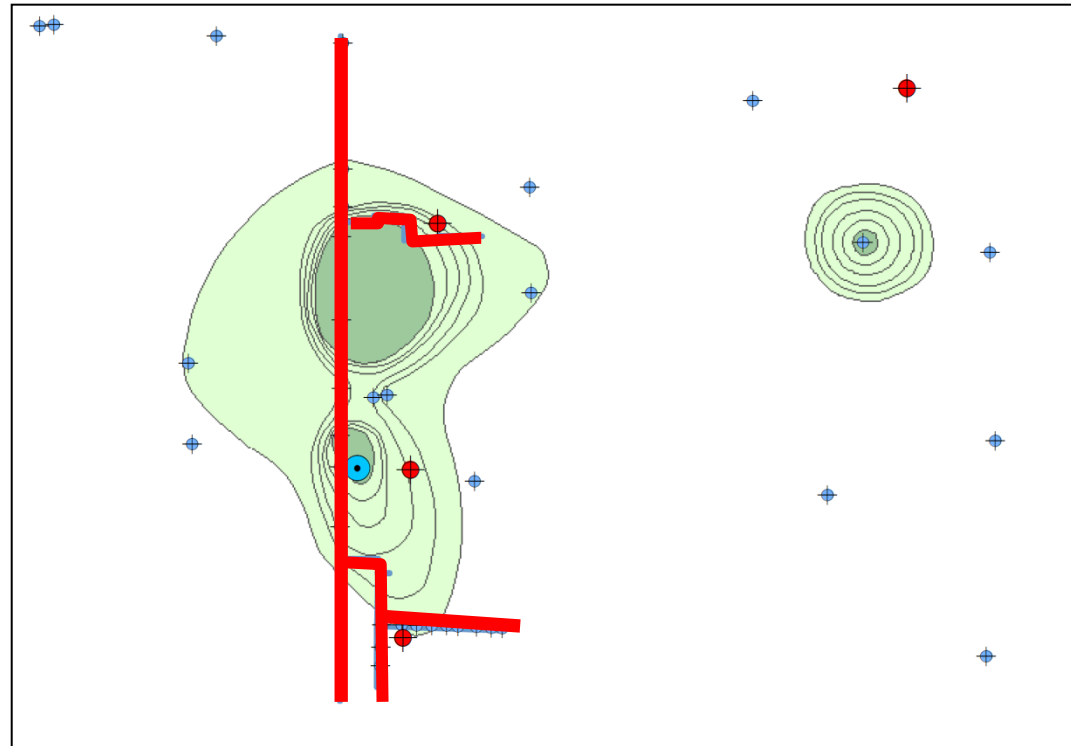
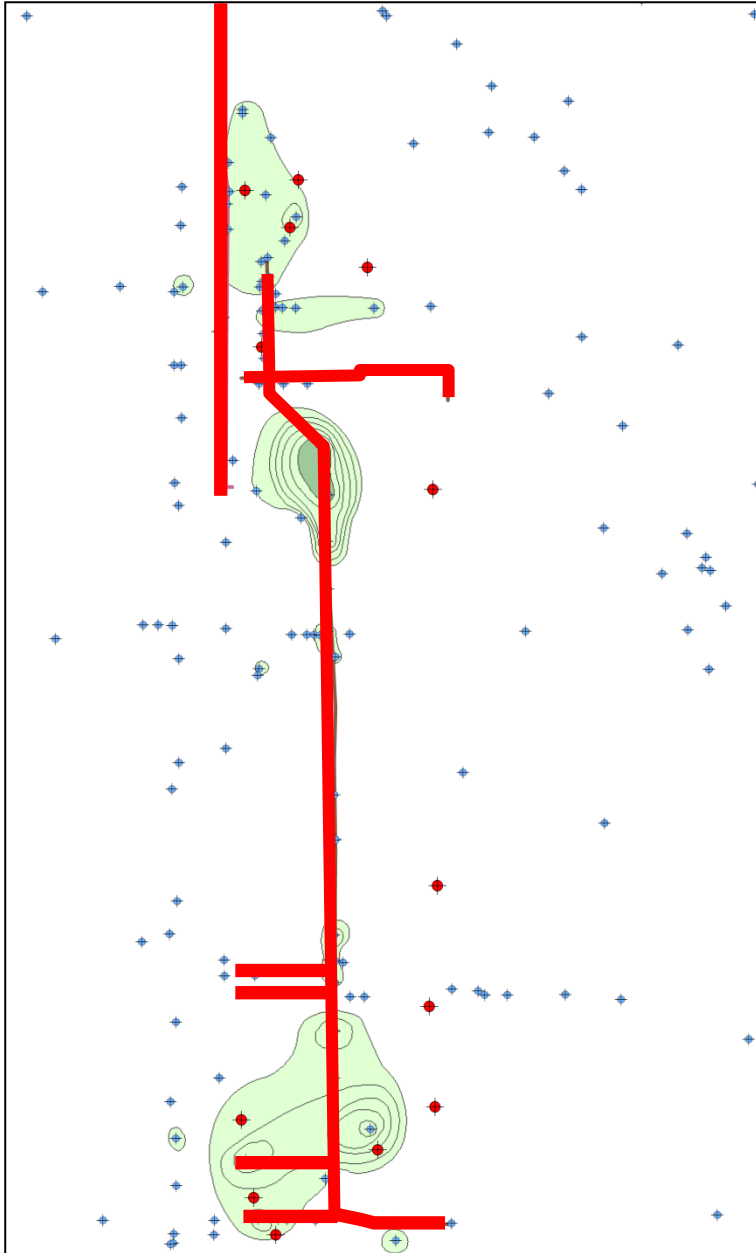
---

- One or many of the following:
  - **Significantly aged LNAPL body**
  - Inherited LNAPL site with no prior remediation
  - **Prior remediation but no source reduction data**

# Remediation History

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- 3 Vacuum Wellpoint Systems
- No LNAPL Recovery Data
- Total Flow, but Not from Individual Pumping Wells



# Evaluating Risk

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- Vapor Pathway
- Direct Contact Pathway
- LNAPL Migration Pathway
- Dissolved Phase Pathway

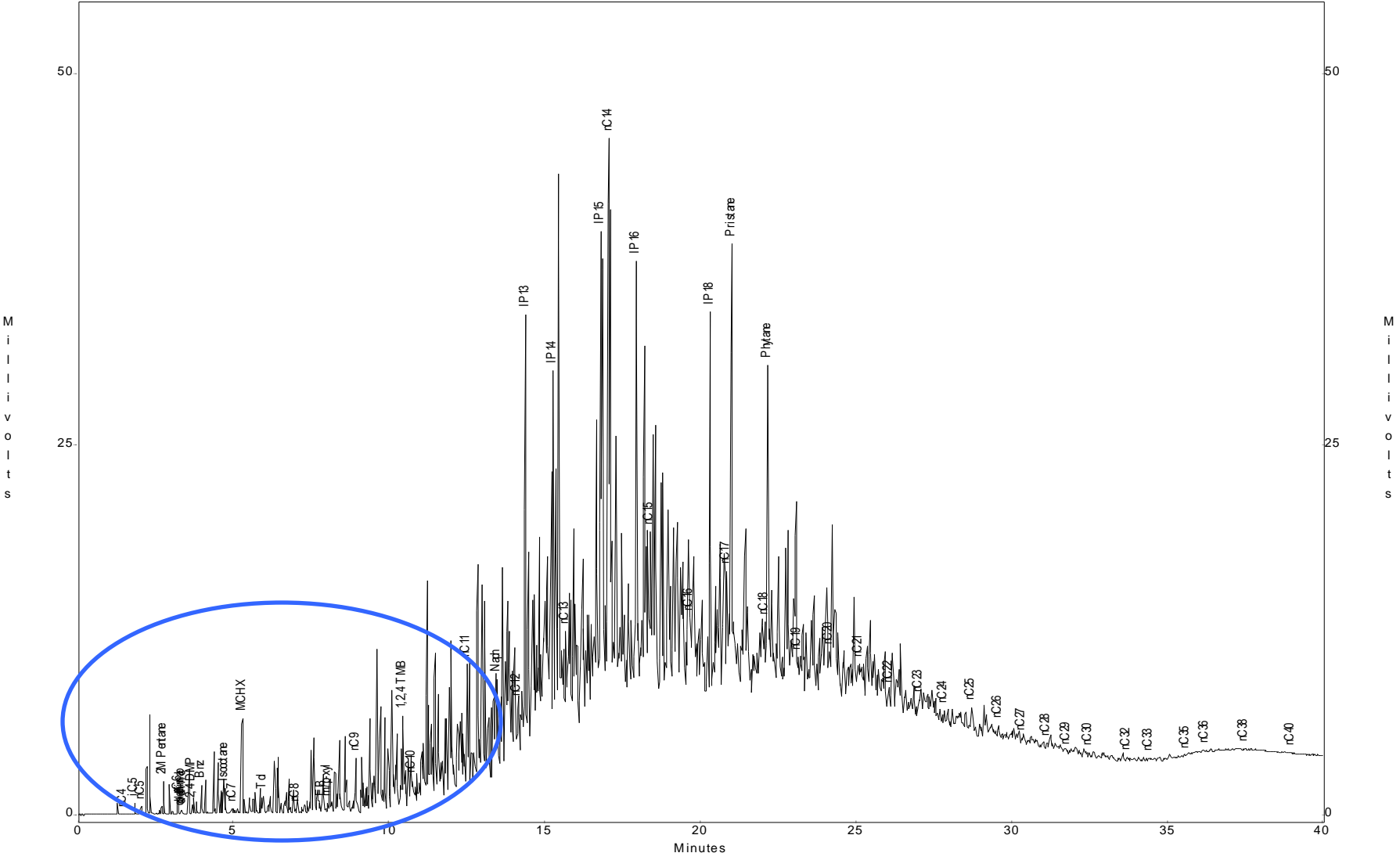
# Evaluating Risk

---

- **Vapor Pathway**
- Direct Contact Pathway
- LNAPL Migration Pathway
- Dissolved Phase Pathway

# Vapor Pathway

Weathered diesel range fuel, small concentrations of finished gasoline product





# Evaluating Risk

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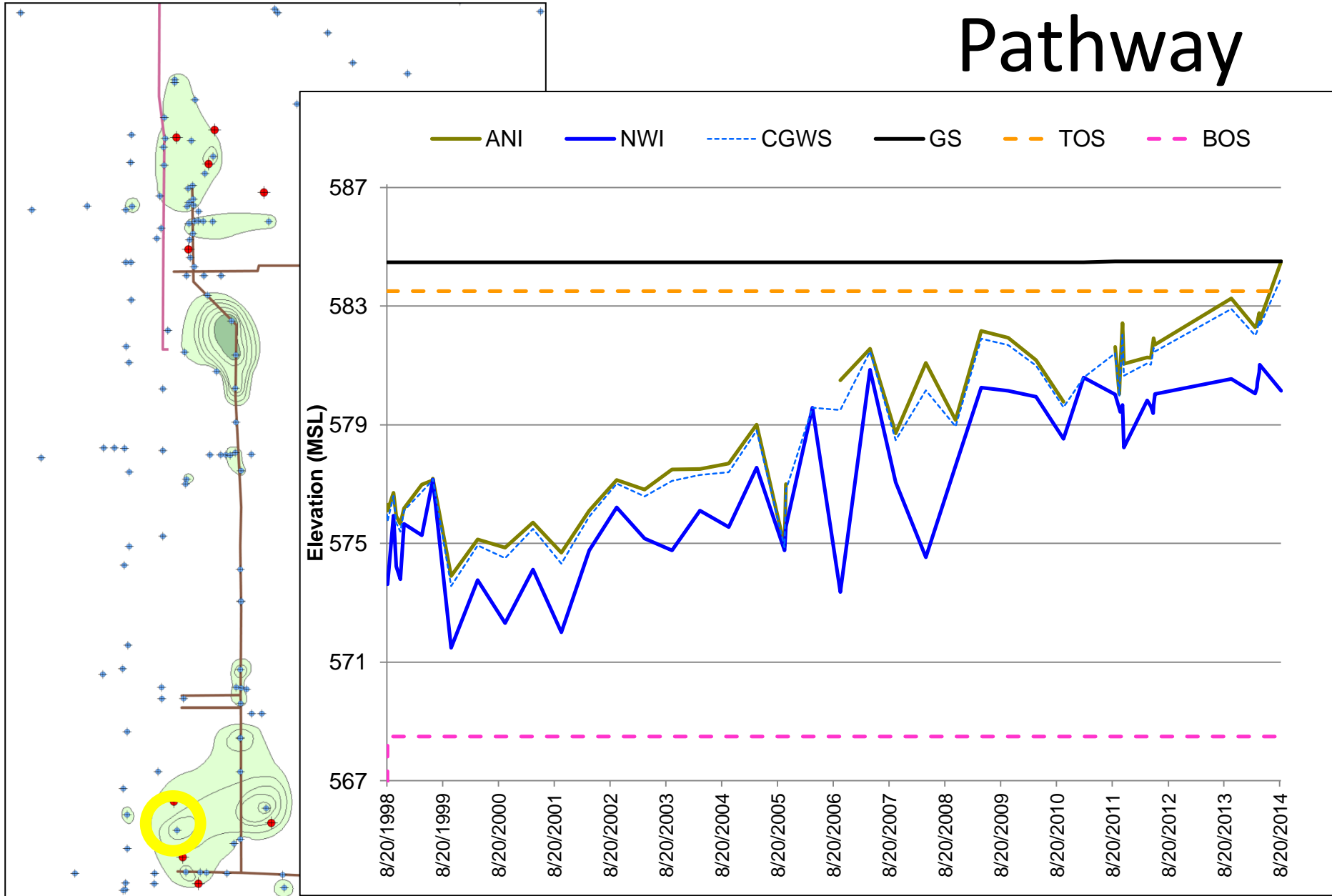
- Vapor Pathway
- Direct Contact Pathway
- LNAPL Migration Pathway
- Dissolved Phase Pathway

# Evaluating Risk

---

- Vapor Pathway
- **Direct Contact Pathway**
- LNAPL Migration Pathway
- Dissolved Phase Pathway

