Bench Scale In-situ Solidification/Stabilization Treatability Tests Using ANSI 16.1.

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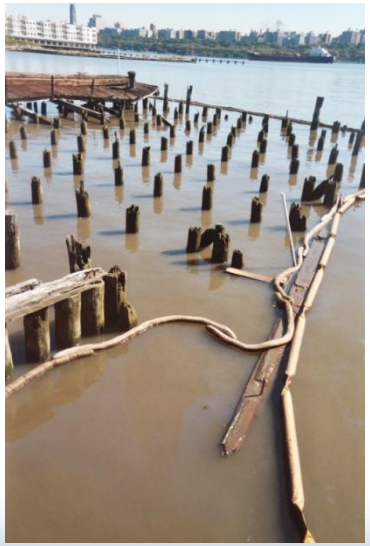
Presentation Outline

- Project background
- Nature of contamination
- Overview of ISS
- Criteria for Evaluating Effectiveness
- Study Activities
- Findings and Results



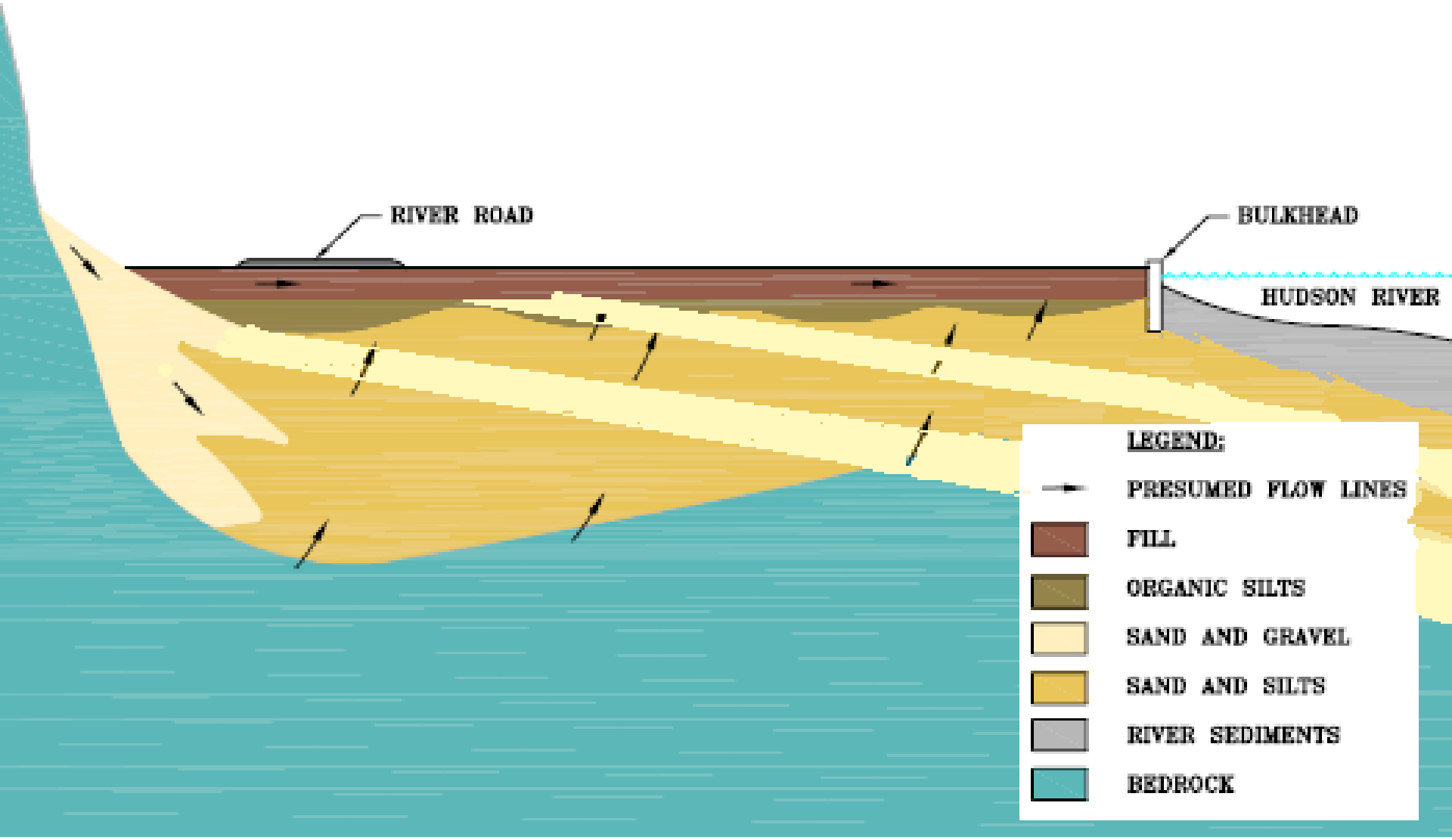
Project Overview

- 15-Acre Riverfront Property
- Former Industrial Usage:
  - chemical plants, edible oil, soap and detergents, roofing pitch storage, hydrogen gas plant
- Proposed Redevelopment as a Mixed Use Residential and Commercial Property
- Contaminated with Arsenic, other Metals, Roofing Tar/Pitch Material, Benzene
- Northern Portion of Site Impacted by Quanta Superfund Site

