In Situ Solidification to Limit Uncertainties in LNAPL/Grossly Contaminated Media Remediation

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1) Background Information

2) Case Study – Olean, NY

3) ISS Key Takeaways

1) Background Information

ISS OVERVIEW

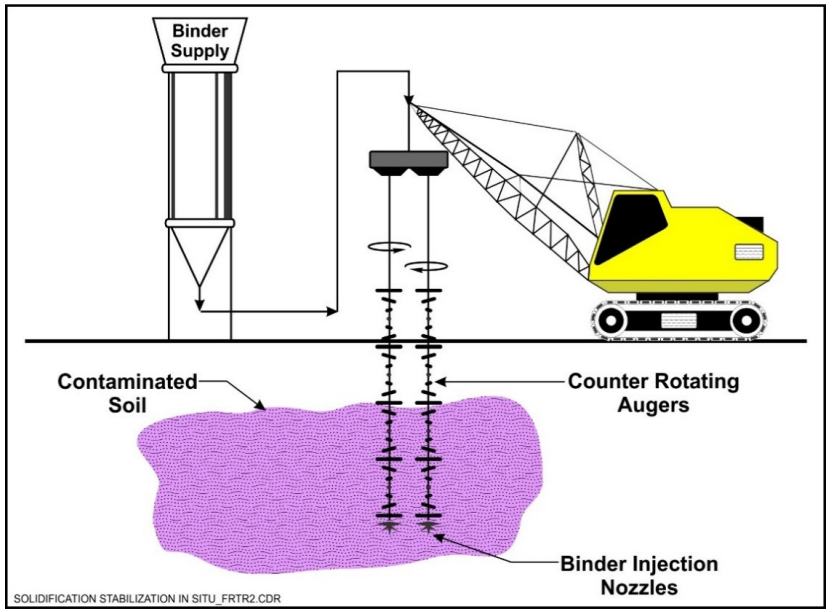
- ISS locks contaminants within a monolith: reduces leachability and hydraulic conductivity
- Protects human health and the environment
- Based on geotechnical ground improvement technology
- Well-established treatment technology
- Widely approved by many regulators
- Can treat a wide variety of impacts (LNAPL, organics, inorganics, PFAS).
- Cost-effective and rapidly implemented approach to LNAPL.
- Can be considered an upgrade to the traditional excavation, transport, and disposal approach.

ISS REAGENTS

- Stabilization - Mix the waste with reagents (binders) that convert the target constituents into relatively immobile species
- Solidification - Encapsulate the low mobility species in a matrix that reduces access by potential leachates and provides the necessary physical properties for handling and disposal
- Portland Cement
  - Is readily available
  - A stable price-competitive product
  - Creates a solid matrix which is durable and proven
  - Binds up water (including impacted water)
- Pozzolans
  - Readily Available Industrial by-product
  - Expansive properties reduce hydraulic conductivity

ISS IMPLEMENTATION

- Common Techniques:
  - Excavation Bucket Mixing (Shallow Depths)
  - Auger Mixing (Shallow and Deeper Depths)
  - Jet Grouting (Deeper and Inaccessible Depths)
- Performance Testing Parameters
  - Strength
  - Hydraulic Conductivity
  - Leachability
  - Verified absence of free liquids