# Direct Contact Pathway



# Evaluating Risk

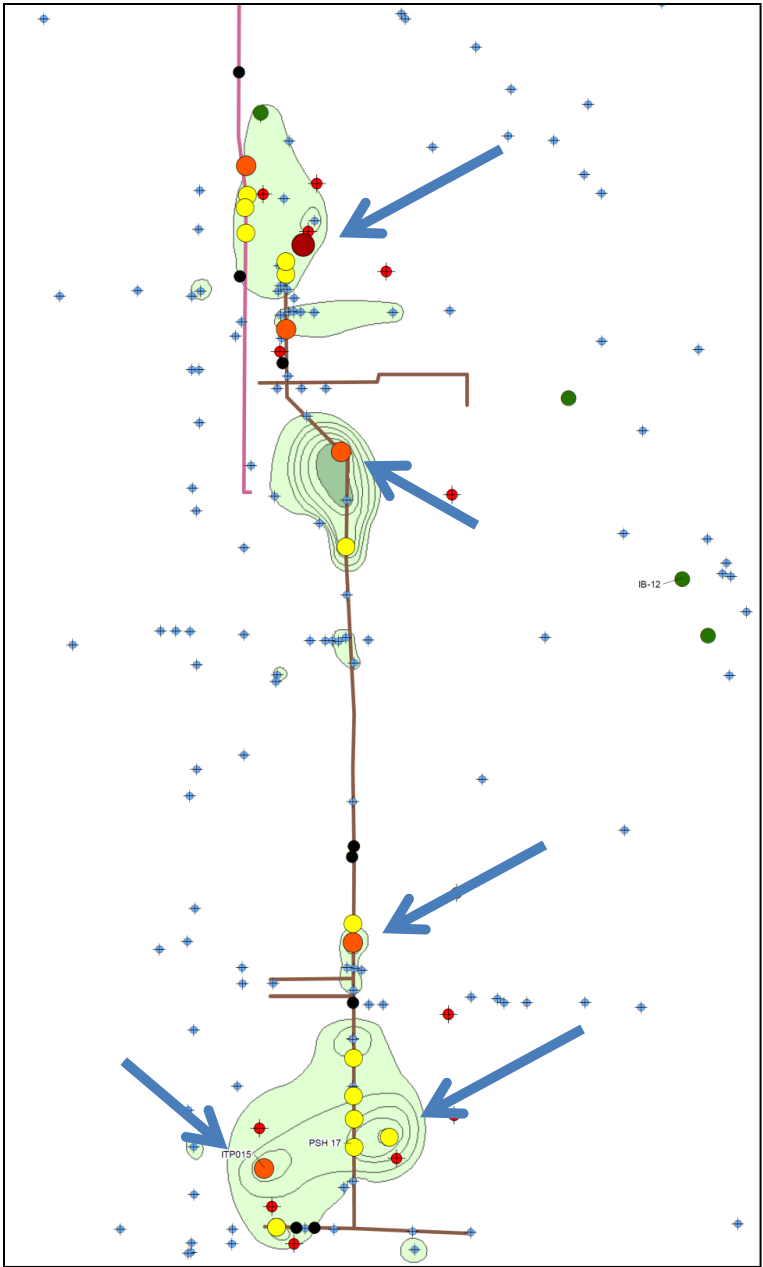
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- Vapor Pathway
- Direct Contact Pathway
- LNAPL Migration Pathway
- Dissolved Phase Pathway

# Evaluating Risk

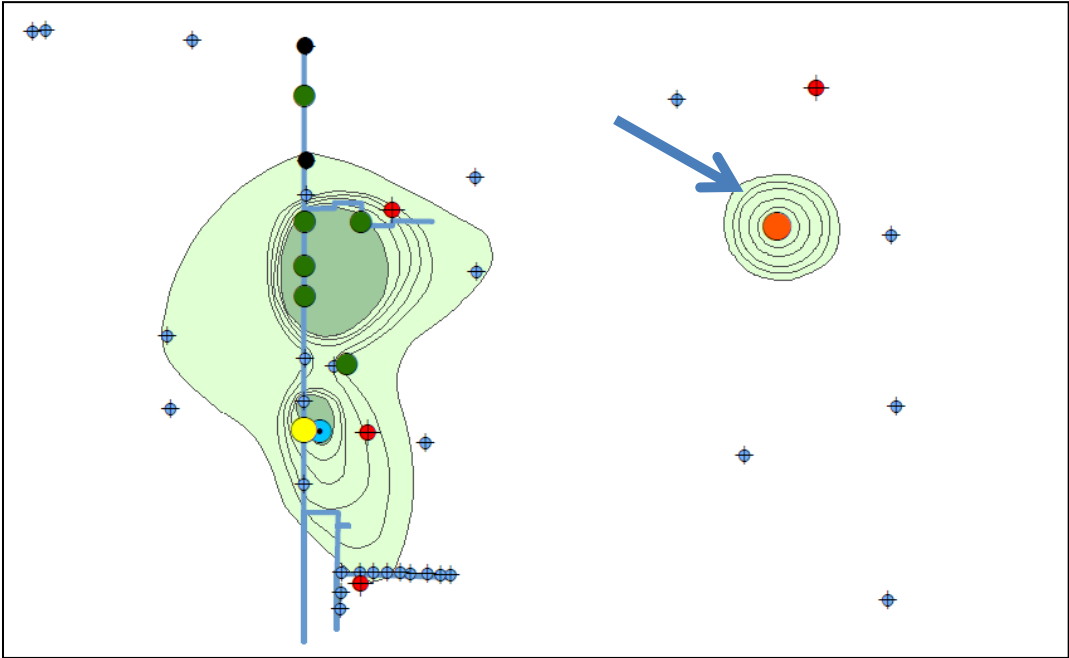
- Vapor Pathway
- Direct Contact Pathway
- **LNAPL Migration Pathway**
- Dissolved Phase Pathway

# LNAPL Migration Pathway



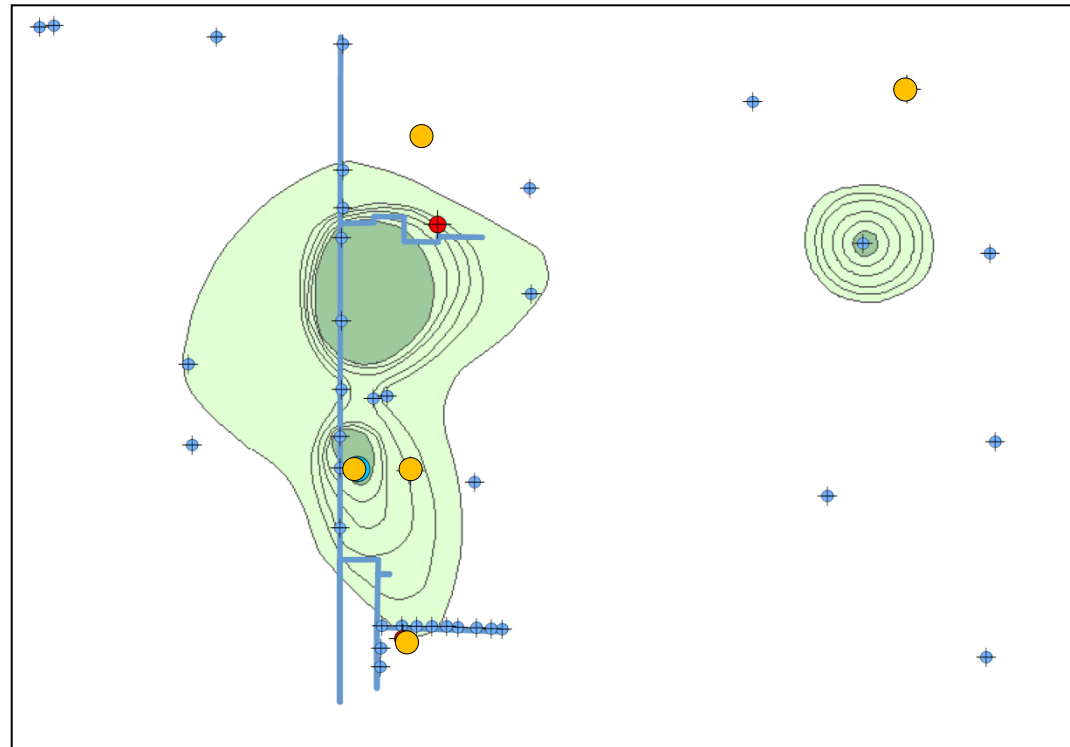
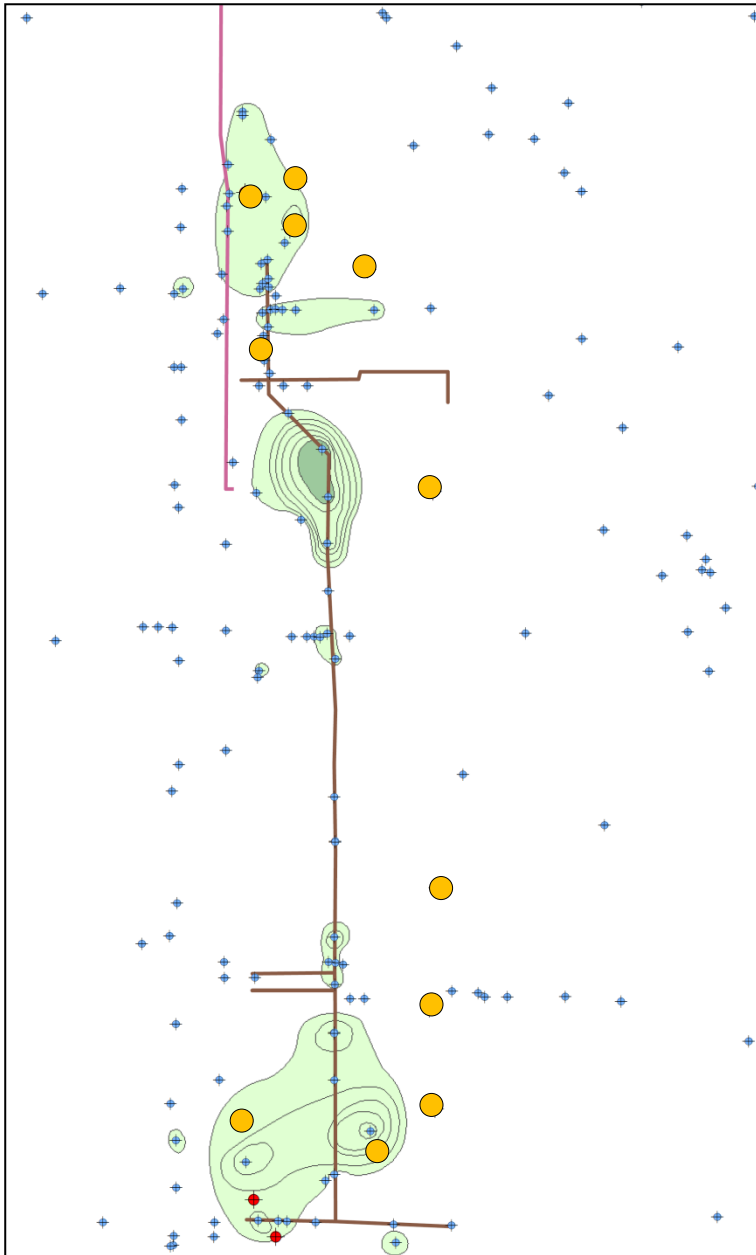
Average Tn Value (ft<sup>2</sup>/day)

