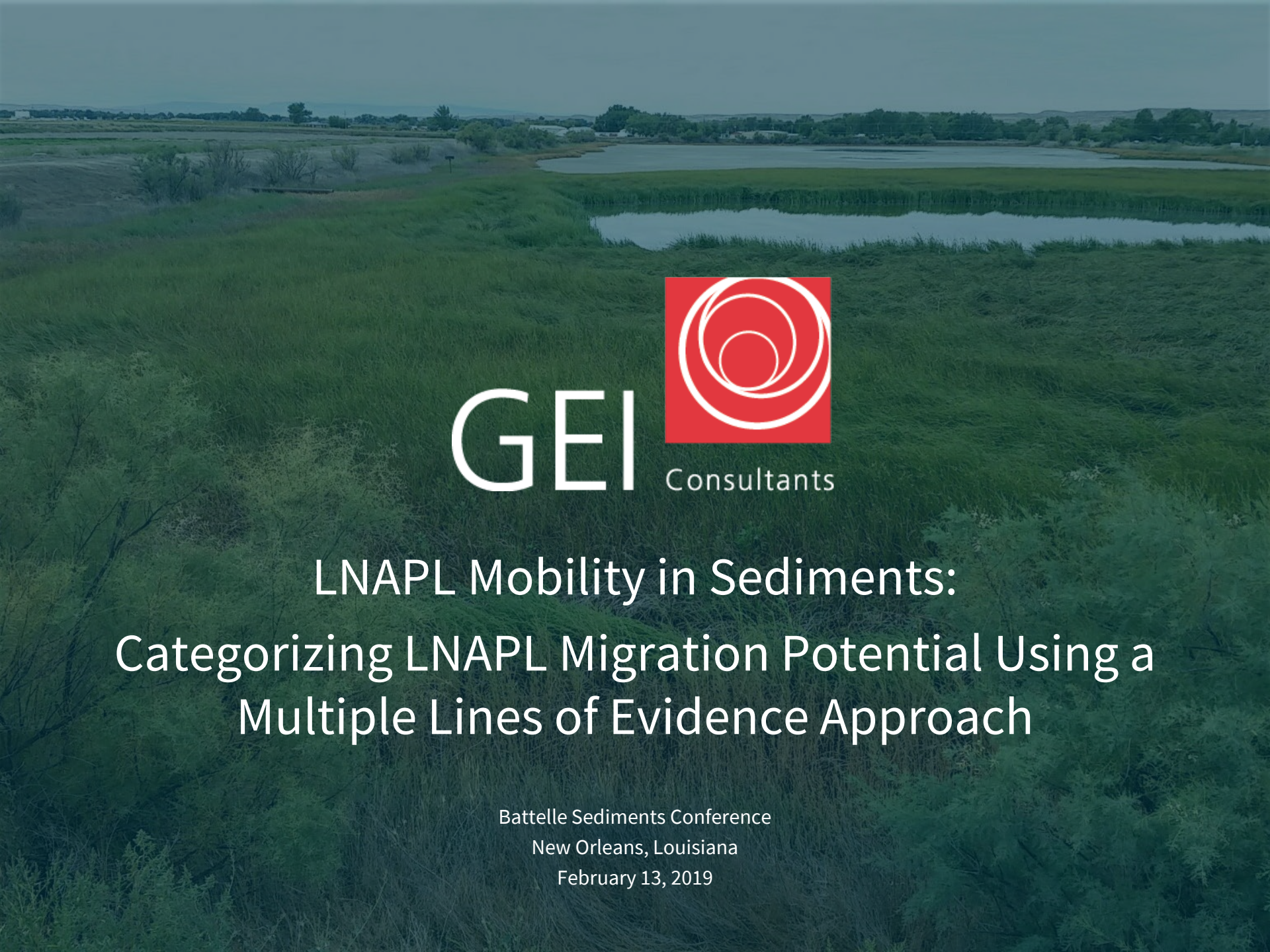


GEI Consultants

LNAPL Mobility in Sediments: Categorizing LNAPL Migration Potential Using a Multiple Lines of Evidence Approach

Battelle Sediments Conference
New Orleans, Louisiana
February 13, 2019

OUTLINE

1 Brief history and sediment provenance
2 Objectives of the LNAPL mobility program
3 Approach to the LNAPL mobility assessment
4 Expected outcomes and next steps