ISS via Auger Mix

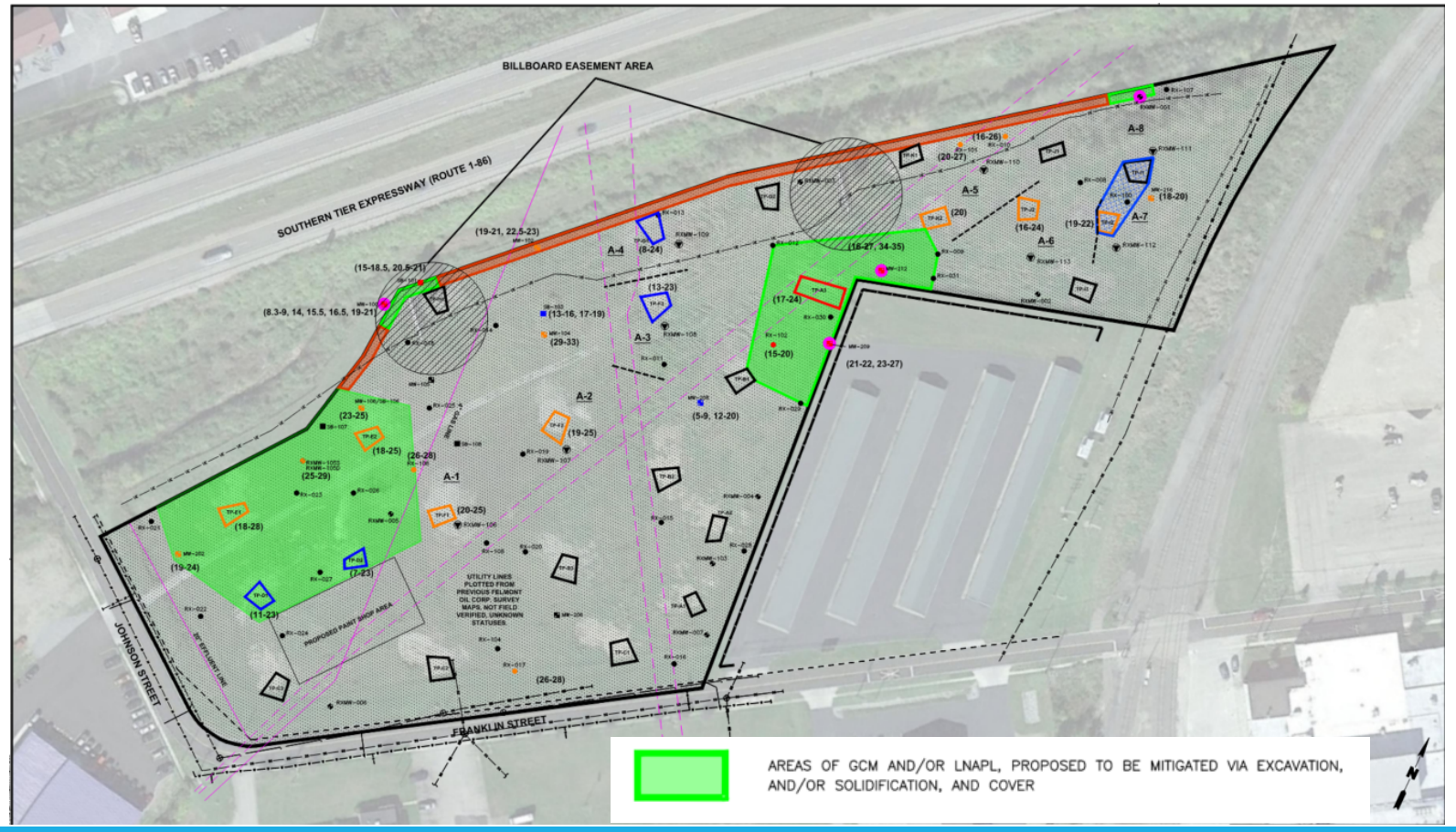
Case Study

OLEAN, NY SITE

ROUX

SITE OVERVIEW

Olean Site Remediation Plan



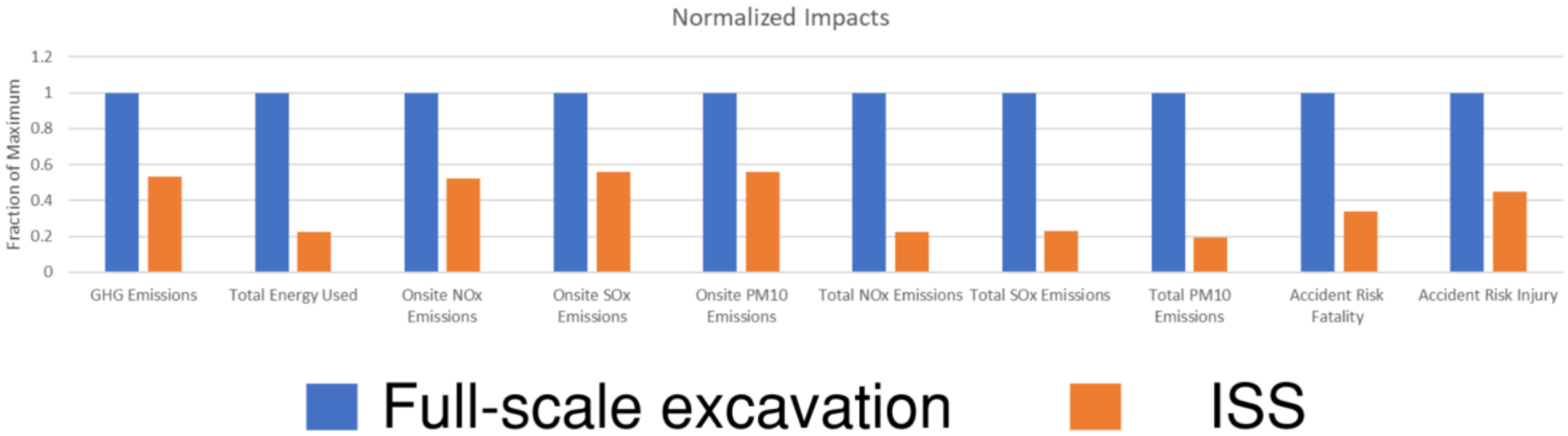
- The Site and the properties immediately surrounding the area of the Site were primarily used as a petroleum refining facility between 1876 and approximately 1954.
- Over 100,000 tons of GCM to be remediated
  - Industrial-based cleanup Excavation costs estimated at $30M+
  - ISS: $17.5M
- ~4,500 tons of hazardous waste in Northern corner
  - pH < 1
  - High reactive sulfide
  - Trapped H2S gas
- Remediation planned to be complete within 3 years

CHALLENGES