- BDL
- 0 to 0.1
- 0.1 to 0.8
- 0.8 to 3
- 3 to 10

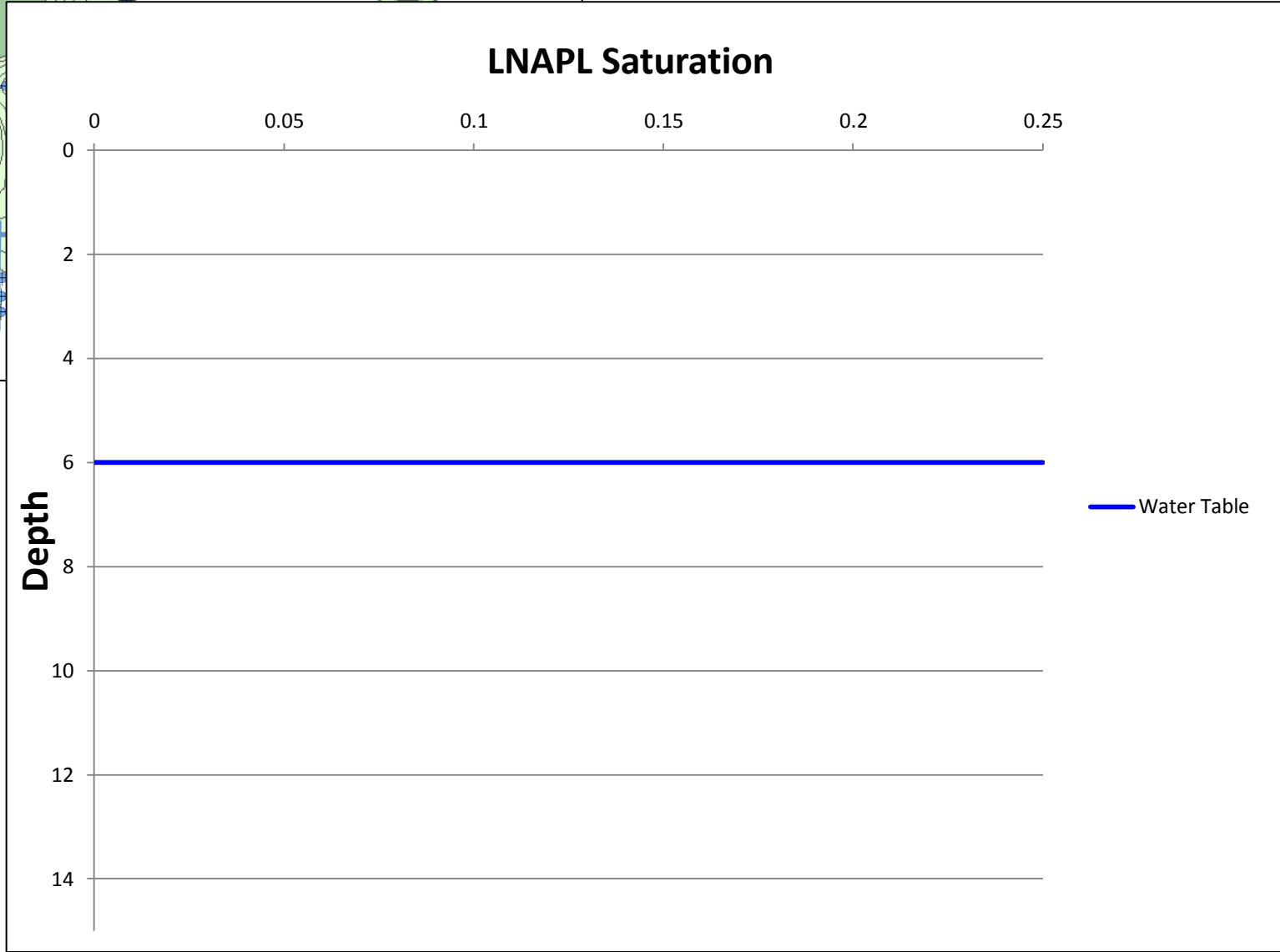
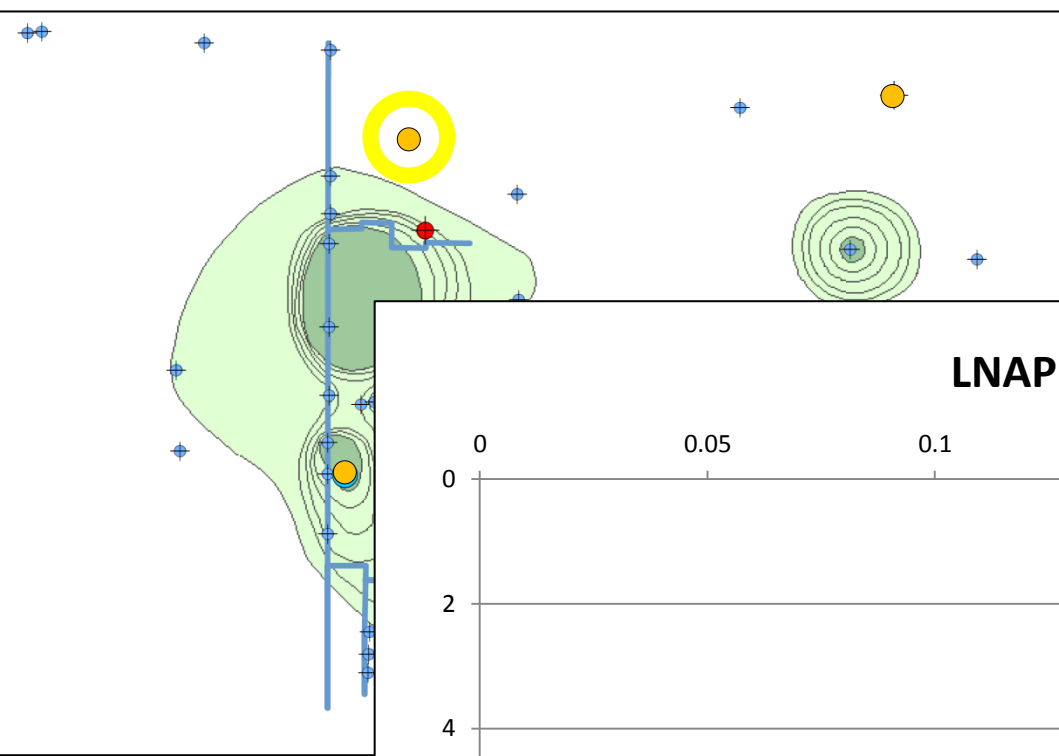


# LNAPL Migration Pathway

- New Monitoring Wells
- Geologic Classification and TPH Grab Sampling
- Undisturbed Cores and Discrete Interval TPH Subsampling

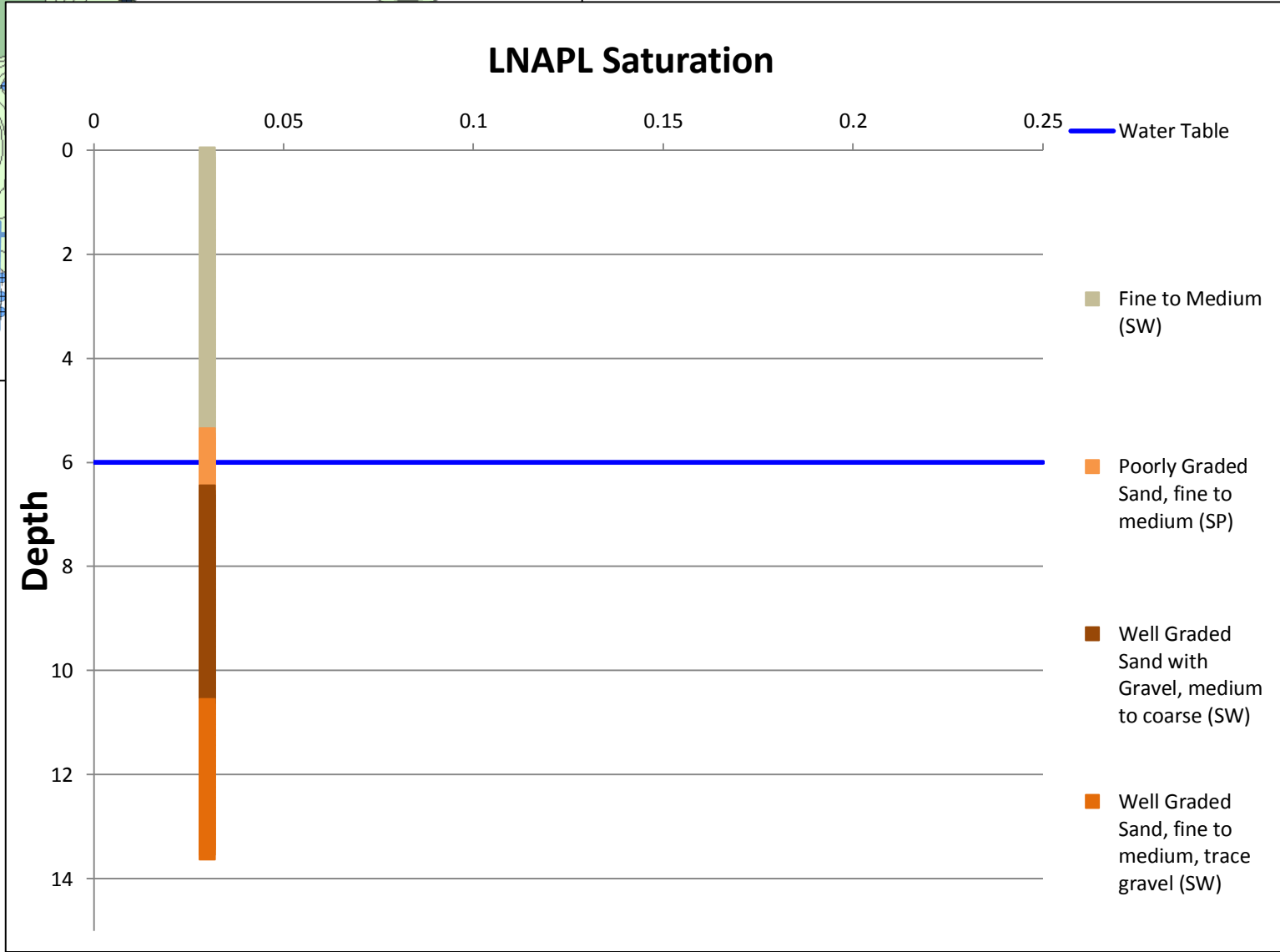
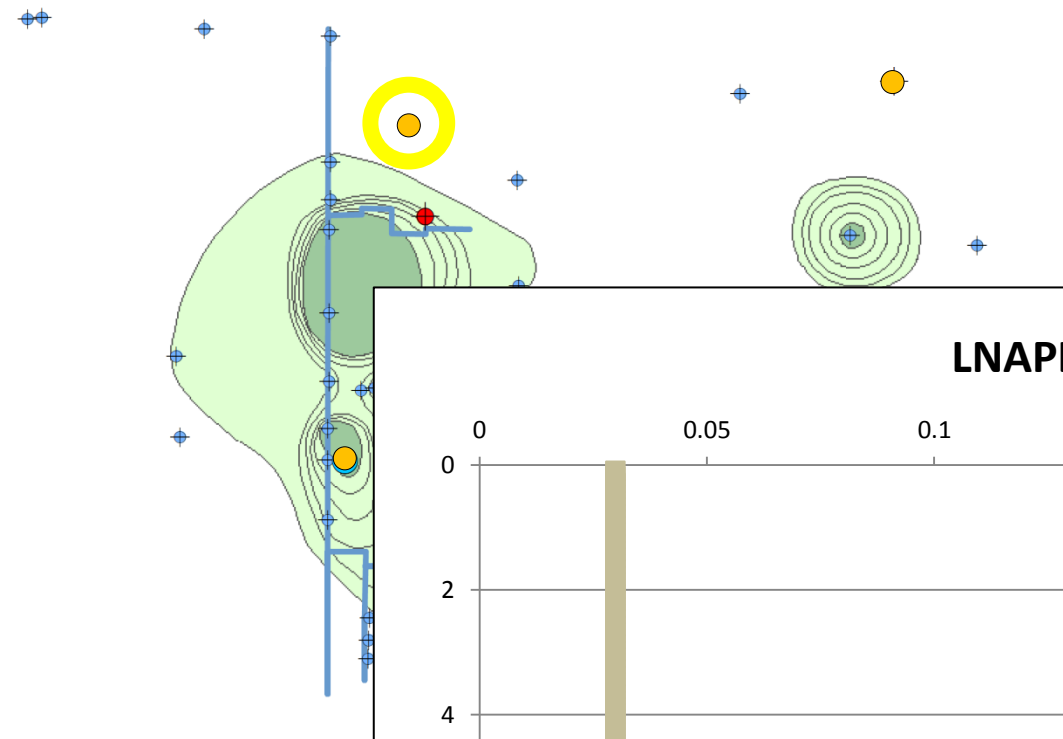


# LNAPL Migration Pathway

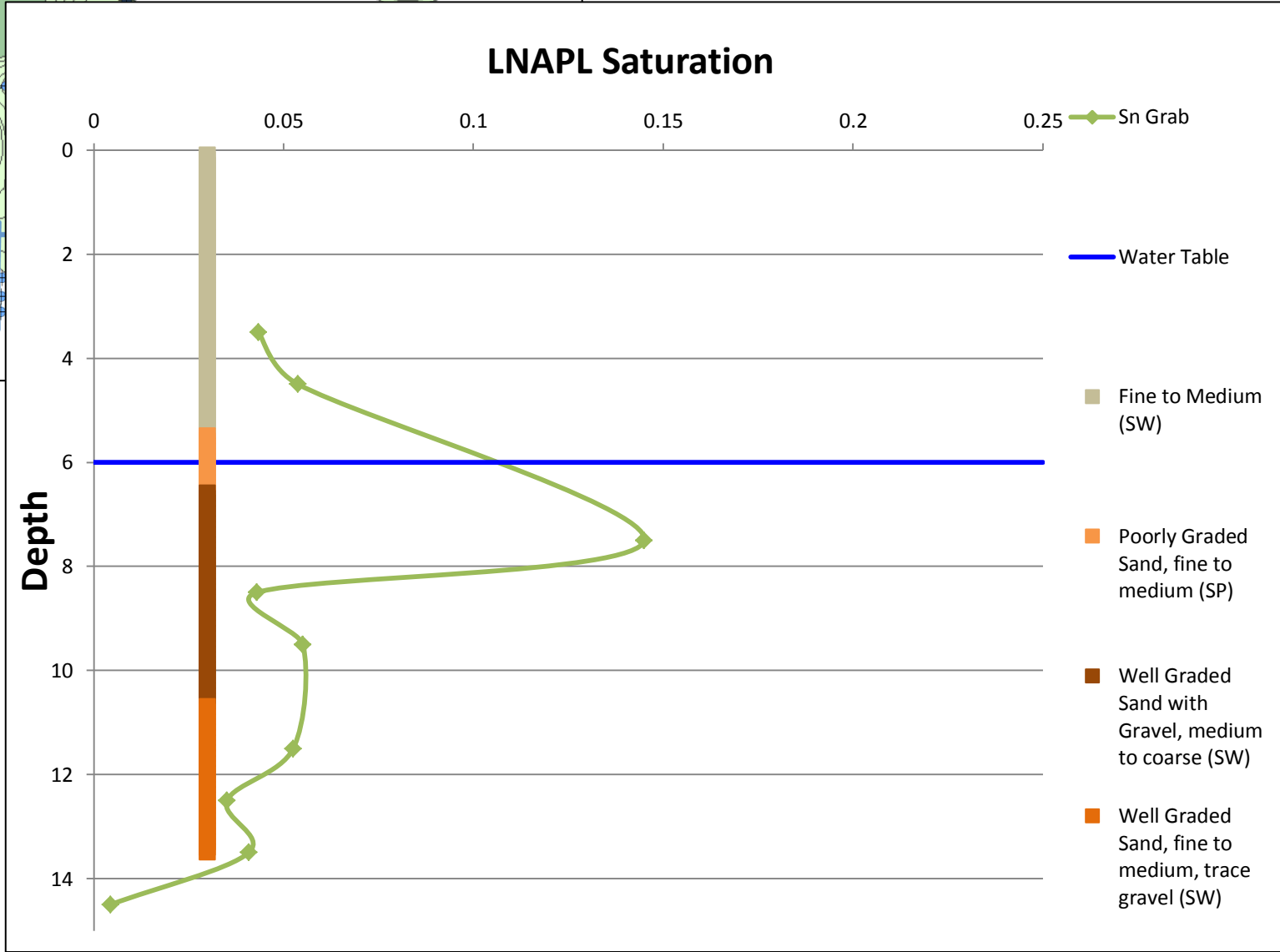
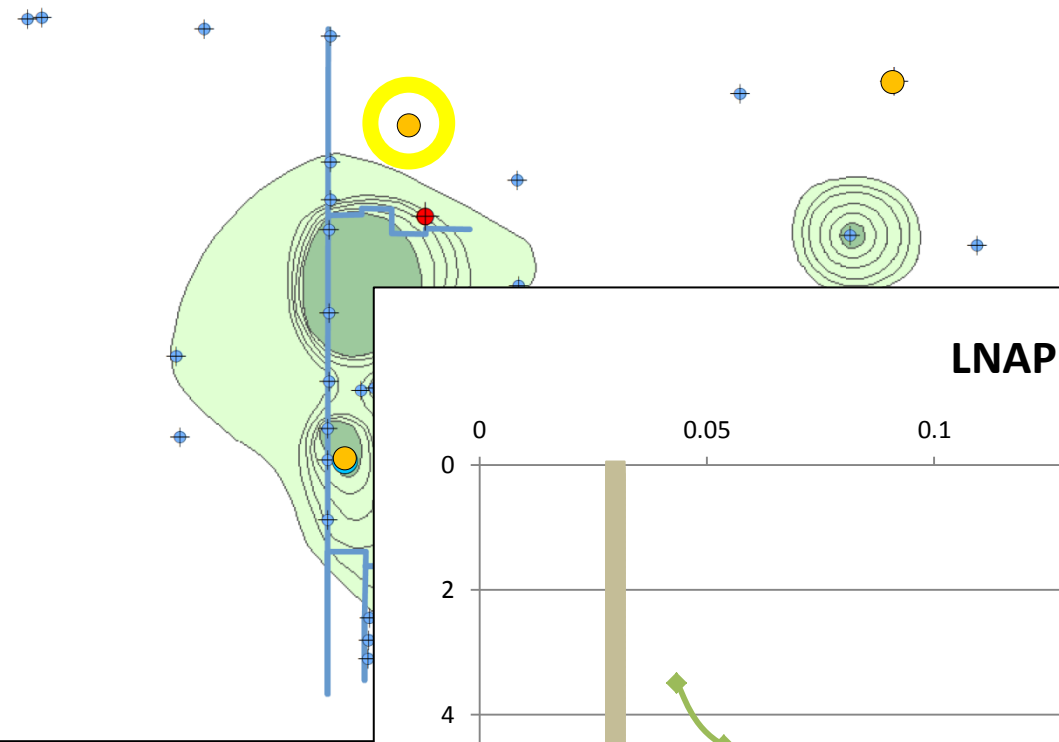