Site and Regulatory Context

Site

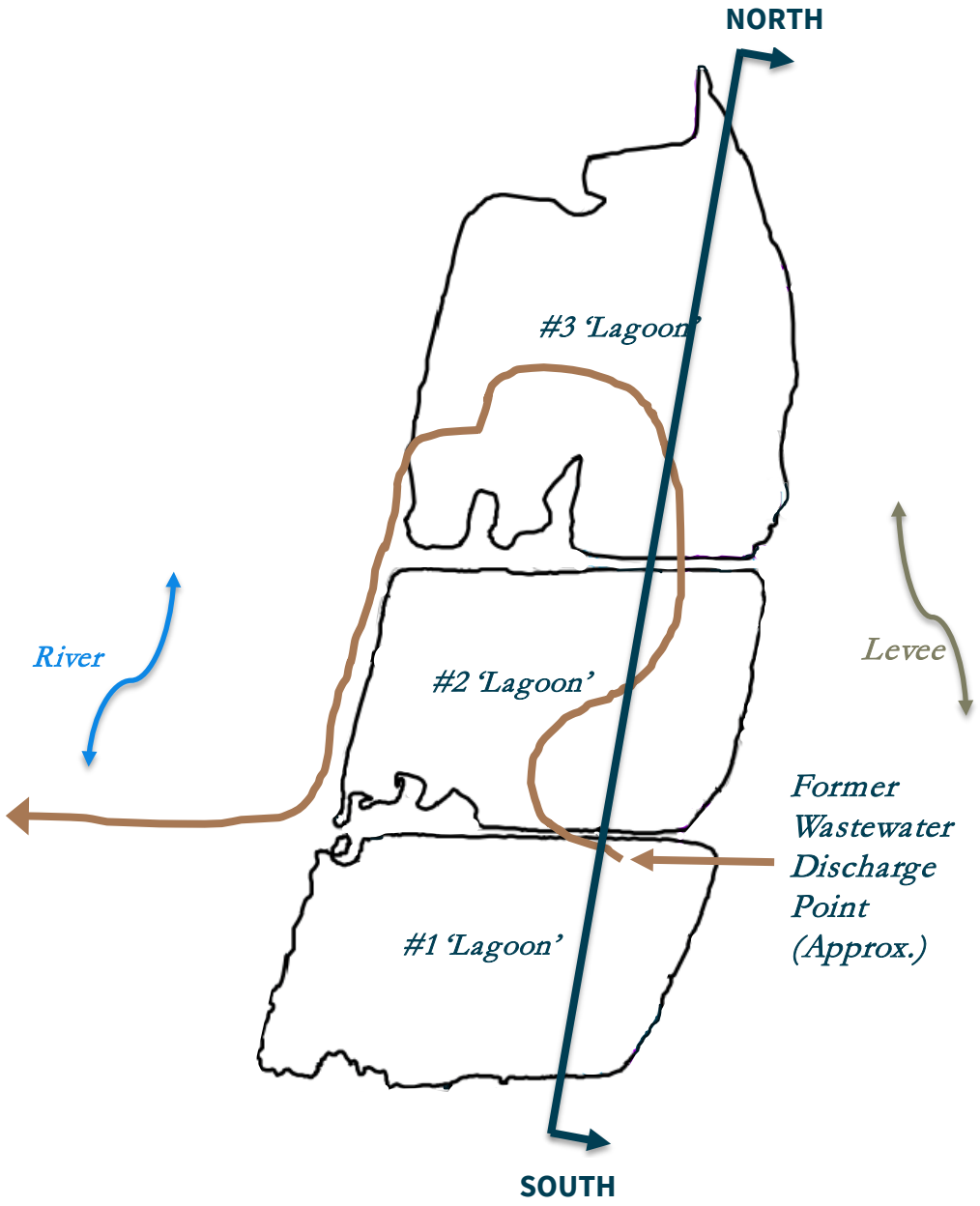
- Former petroleum facility - multiple operators over time
- Previous investigations and remediation – mostly upland areas
- River-side ‘lagoons’ - formerly received wastewater – limited investigation

Regulatory

- We developed strategic plan to address environmental concerns – including sediment
- Strategic plan breaks logjam – now with approved path forward from Agency
- **This presentation focuses on LNAPL mobility in sediment**

‘Lagoon’ layout

- ‘Lagoons’ originated as borrow pits during levee construction in 1950’s
- Shallow, interconnected water bodies with one discharge point to river
- Received wastewater from mid 1950’s to 1980’s
- LNAPL likely co-deposited with sediment