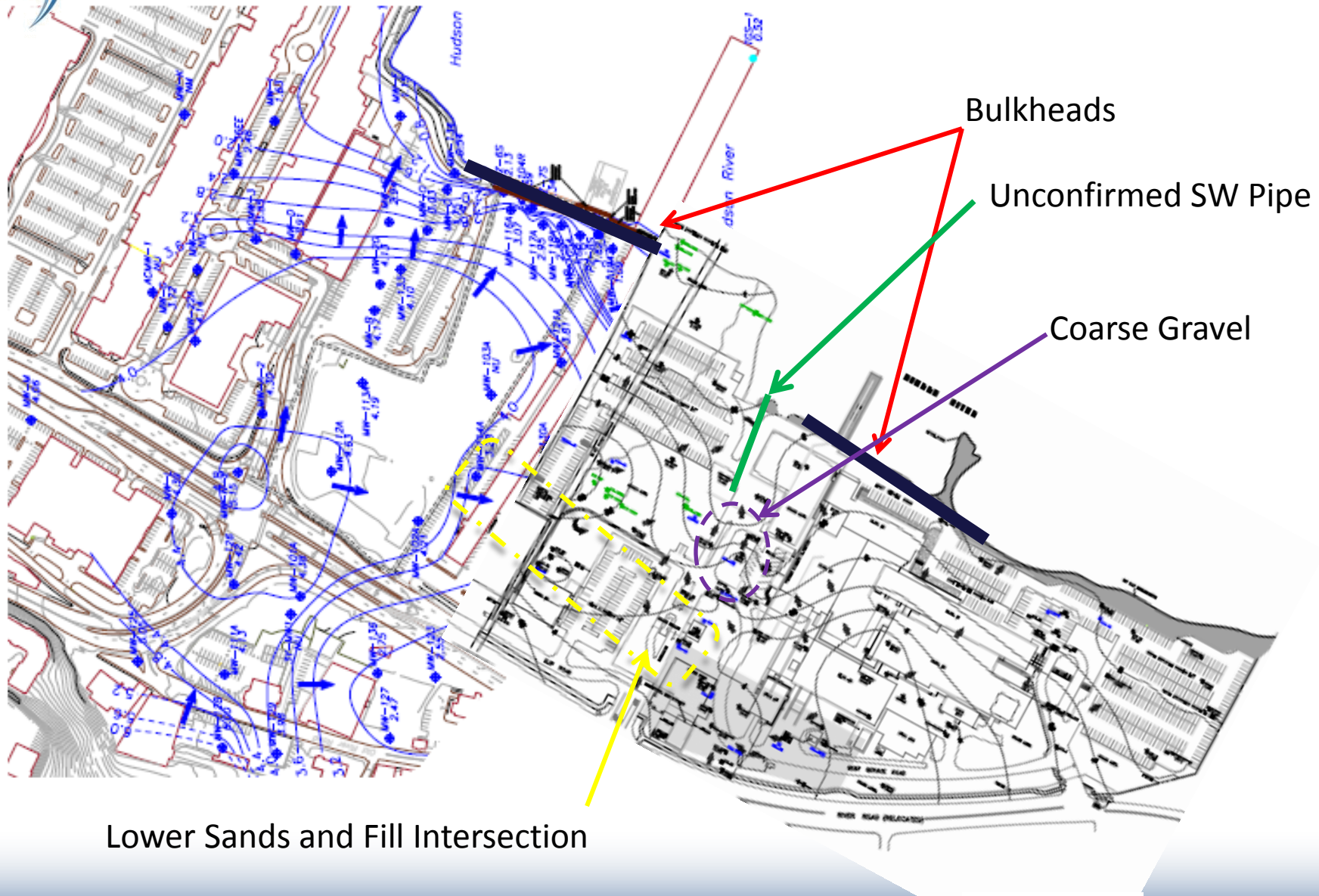
Site Geology/Hydrogeology

- Fill – Silts, Sands, Debris. 5-25’ Thick.
  - 20 to >100 ft/day
- Upper Sands. F/M Grain. Lacustrian Fan
  - 2 to 20 ft/day
- Organic Silts and Clays. Swamp/Marsh
  - 0.001 to 2 feet/day
- Lower Sands. F/M w Gravel. Lacustrian Fan
  - 5 to 20 ft/day
- Stockton Formation. 50 to >90 feet bgs