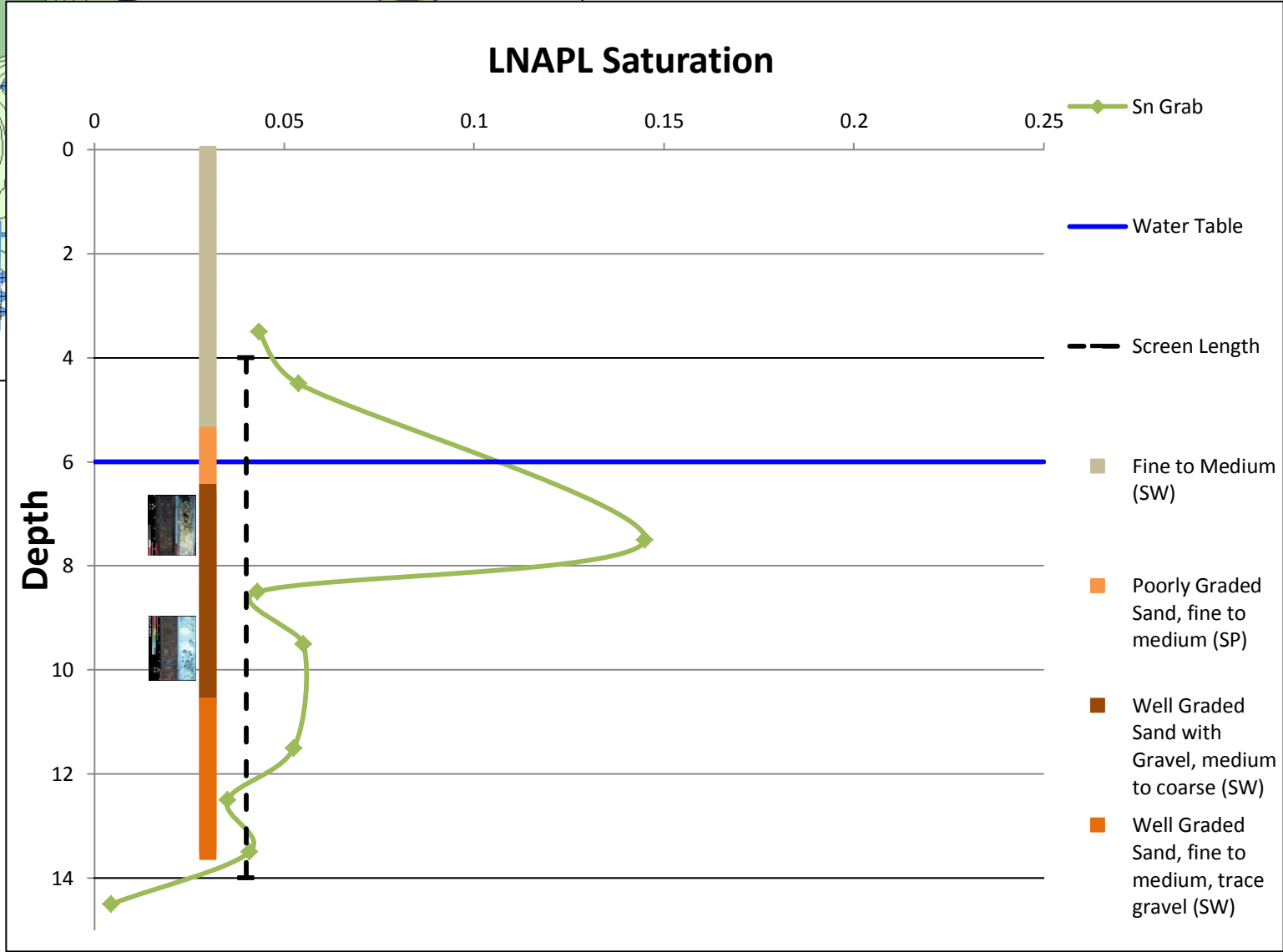
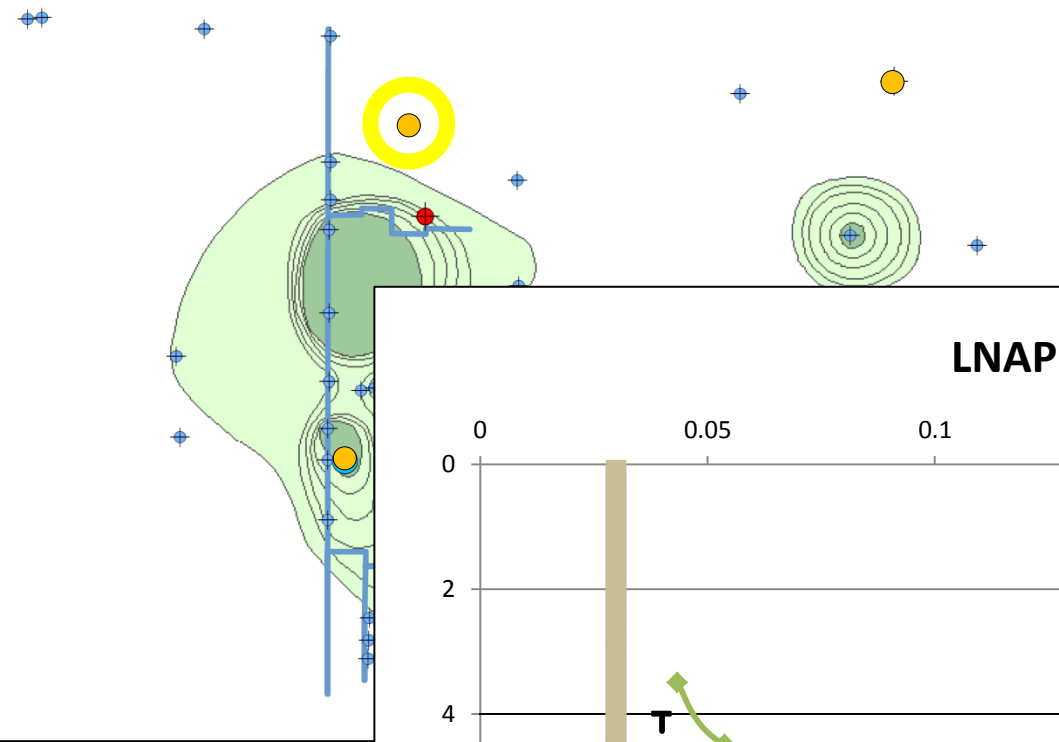
# LNAPL Migration Pathway



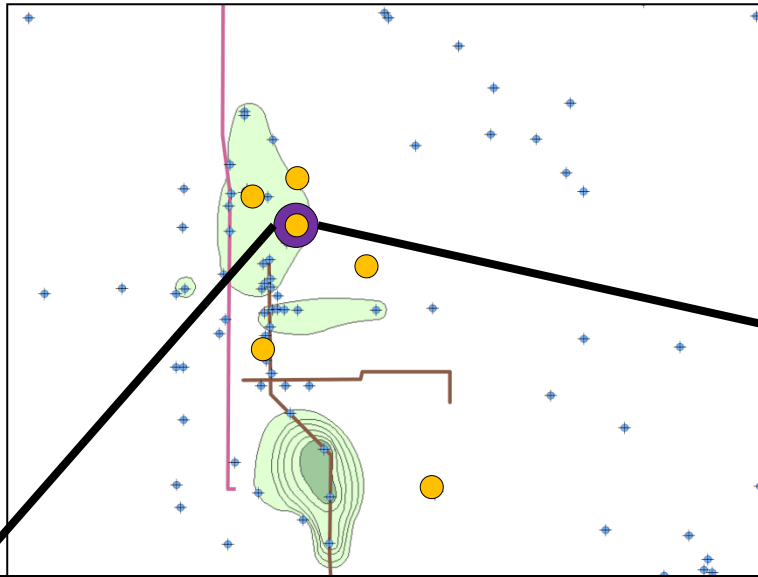
# LNAPL Migration Pathway



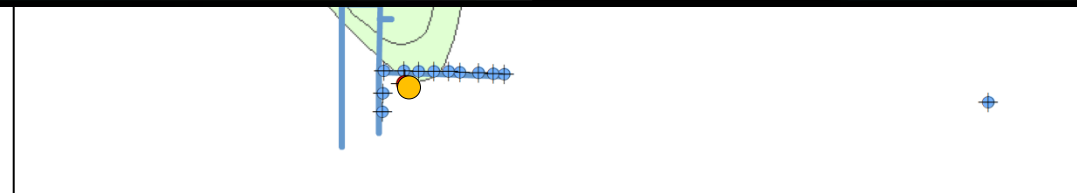
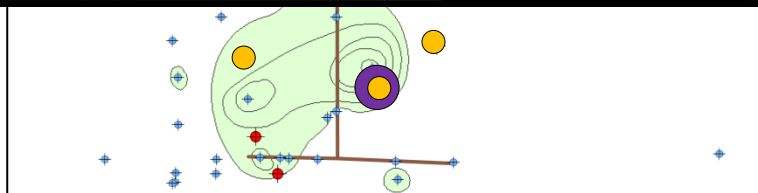
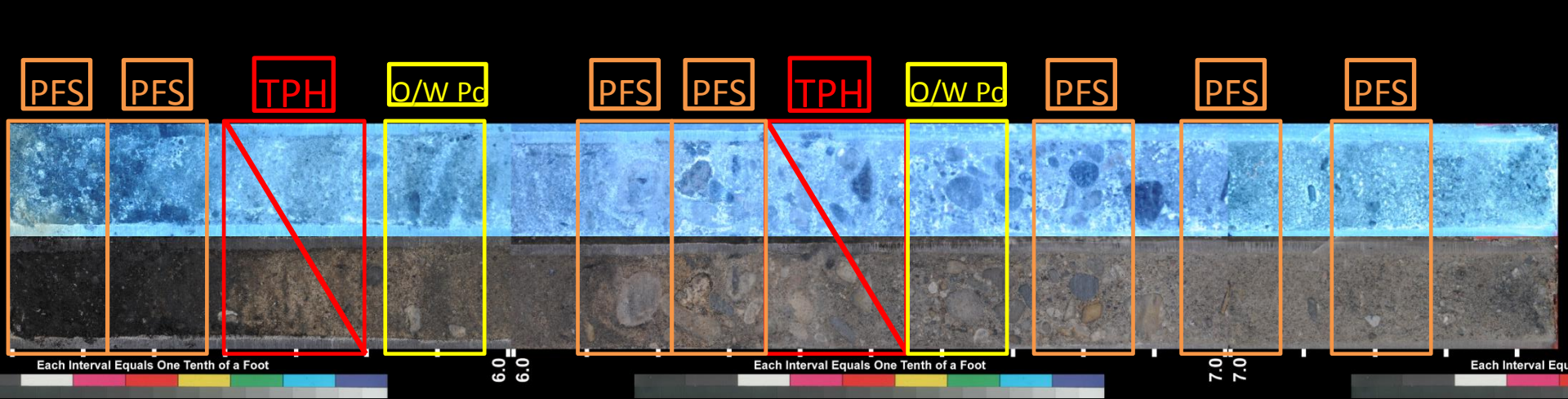
# LNAPL Migration Pathway