‘Lagoon’ Cross Section Schematic / CSM

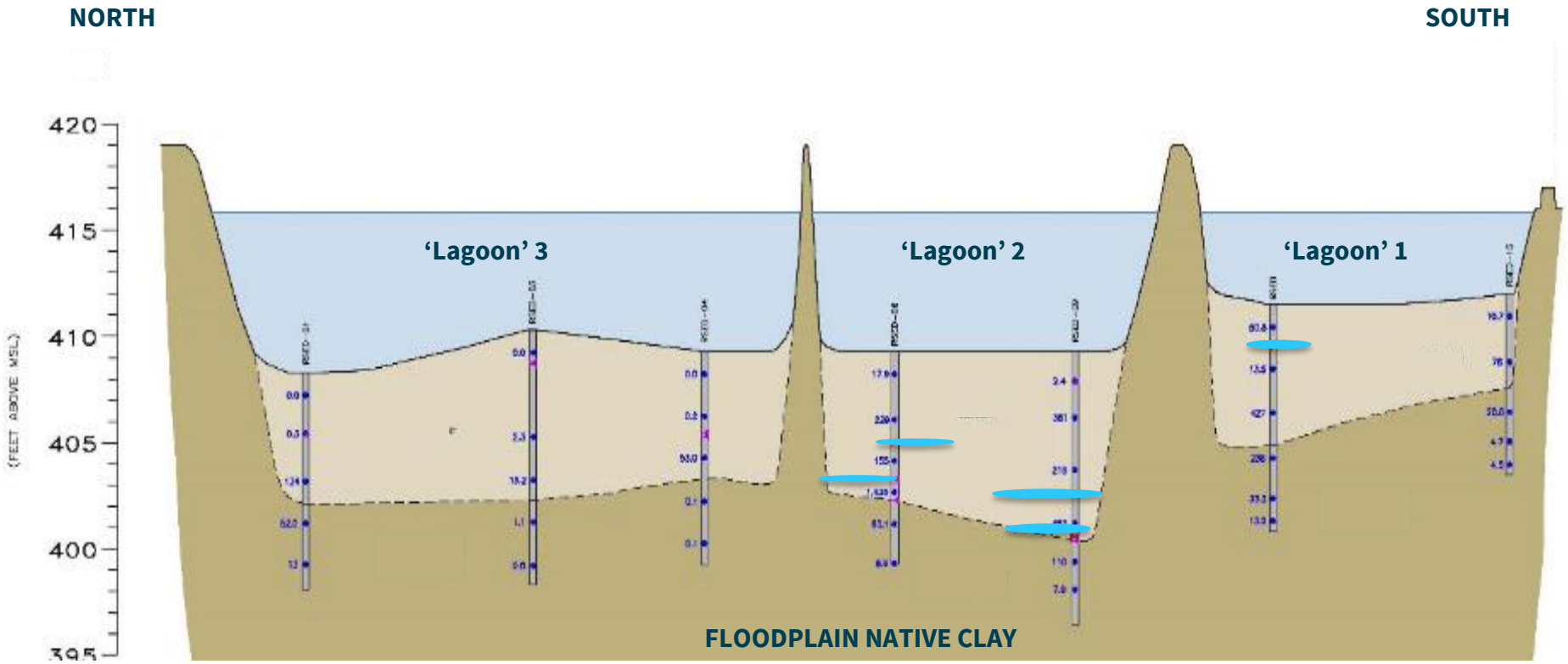


Figure from sediment investigation Work Plan, courtesy GEI Consultants, Inc., and St. John-Mittelhauser, Inc.

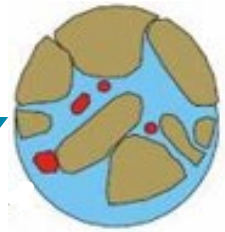
Objectives for LNAPL Assessment

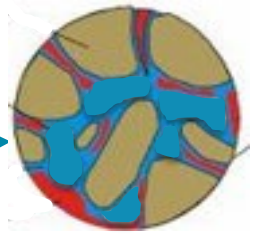
Categorize LNAPL as either:

- Residual (immobile)
- Mobile
- Potentially Migrating (beyond existing extent)

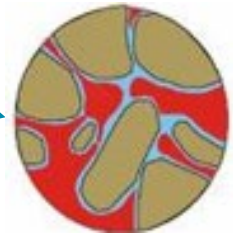
Identifying the LNAPL category is required to confirm the cap remedy is appropriate