Site Geology/Hydrogeology



Shallow Groundwater Flow



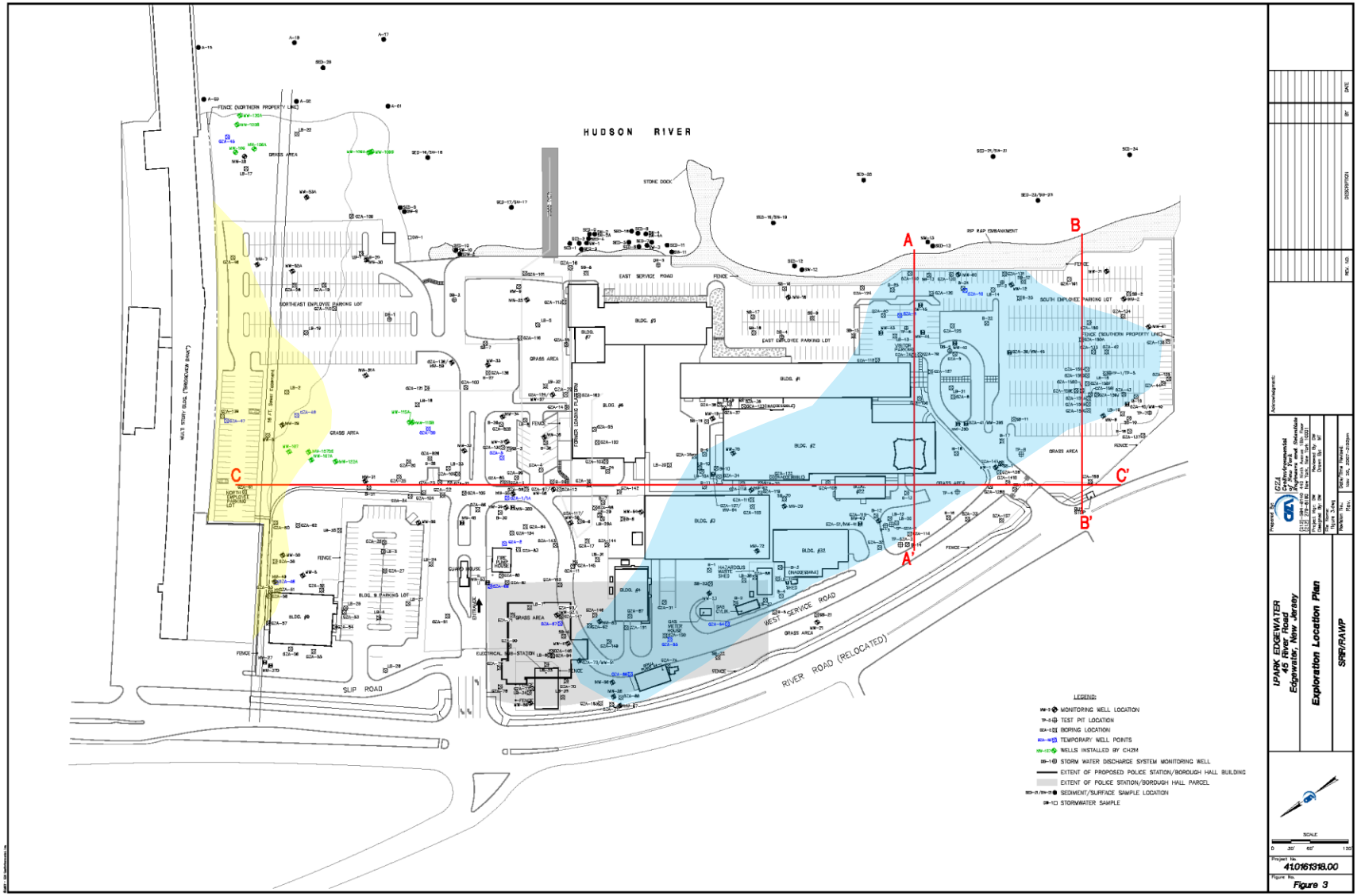
Nature of Contamination

- Historic Fill Material
- Compounds above NJDEP Soil Clean-up Criteria
  - Arsenic, Cadmium, Lead & Zinc
  - SVOCs
- Coal tar derived roofing pitch and VOCs (Benzene)

Hard pitch – appears brittle

Liquid Pitch– Flows at Summer Temperatures

Soft Pitch – appears malleable



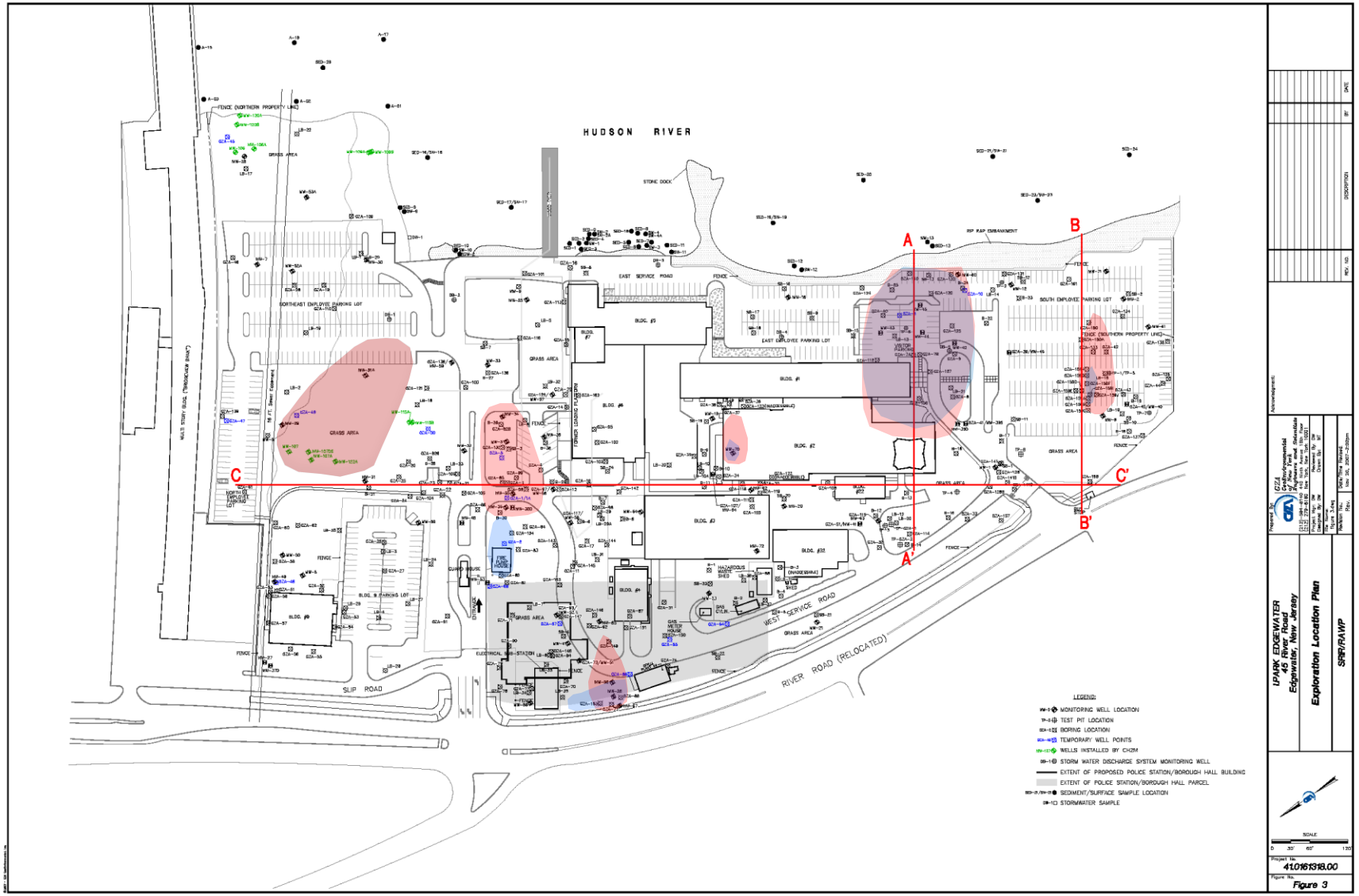
IPARK EDGEWATER
45 River Road
Edgewater, New Jersey