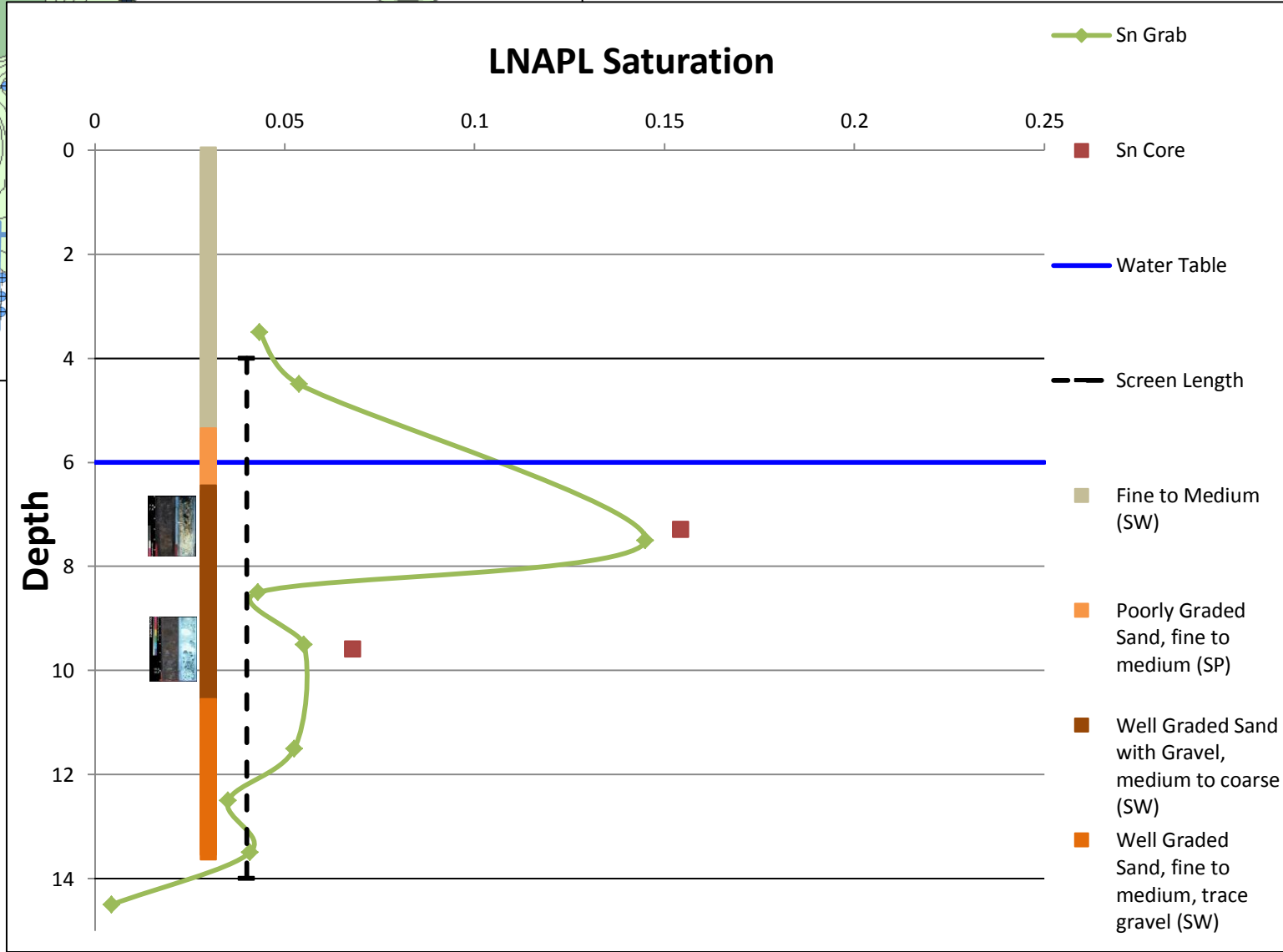
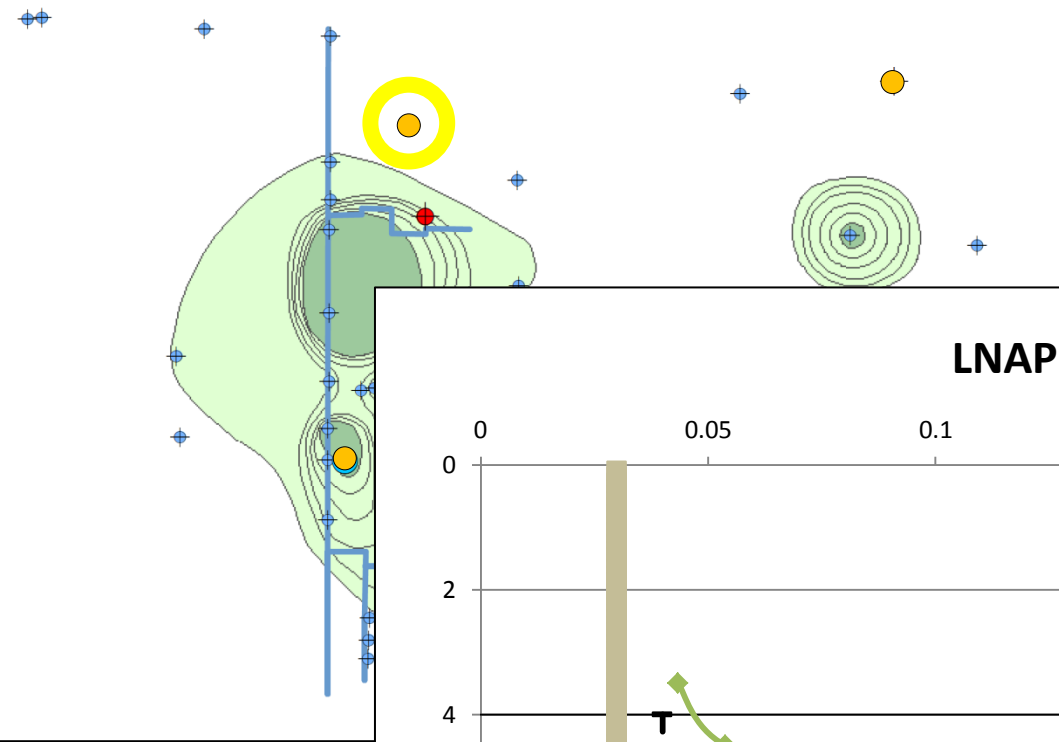
# LNAPL Migration Pathway



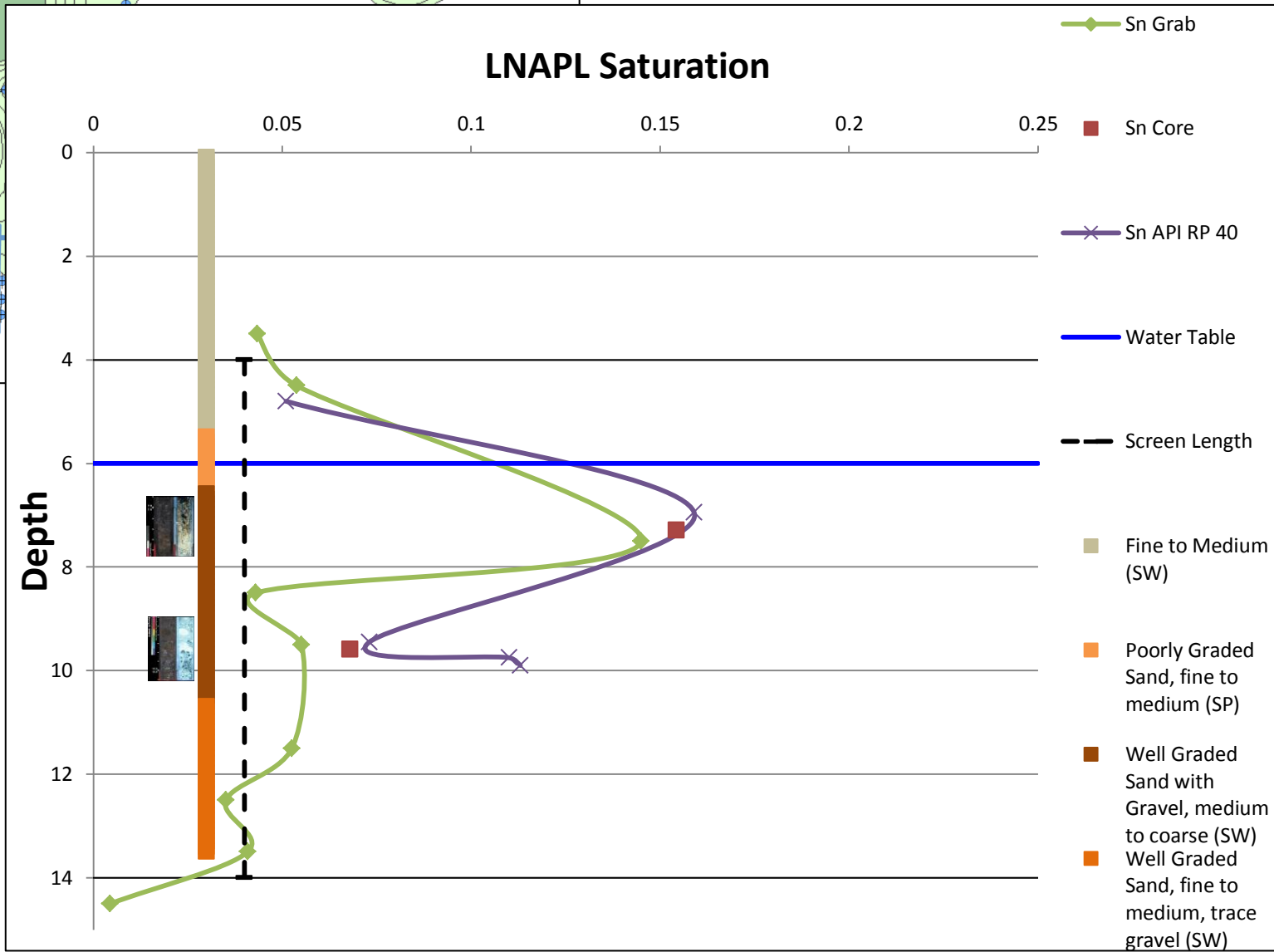
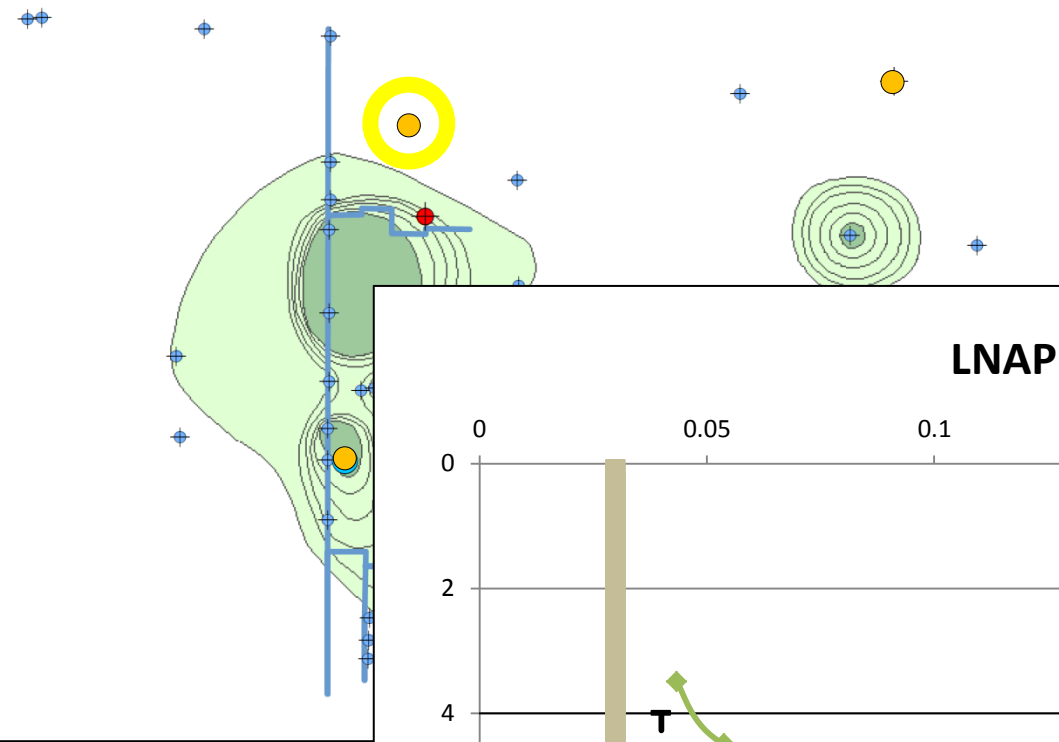
- Undisturbed Cores Sampled for Pore Fluid Saturation Data and Capillary Pressure – Saturation Curves