Schematic





Present, but lacking sufficient saturation or site conditions for lateral or vertical migration



Present at saturations high enough that may result in lateral or vertical migration

Remedy Implication

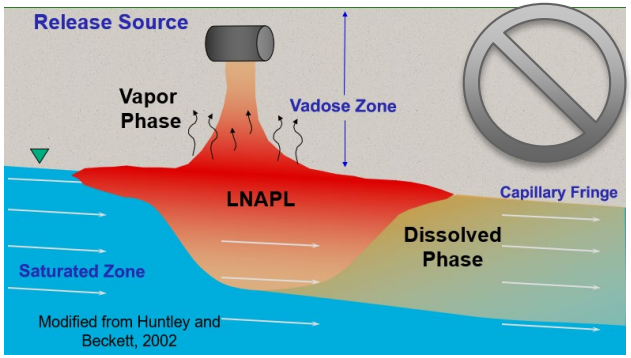
- Sediment cap the entire 'lagoon'
- GAC amended cap only over areas affected by residual LNAPL

- GAC amended cap over the entire 'lagoon'

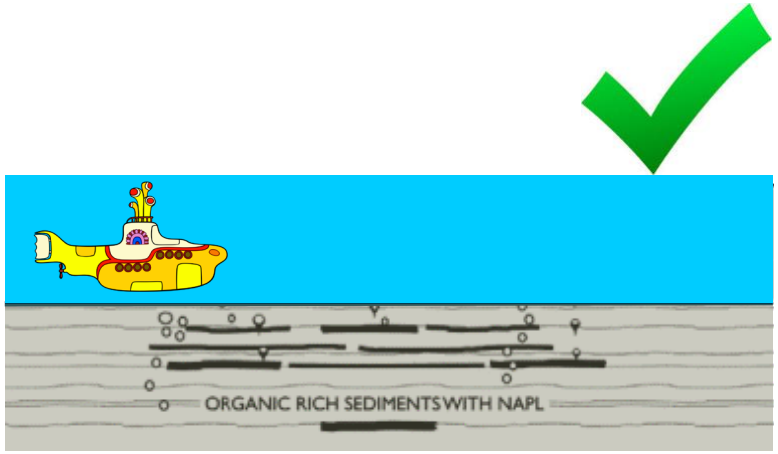
- Determine the extent and rate of migrating LNAPL
- Take steps to ensure it's no longer mobile or migrating
  - Removal
  - In-situ stabilization
  - Active cap

Challenges

- Typical approach employed in upland investigations does not work
  - i.e., can't install wells, test transmissivity, observe changes over time, different release characteristics, etc.
- Limited opportunity to collect data due to high cost of sampling
- No Standardized guidance for LNAPL in sediment investigations (ASTM committee currently in progress)
- Must look at multiple lines of evidence from micro to macro scale