Exploration Location Plan

SRR/RAWP

Project No.
41.0161318.00

Figure No.
Figure 3



Prepared for:
GZA
GeoEnvironmental
Engineers and Scientists
Exploration Location Plan
SRR/RAWP
IPARK EDGEWATER
45 River Road
Edgewater, New Jersey
SCALE
0 30' 60' 120'
Project No.
41.0161318.00
Figure No.
Figure 3

IN-SITU SOLIDIFICATION/STABILIZATION

- Mixing contaminated soils with a reagent
  - Portland cement
  - Fly ash

- Creation of a solidified monolith

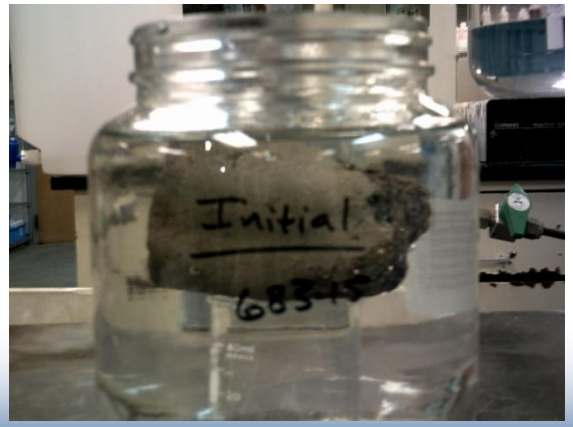
- Objectives of ISS:
  1. Reduction in permeability
  2. Elimination of NAPL by incorporation in solidified monolith
  3. Reduction in contaminant leaching to groundwater by binding of contaminants

Criteria for Evaluating Effectiveness

1. Unconfined Compressive Strength Test
2. Permeability Test

Criteria for Evaluating Effectiveness

1. Synthetic Precipitation Leaching Procedure (SPLP)
   - Traditional Method
   - Evaluation of the reduction in leachability
   - NOT considered an appropriate analytical method by GZA
   - physical crushing of the samples and the associated increase in surface area
2. ANSI 16.1 Leachability Test
   - Developed for the low level radioactive waste disposal
   - Five day procedure



SPECIMEN (CUBE, CYLINDER, OR SPHERE) OF SOLIDIFIED NUCLEAR WASTE (ACTUAL OR SIMULATED)

DEMINERALIZED WATER (VOLUME OF WATER + SURFACE AREA OF SPECIMEN = 10 ± 0.2 cm)

ANALYZE REMOVED LEACHATE FOR ELEMENTS $a_1, a_2 \ldots$

$\Delta t = 2$ hours

$t = 2$ hours $= 7.2 \times 10^3$ s

$T = 1.8 \times 10^3$ s [see Eq. (1)]

REPLACE LEACHATE WITH FRESH LEACHANT (DE-MINERALIZED WATER)

ANALYZE REMOVED LEACHATE FOR ELEMENTS $a_1, a_2 \ldots$

$\Delta t = 5$ hours

$t = 7$ hours $= 2.52 \times 10^4$ s

$T = 1.48 \times 10^4$ s

REPLACE LEACHATE WITH FRESH LEACHANT (DE-MINERALIZED WATER)

ANALYZE REMOVED LEACHATE FOR ELEMENTS $a_1, a_2 \ldots$

$\Delta t = 17$ hours

$t = 24$ hours $= 8.64 \times 10^4$ s

$T = 5.12 \times 10^4$ s

REPLACE LEACHATE WITH FRESH LEACHANT (DE-MINERALIZED WATER)

ANALYZE REMOVED LEACHATE FOR ELEMENTS $a_1, a_2 \ldots$

$\Delta t = 24$ hours

$t = 48$ hours $= 1.73 \times 10^5$ s

$T = 1.26 \times 10^5$ s

REPLACE LEACHATE WITH FRESH LEACHANT (DE-MINERALIZED WATER)

ANALYZE REMOVED LEACHATE FOR ELEMENTS $a_1, a_2 \ldots$

$\Delta t = 24$ hours

$t = 72$ hours $= 2.59 \times 10^5$ s

$T = 2.14 \times 10^5$ s

REPLACE LEACHATE WITH FRESH LEACHANT (DE-MINERALIZED WATER)

ANALYZE REMOVED LEACHATE FOR ELEMENTS $a_1, a_2 \ldots$

$\Delta t = 24$ hours

$t = 96$ hours $= 3.46 \times 10^5$ s

$T = 3.01 \times 10^5$ s

$$D = \pi \left[\frac{a_n / A_o}{(\Delta t)_n} \right]^2 \left[\frac{V}{S} \right]^2 T \ , \qquad (1)$$

where:

D is the effective diffusivity (cm^2/s);

V is the volume of specimen (cm^3);

S is the geometric surface area of the specimen as calculated from measured dimensions (cm^2);