# LNAPL Migration Pathway

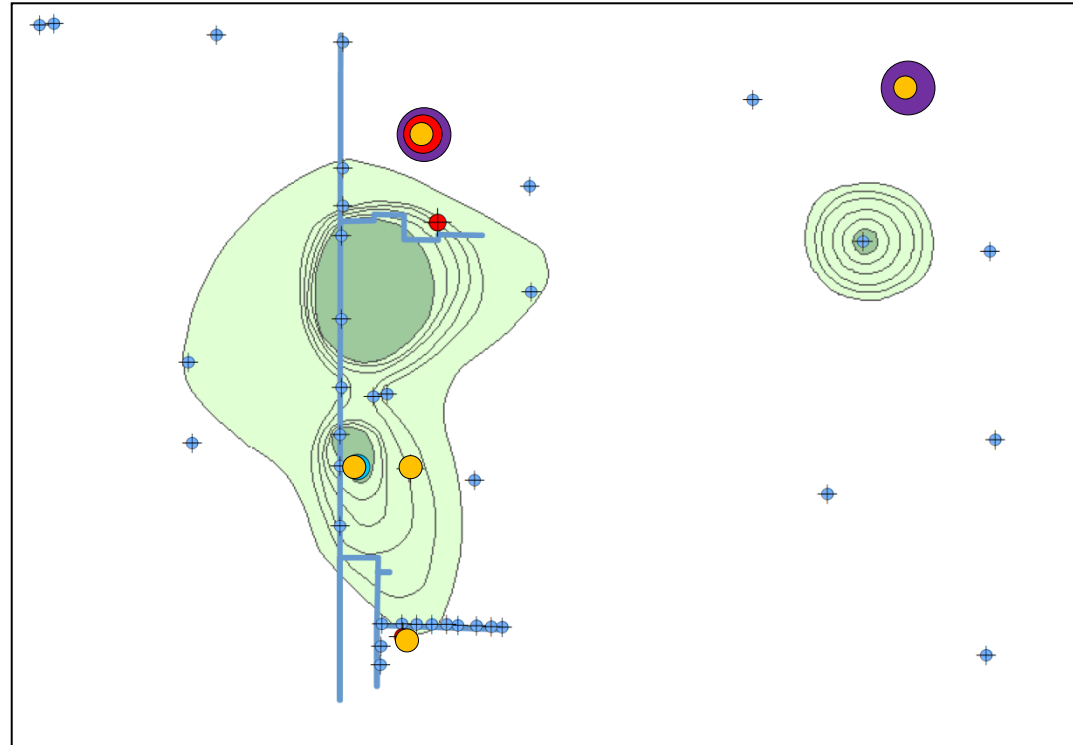
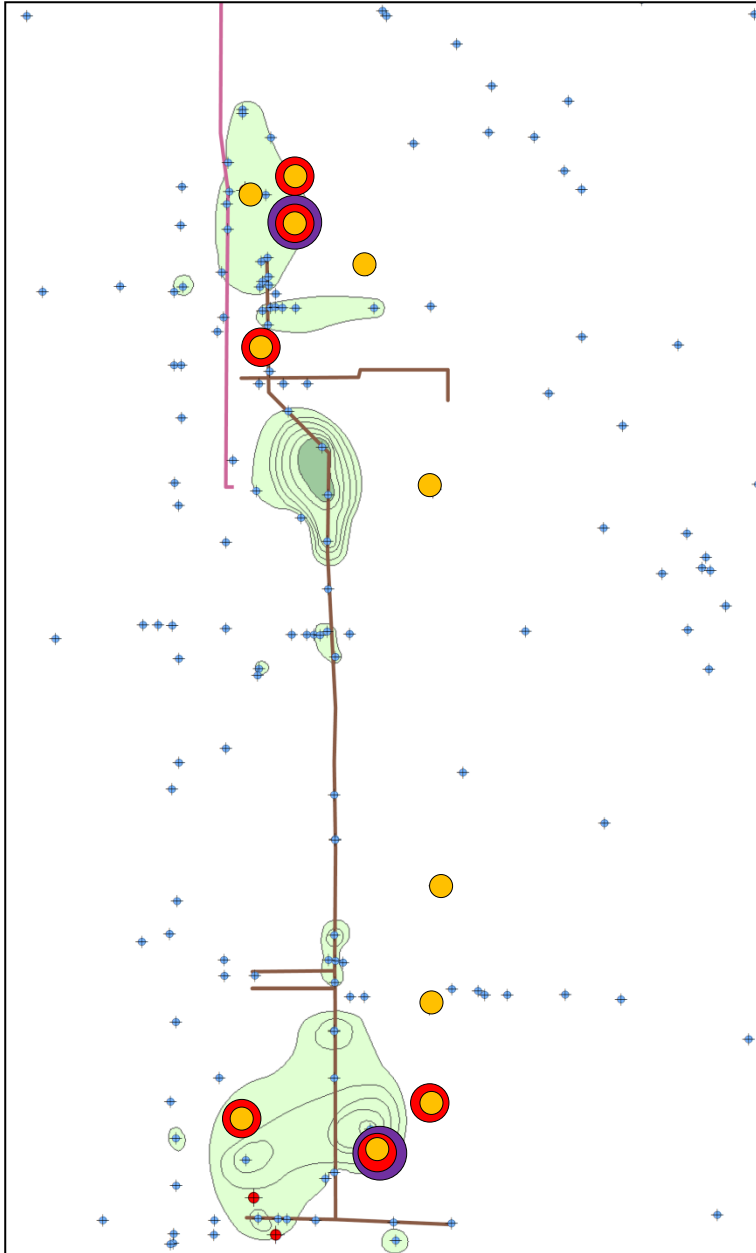


# LNAPL Migration Pathway

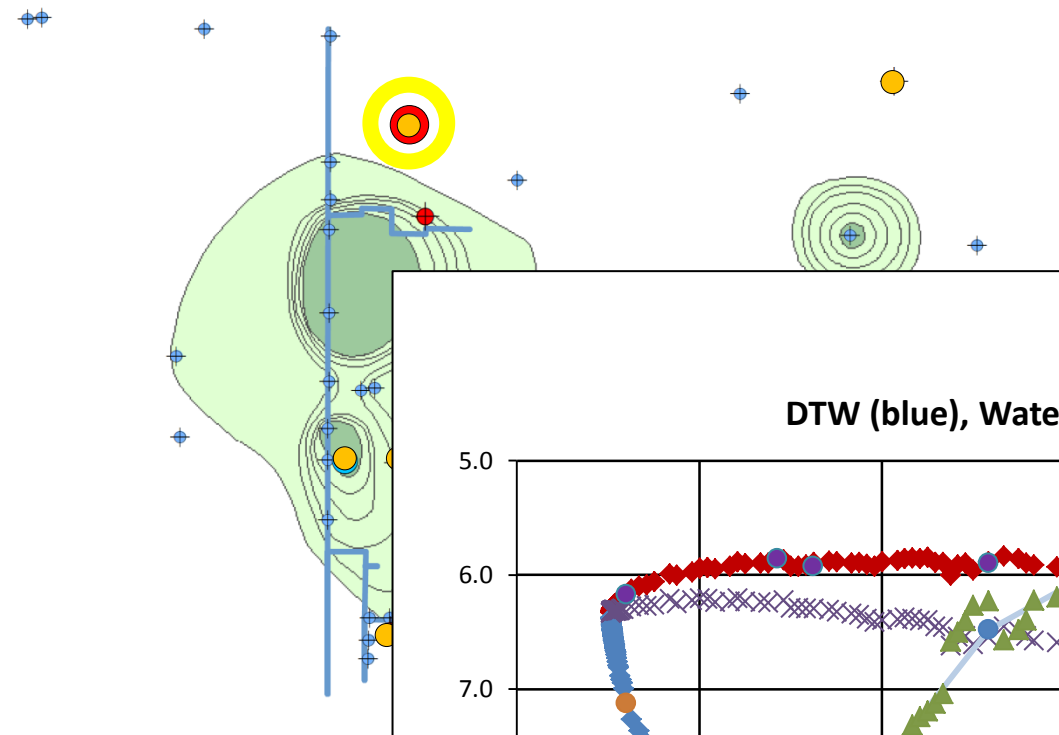


# LNAPL Migration Pathway

- Monitoring Wells with Mobile LNAPL
- $T_n$  Tests Completed (Manual Skim or Baildown)

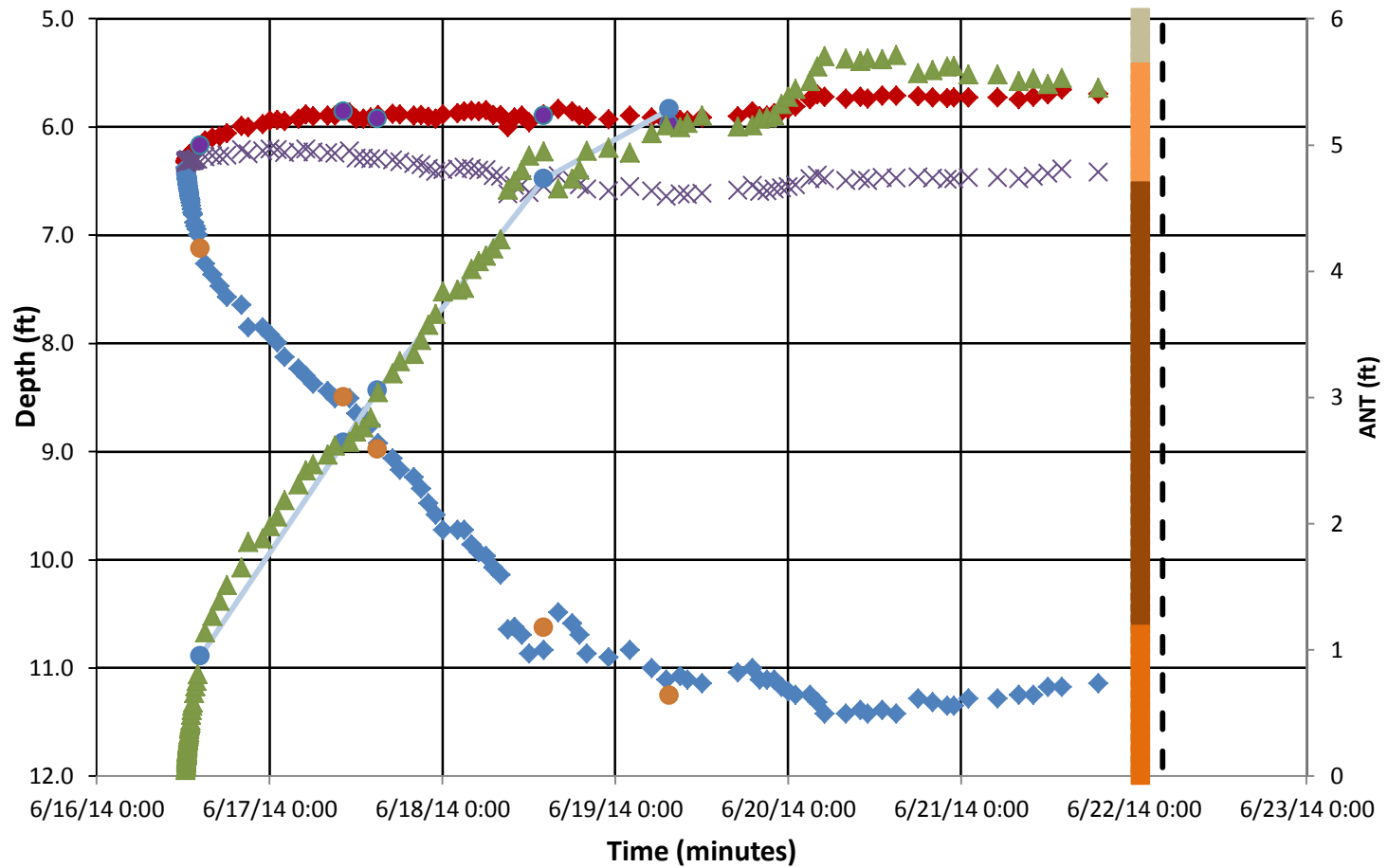


# LNAPL Migration Pathway



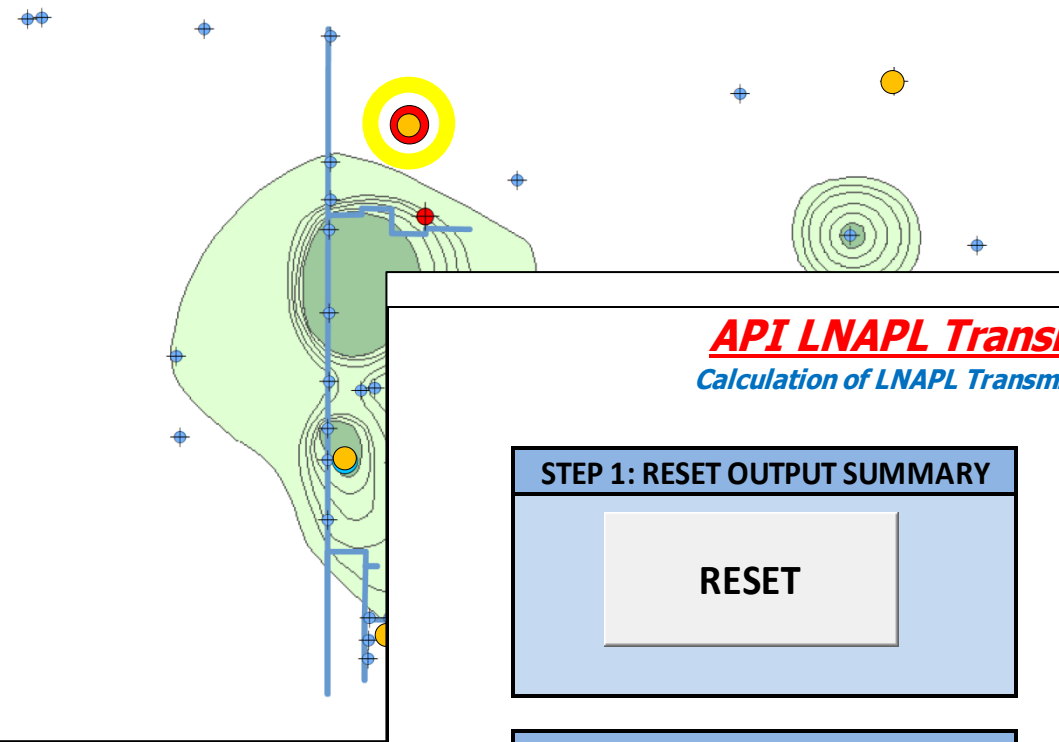
## Baildown Test

DTW (blue), Water Table (purple), DTP (red), ANT (green)





# LNAPL Migration Pathway



## ***API LNAPL Transmissivity Workbook*** *Calculation of LNAPL Transmissivity from Baildown Test Data*

### STEP 1: RESET OUTPUT SUMMARY

RESET

### STEP 2: ENTER DATA & VIEW FIGURES

#### STEP 3: CHOOSE WELL CONDITIONS

Unconfined

Confined

Perched

### STEP 4: LNAPL TRANSMISSIVITY SUMMARY

Output Summary

Mean LNAPL Transmissivity (ft<sup>2</sup>/d)