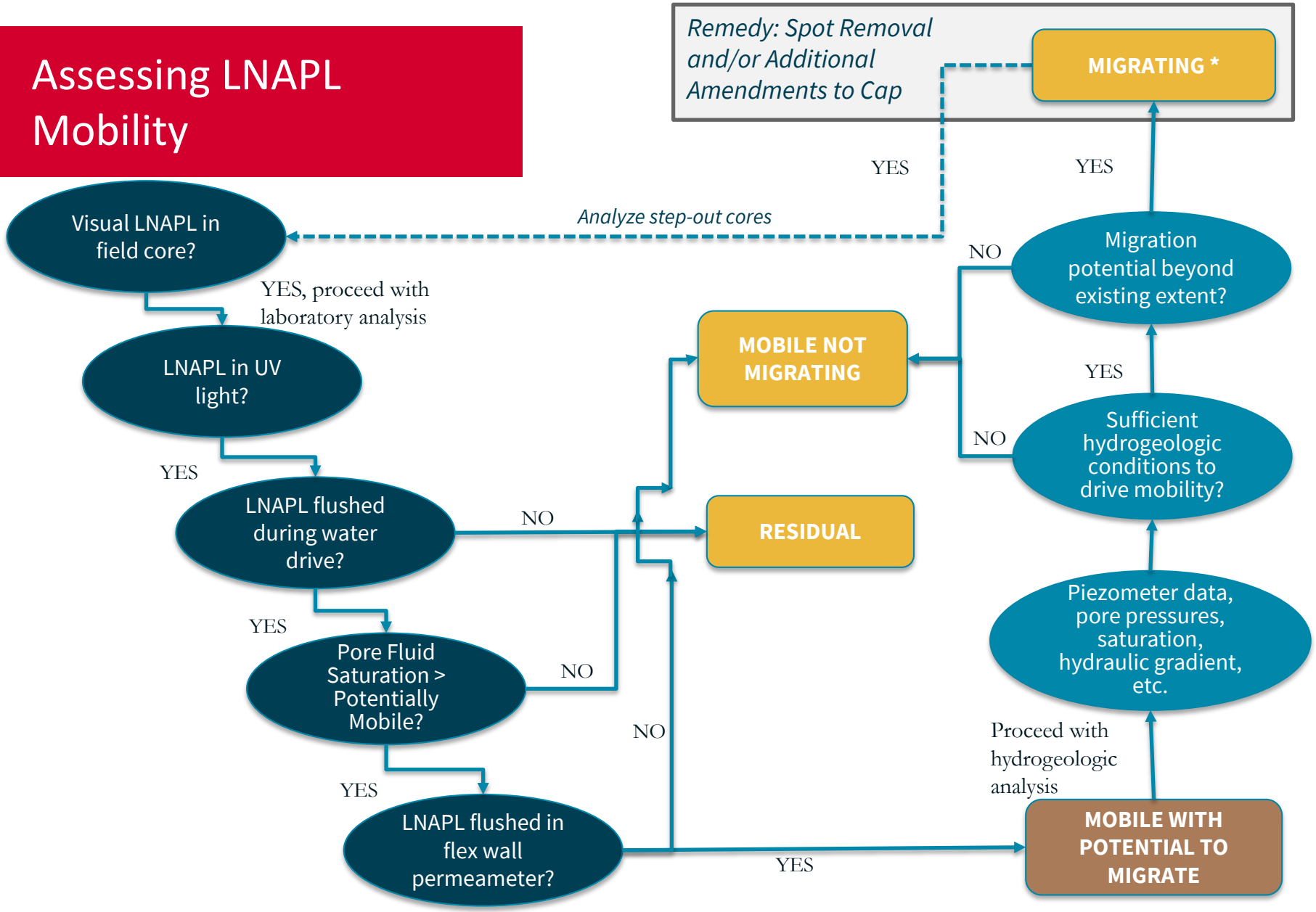


Source: LNAPL Training Part 1:An Improved Understanding of LNAPL Behavior in the Subsurface.