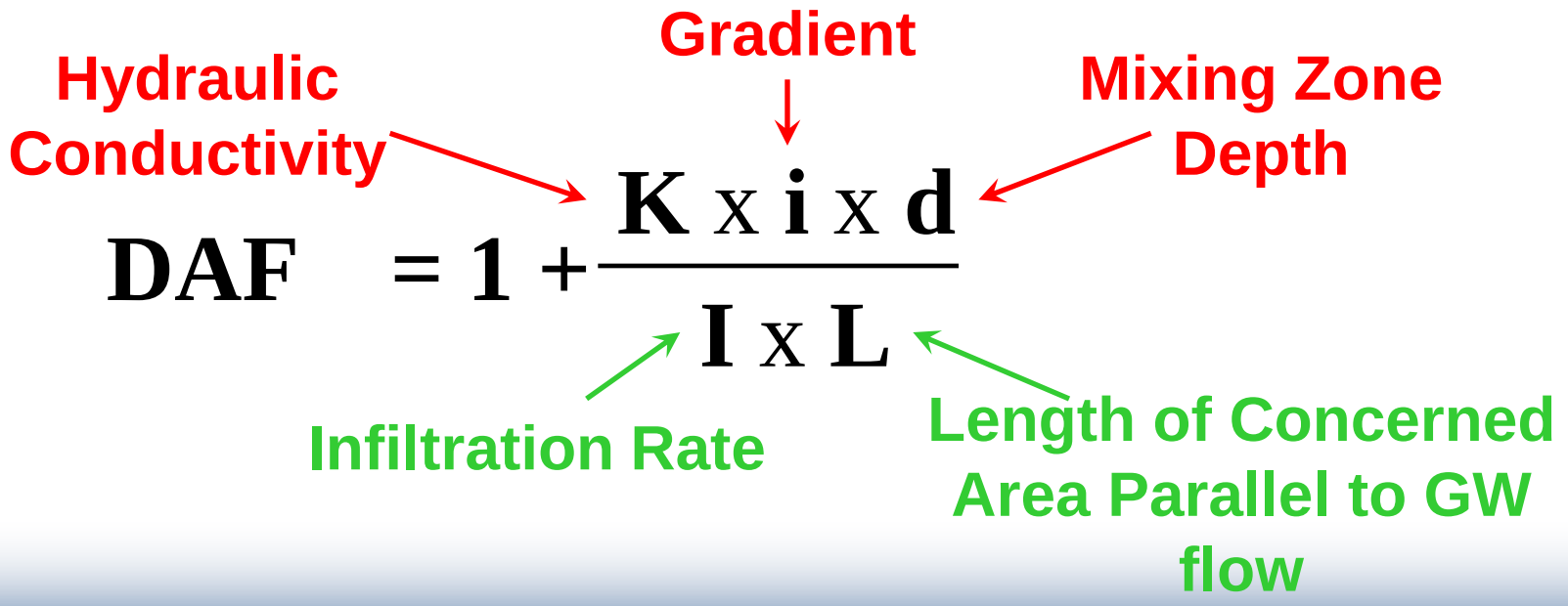
T is the leaching time representing the "mean time" of the leaching interval (s) as follows:

The Leachability Index of a nuclide, i, of concern in a material is defined as

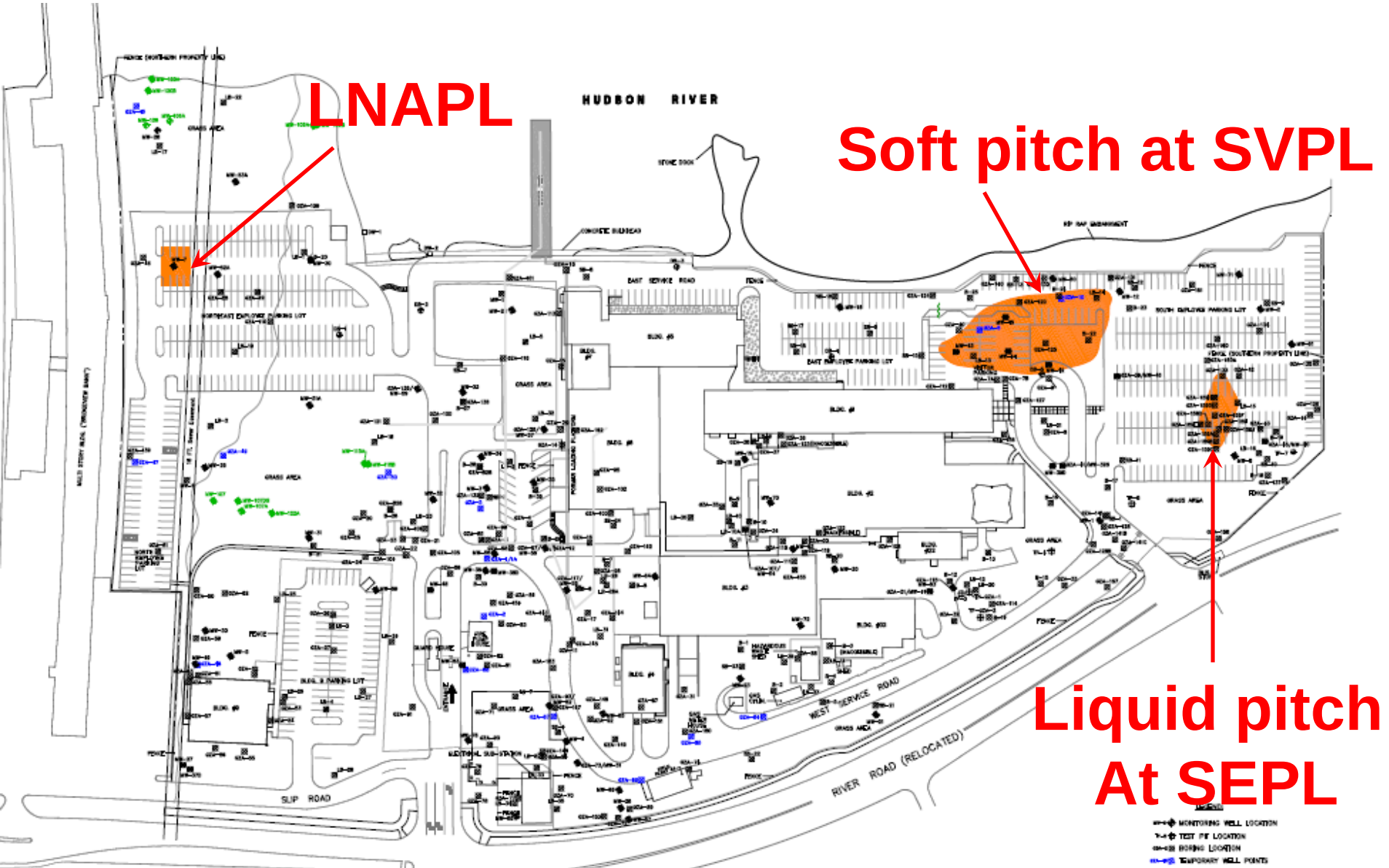
$$L_i = \frac{1}{7} \sum_{1}^{7} [\log(\beta / D_i)]_n \ , \qquad (6)$$