0.25

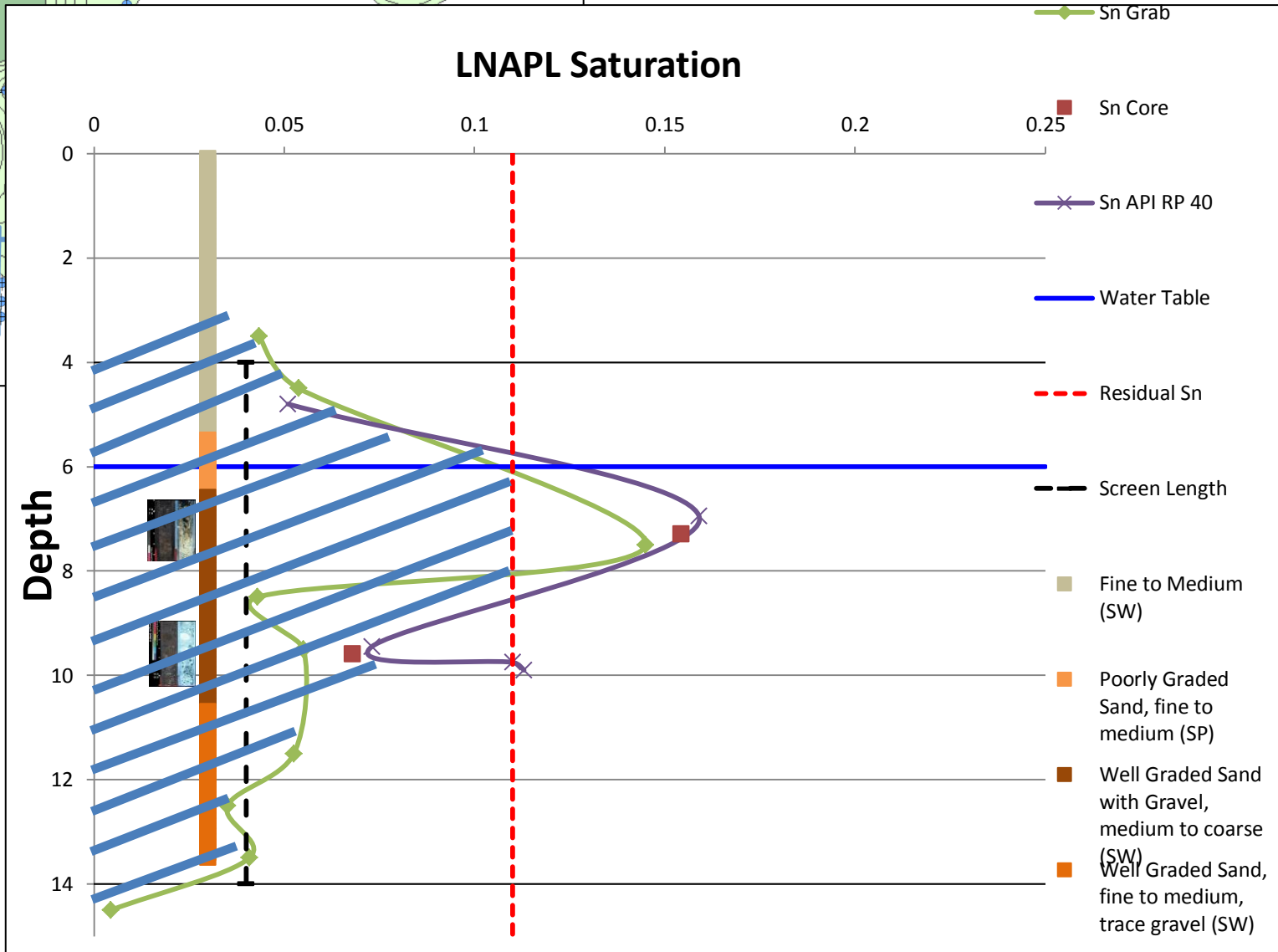
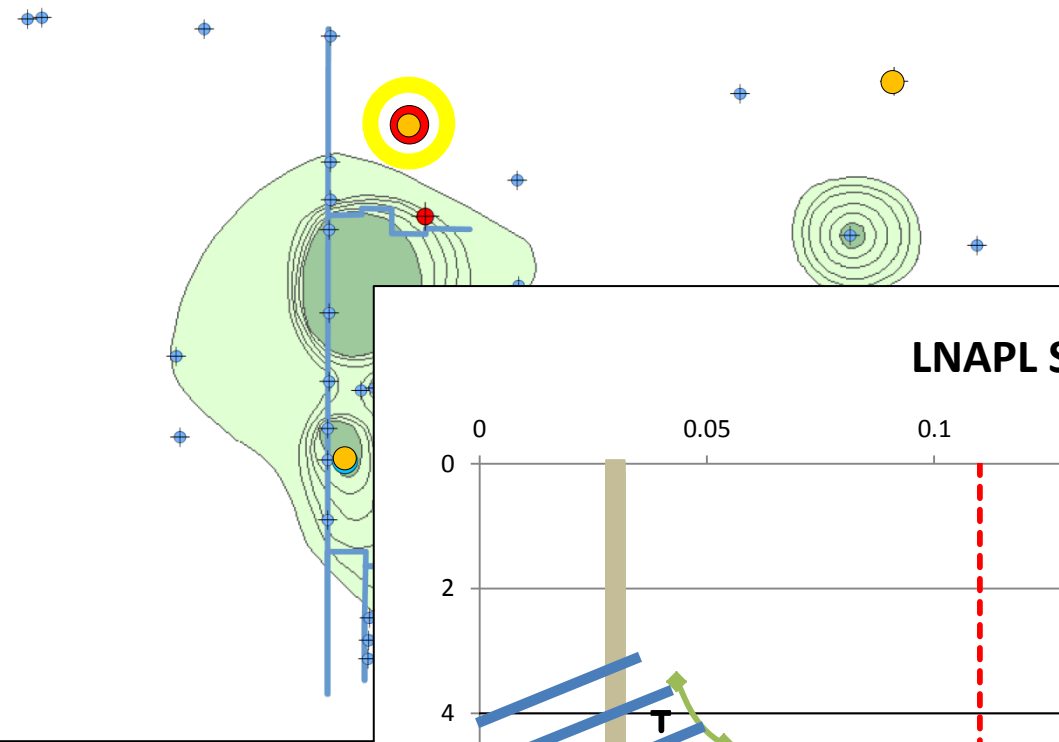
Standard Deviation (ft<sup>2</sup>/d)

0.08

Coefficient of Variation

0.30

# LNAPL Migration Pathway

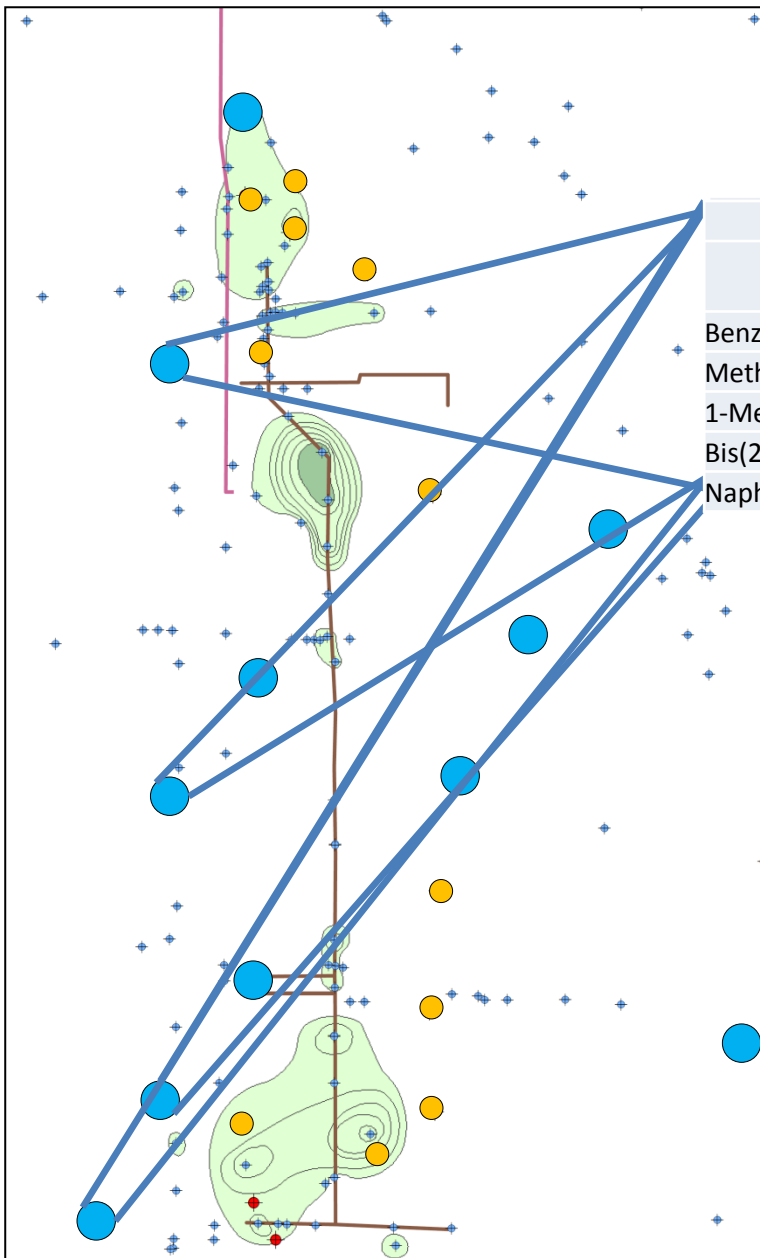


# Evaluating Risk

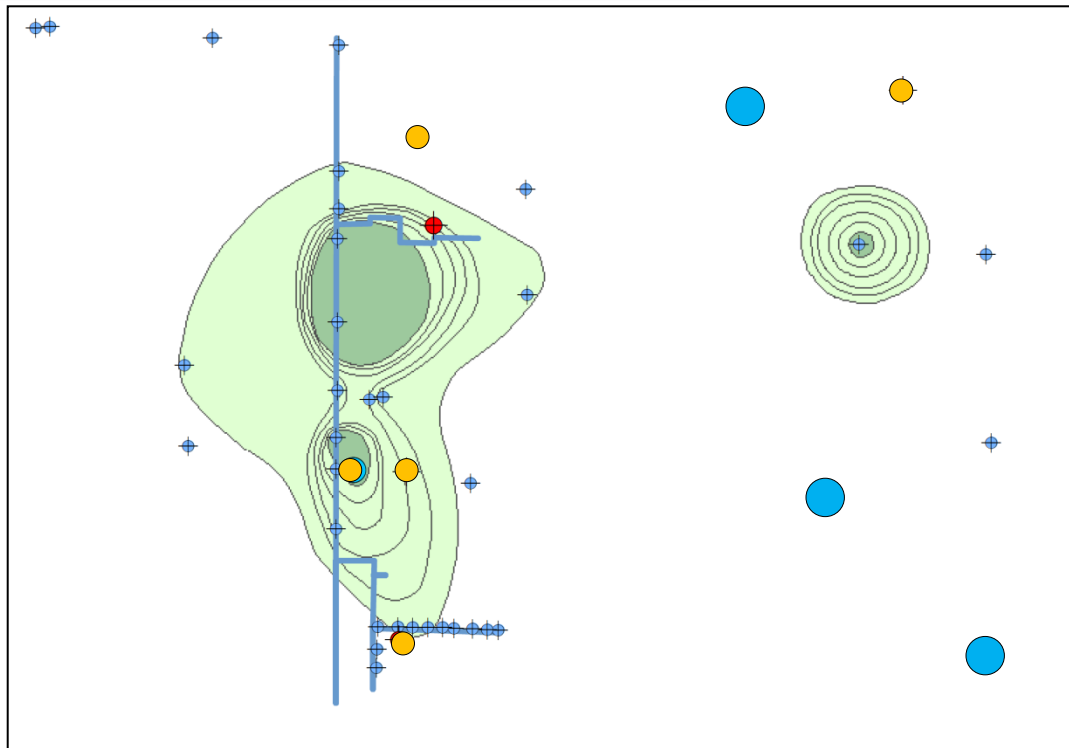
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- Vapor Pathway
- Direct Contact Pathway
- LNAPL Migration Pathway
- **Dissolved Phase Pathway**