Source: Figure borrowed and modified from McLinn and Stolzenberg, 2009

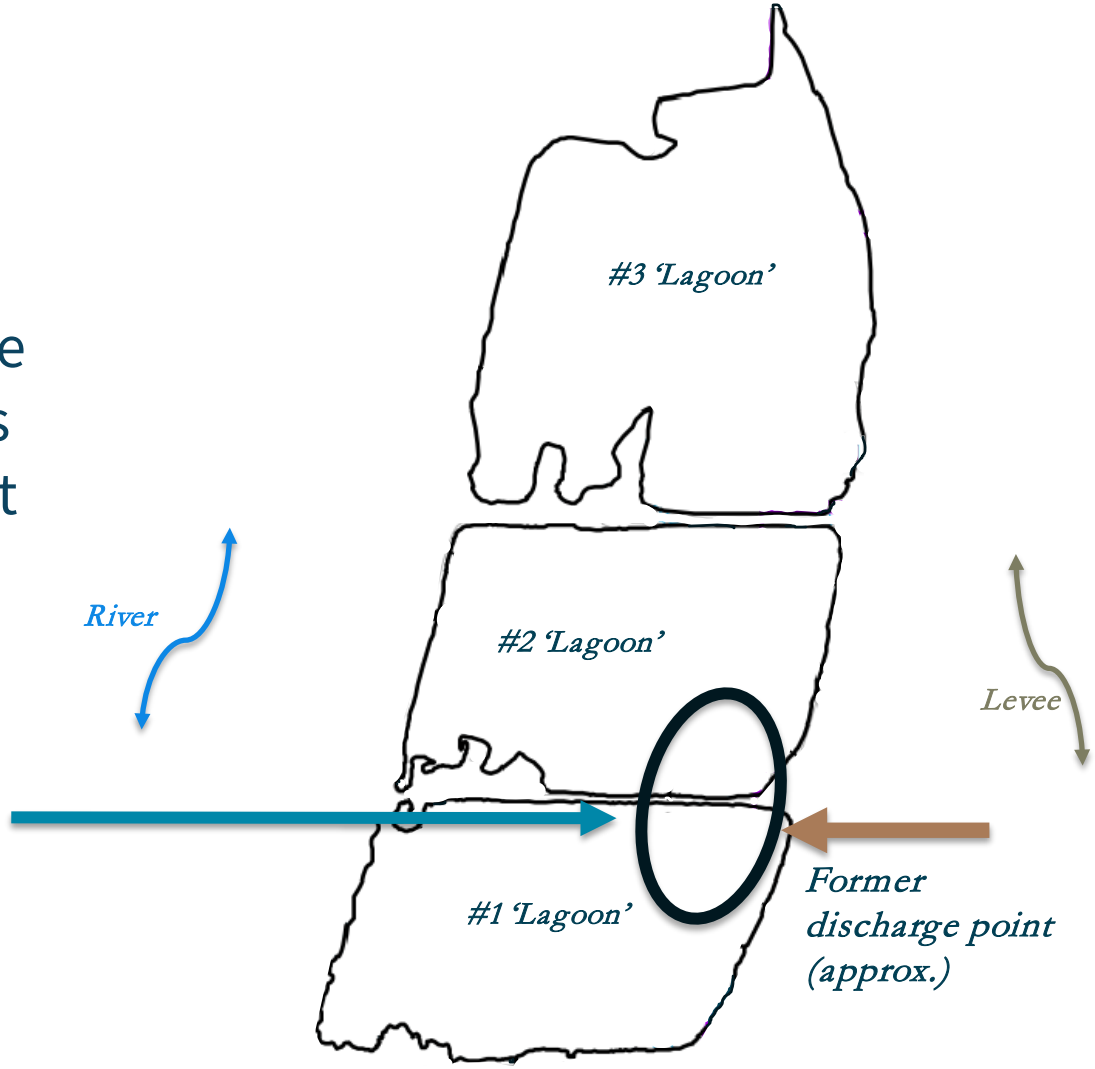
Assessing LNAPL Mobility



** Or if lead or benzene > TCLP limits present*

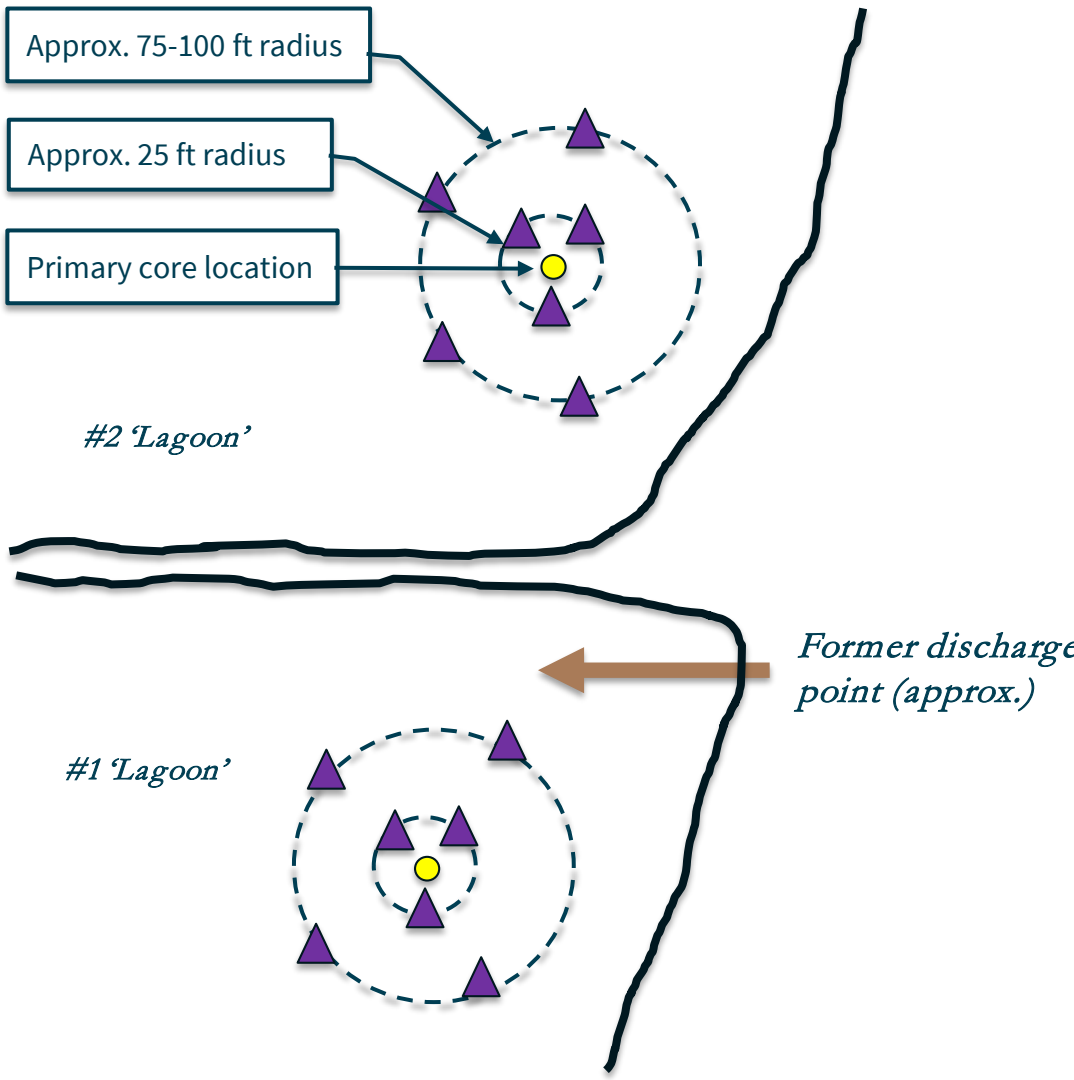
Overall Field Approach

- LNAPL (sheens and/or free product) in discontinuous lenses in deeper sediment
- Elevated PAHs, BTEX and/or lead mostly in deeper sediment
- Targeted LNAPL mobility investigation in area of most elevated visual observations



Targeted Field Investigation

- Primary core in in same location as the worst apparent visual impacts from previous investigation
- Step-out cores archived for potential lab analysis
- Goal is to delineate any potentially migrating LNAPL in a single mobilization and design appropriate remedy



Laboratory Methods: Water Drive

- A subsampled ‘plug’ is extracted from the frozen core (1” to 2” diameter) and placed in the apparatus to thaw