Site Specific Leachate Criteria

- Site-specific Dilution Attenuation Factors (DAF)
  - Applied for approval by the NJDEP
  - Five parameters are used
  - Specific to each area evaluated



Treatability Study - Field



Treatability Study - Field

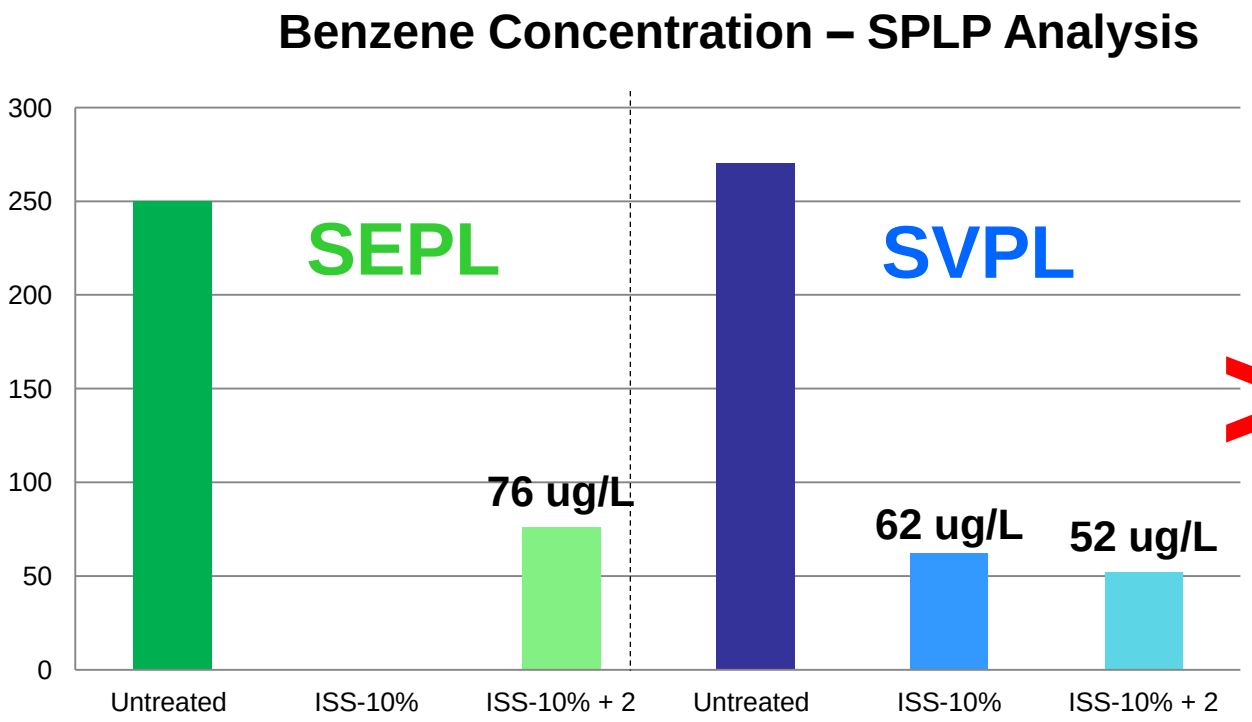
- Soil Borings performed
  - In Each of the 3 Areas
  - Collected Composite Samples in 5 gallon buckets

Treatability Study - Lab

- Prepared Standard Operating Procedures
- Mixture Designs Applied
  - Type I Portland Cement
    - Addition rates of 10%, 8% & 6%
    - Additional 2% Organoclay to each
- Bench scale Hobart type mixer

- 4-inch diameter plastic cylindrical curing molds
- Cured for 28 days
- Only 10% mixture was run