# Dissolved Phase Pathway

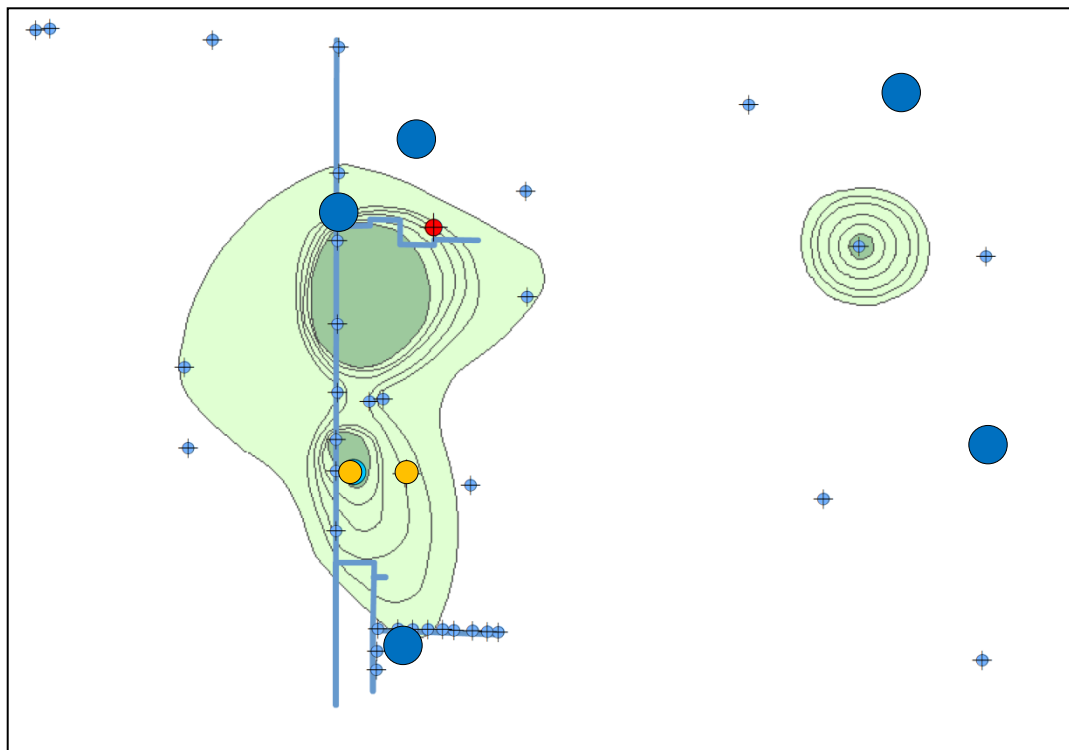
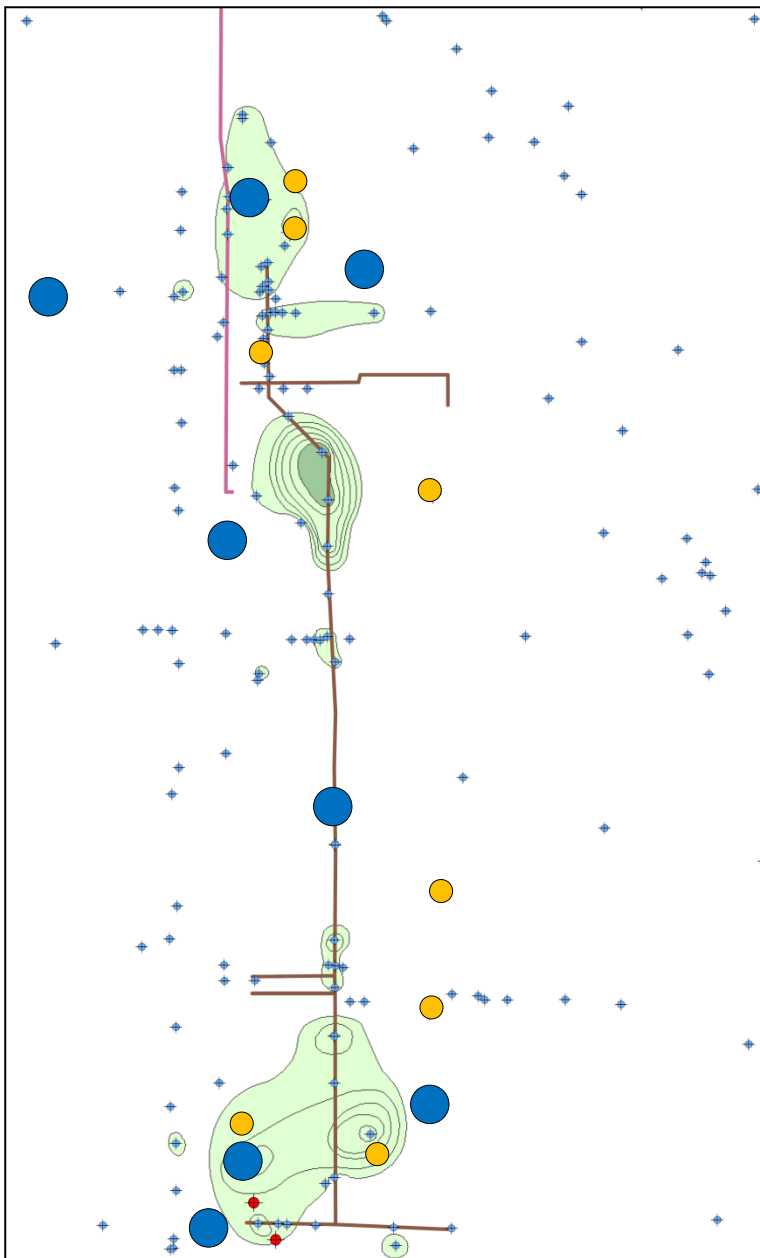


809			
Chemical Name	Screening Level (µg/L)	9/26/2013	10/30/2013
Benzene	5	0.24 J	0.50 U
Methylene Chloride	5	5.0 U	5.0 U
1-Methylnaphthalene	9.7	5.0 U	0.96 U
Bis(2-ethylhexyl) phthalate	6	50 U	9.6 U
Naphthalene	1.4	5.0 U	0.96 U



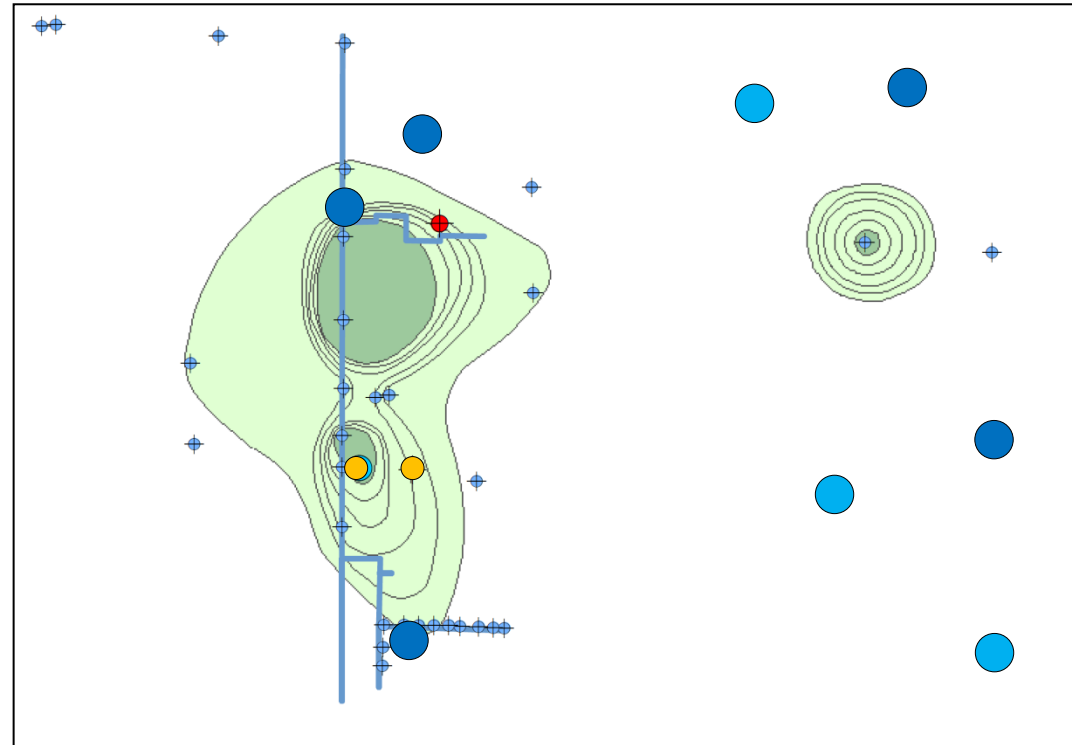
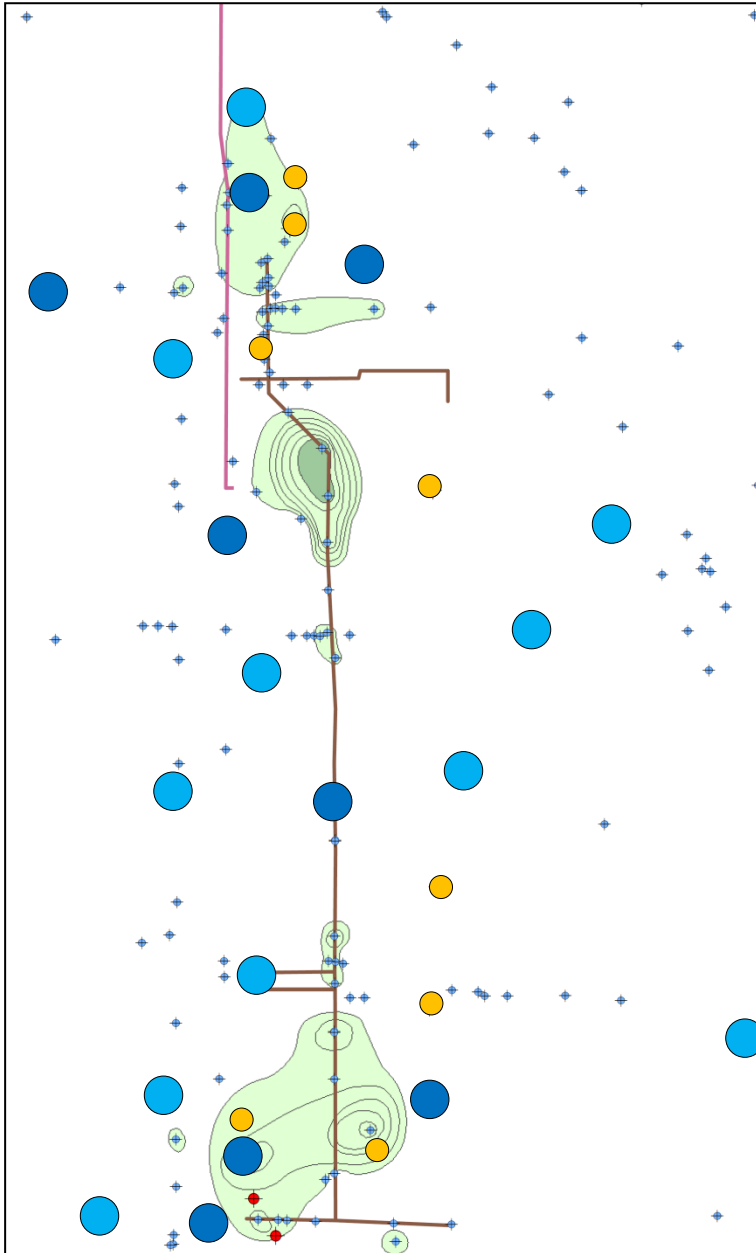
# Dissolved Phase Pathway

- Dissolved phase sampling: September and October 2014



# Dissolved Phase Pathway

- Full Dissolved Phase Plume Analysis: 2013/2014



# Next Steps

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- Evaluate recent dissolved phase data
- Modeling dissolved phase contaminant transport without system pumping
- Evaluate natural attenuation using CO<sub>2</sub> flux study, temperature profile study and evaluation of bioavailable electron acceptors

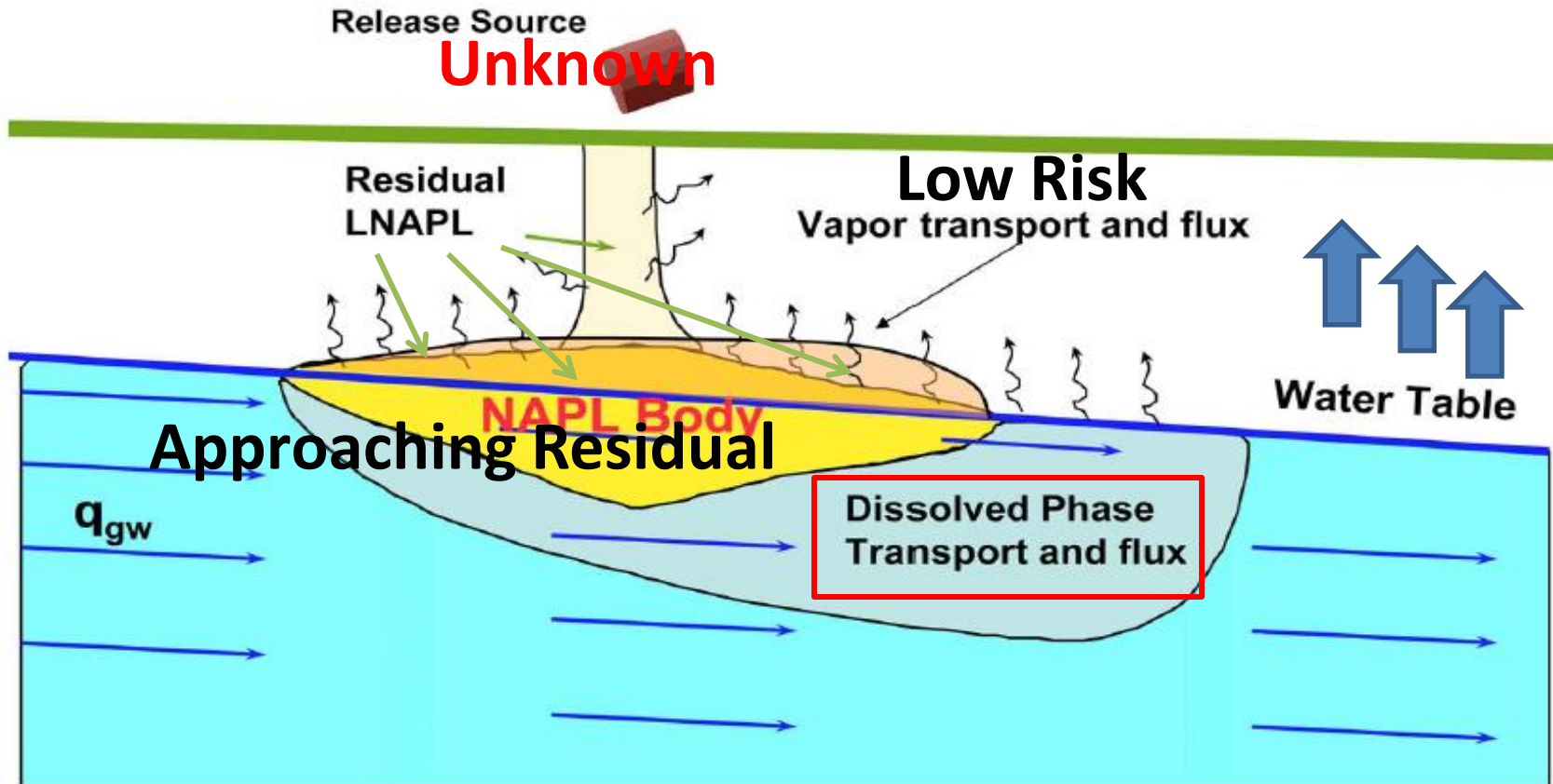
# Preliminary Conclusions

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- Vapor risk minimal
- Direct contact risk must be addressed by future remedy at isolated areas of high water table
- LNAPL mobility testing showed localized areas of potentially recoverable volumes but minimal risk reduction by LNAPL recovery
- Dissolved phase data suggests low risk but data gaps must be filled



# Evaluating Risk



# Thank You

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# Questions