- Set the confining pressure and begin slowly pumping water upward through sample (at least 3 pore volumes)
- Visual observations of eluted water are made and volume of any visible produced LNAPL is recorded
- If LNAPL is observed, then sample proceeds to pore fluid saturation (Dean Stark method)

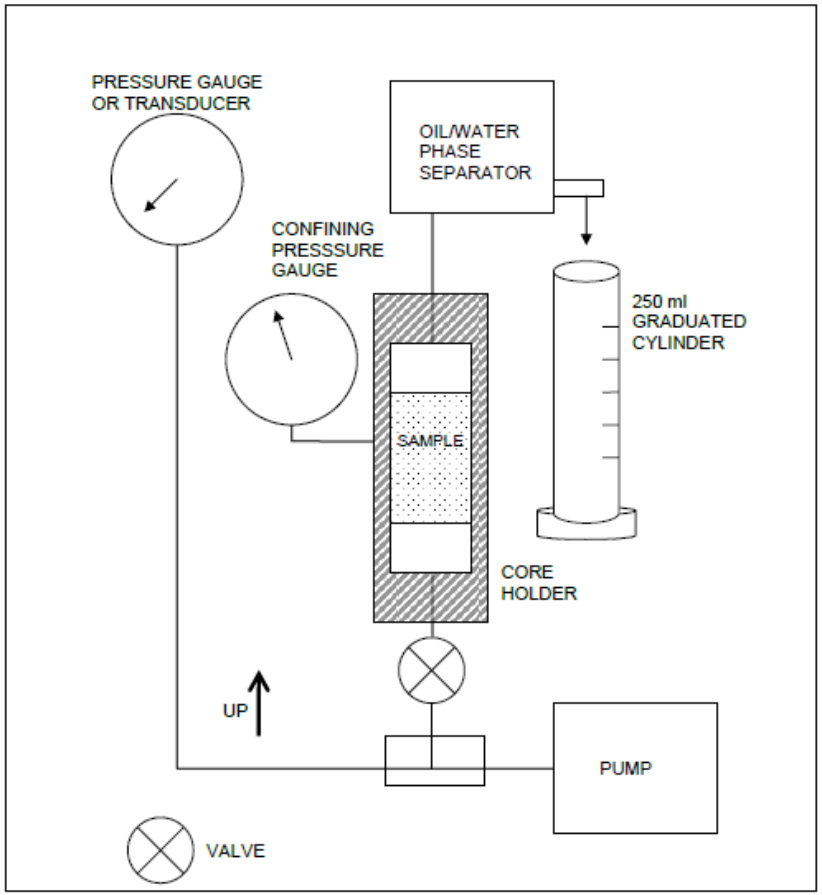


Figure 1 – RSWD Test Diagram

Pore Fluid Saturation: Dean Stark Extraction, API RP 40

- Solvent distillation to remove pore fluids and quantify NAPL and water
  - Usually toluene is used as solvent
- Essentially ‘cleans’ the grains and weigh the fluids
- Can use either the same plug from water drive test, or a parallel plug from the parent core
- Basic sample properties (pore volume, bulk volume) determined separately
- Results described as percentages of the sample pore space