Results – SPLP Analysis



SEPL Site Specific Leachate Criteria = 41.6 ug/L

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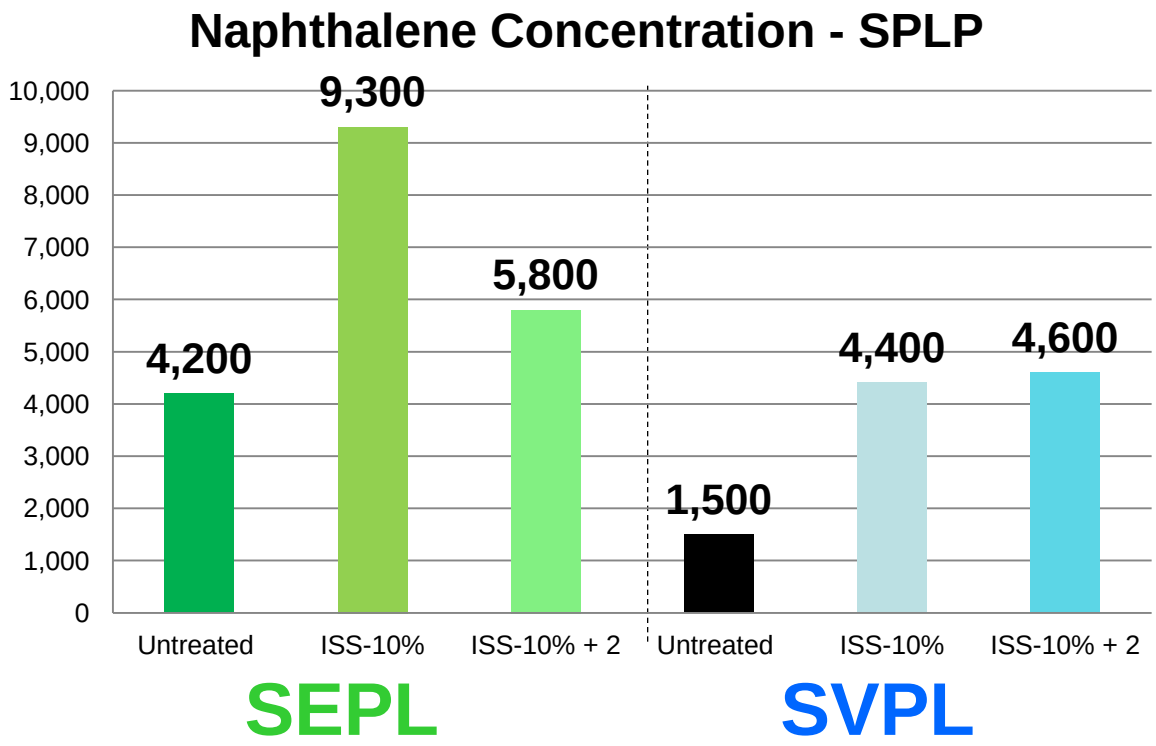
SVPL Site Specific Leachate Criteria = 15.5 ug/L

Results – SPLP Analysis



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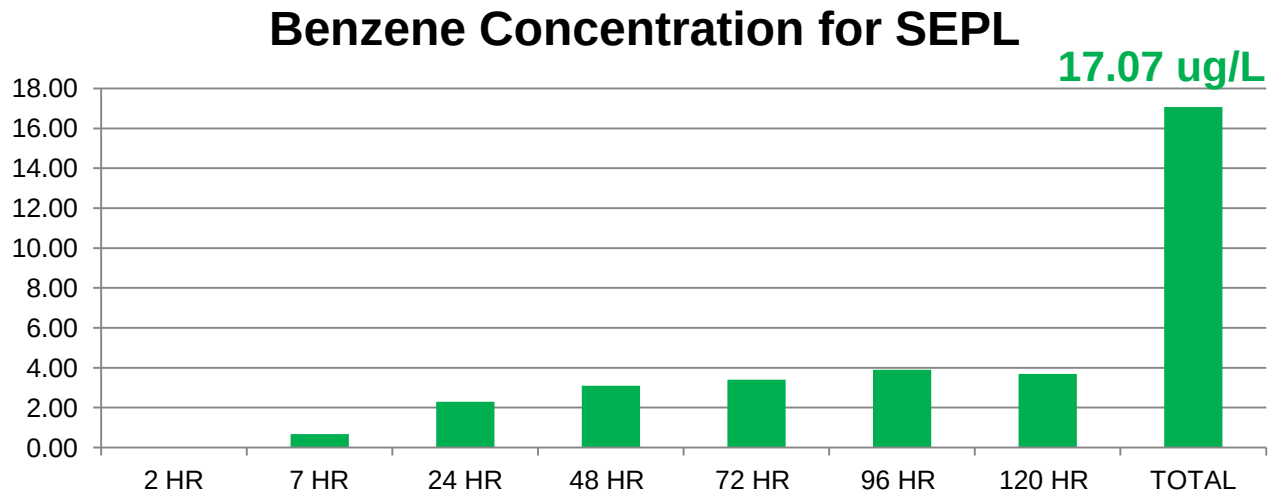
SEPL Site Specific Leachate Criteria = 62,350 ug/L

SEPL Site Specific Leachate Criteria = 23,281 ug/L

Results – ANSI Analysis



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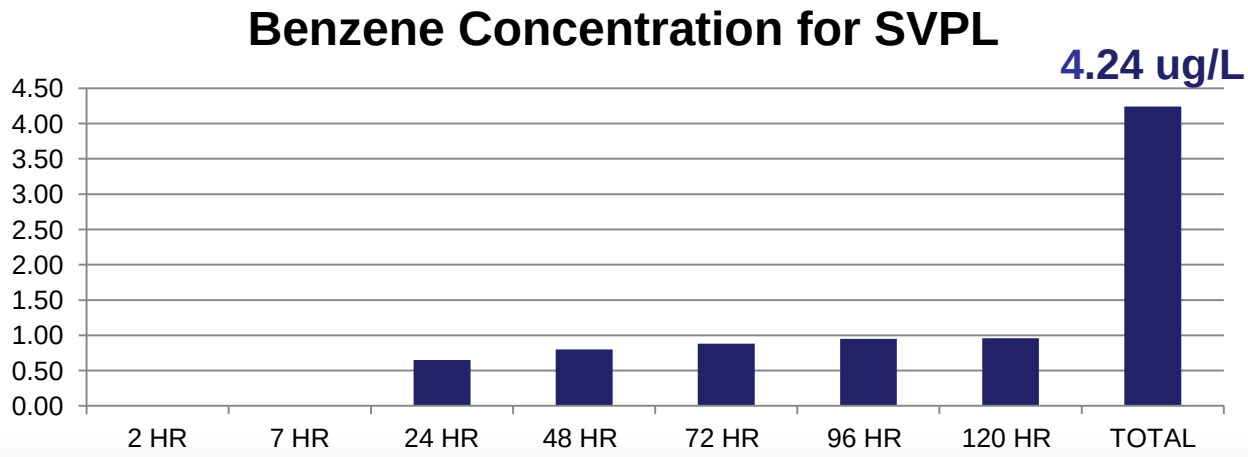
SEPL Site Specific Leachate Criteria = 41.6 ug/L



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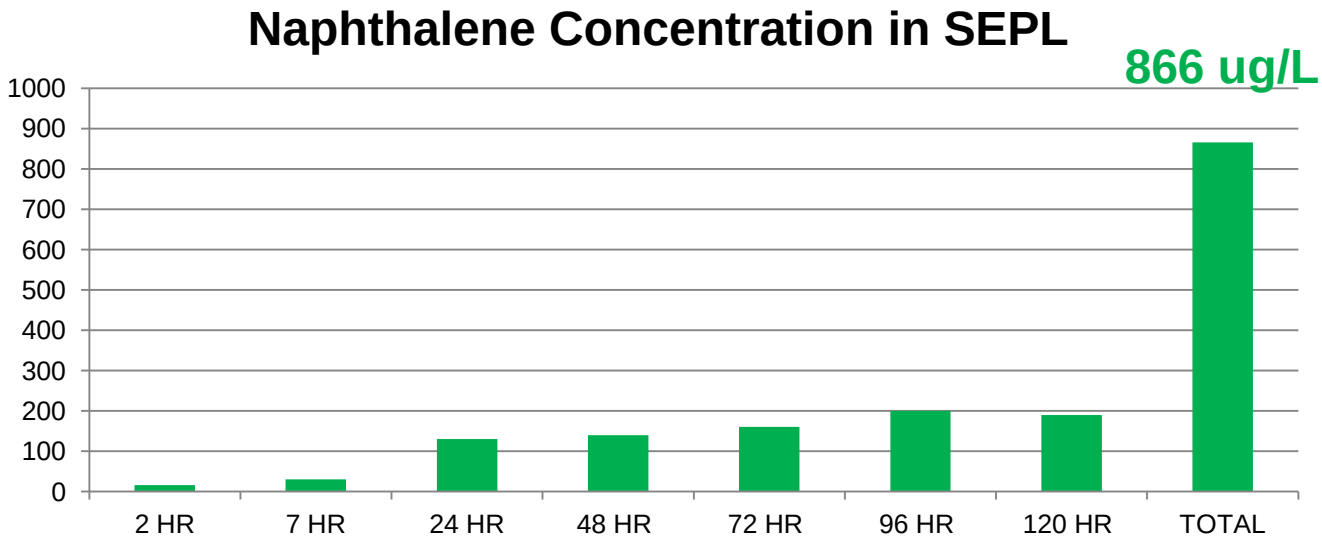
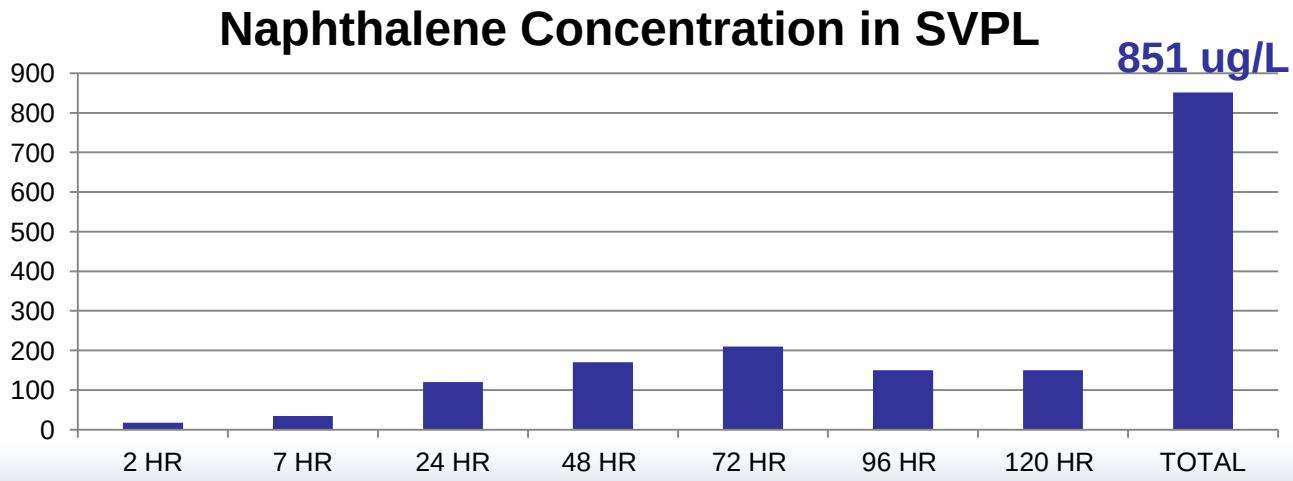
SVPL Site Specific Leachate Criteria = 15.5 ug/L

Results – ANSI Analysis



866 ug/L <

SEPL Site Specific Leachate Criteria = 62,350 ug/L

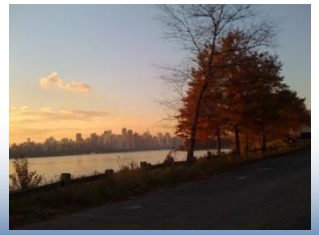


851 ug/L <

SEPL Site Specific Leachate Criteria = 23,281 ug/L

Results

- Effective reduction in leachate concentrations of COCs.
- Resultant leachate concentrations met site specific leachate criteria
  - SPLP not an appropriate method to evaluate ISS effectiveness
  - ANSI more appropriate test to represent actual leaching conditions
- Decrease in permeability to less than 10-6 cm/second
  - effectively impermeable
- Unconfined compressive strength greater than 30 psi
  - the monolith will be competent and withstand typical use forces




Conclusions

- Soils and coal tar at the Site were amenable to ISS
- ISS is a proven remedial technology that would work at the Site
- The use of ISS rather than excavation, transportation and Disposal resulted in a 35% savings on remedial costs