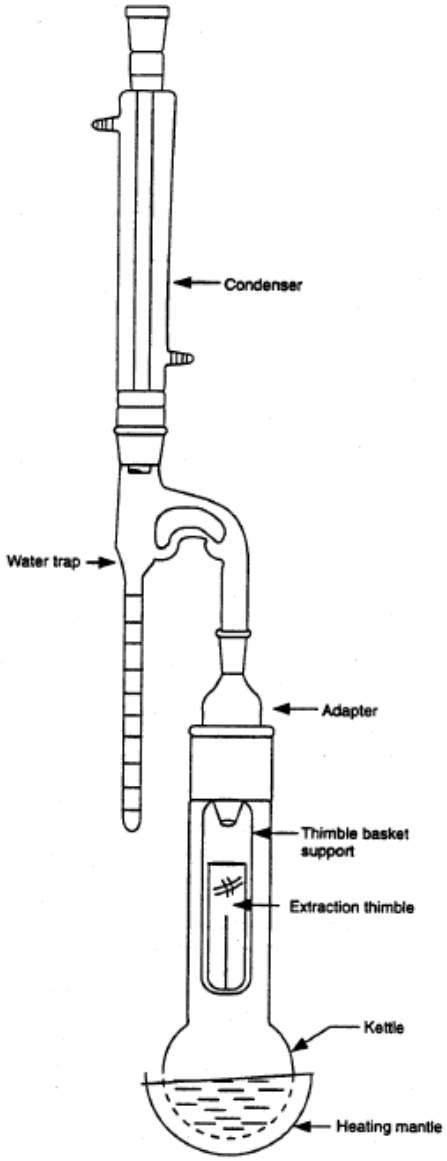


Figure 4-4—Dean-Stark Apparatus for Volumetric Determination of Water

Flexible Wall Permeameter: ASTM D5084 Method A

- Separate plug extracted from parent core
- Confining pressures and hydraulic gradients closer to in-situ conditions (compared with water drive)
- Constant head, constant tailwater elevation
- Stepped gradients up to 4 times in-situ with observations of eluted fluid at each step
- If LNAPL is observed, then proceed with hydrogeologic analysis of mobility

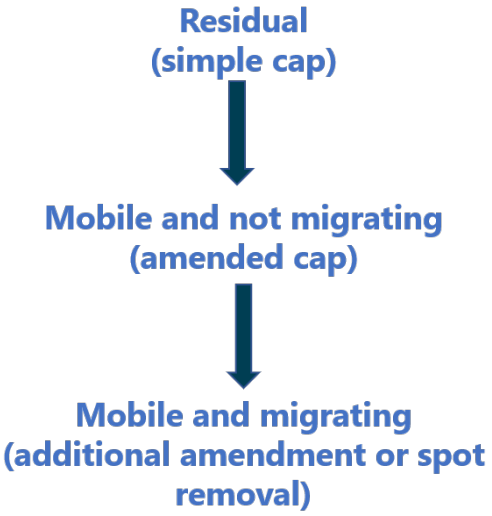
Image from: http://www.worldoftest.com/permeability-cells-flexible-wall-permeameter

Broader Lagoon Implications

- All three ‘lagoons’ will be investigated for geotechnical and environmental purposes with multiple cores across each lagoon
- Each core across the lagoons will be logged for visual LNAPL observations and compared with the ‘worst case’ locations
- We assume that lesser degree LNAPL visual observations have less mobility potential than the ‘worst case’ locations

Expected Outcomes/Next Steps

- Know if LNAPL is residual, mobile, or migrating to fine-tune the cap remedy
- Have all the environmental, geotechnical and hydrogeologic information needed to finalize the CSM, risk assessment, and remedy design
- This approach achieves a cost-effect remedial solution that is protective of the environment
- Next steps…perform the investigation!



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