- Required shoring or sloping
- Limited disposal acceptability of hazardous waste characterized in Northern corner
- Release of pockets of hydrogen sulfide gas during disturbance
- Unpredictable remedial extents due to obligation to chase encountered GCM/LNAPL
- Time constraints
- Backfill vs. Swell management

GREEN AND SUSTAINABLE REMEDIATION EVALUATION

SiteWise Model GSR Evaluation



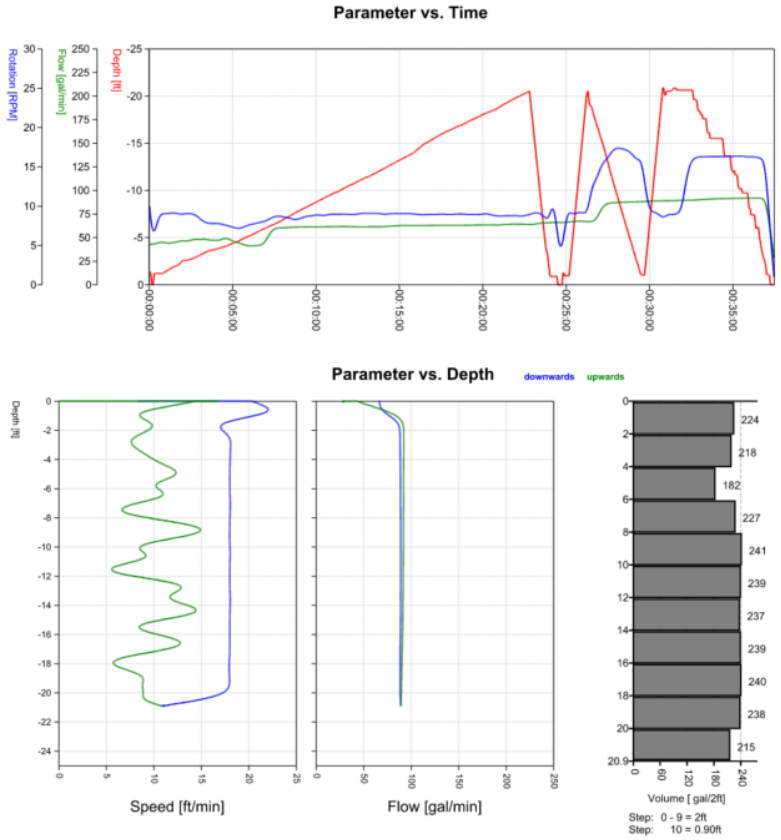
REMEDIAL APPROACH

- Shallow Excavation
- ISS to Address GCM/LNAPL
- Soil Cover System
- Sub-slab Depressurization System Infrastructure
- Vapor Barrier integrated into building floors
- Long-term Monitoring
- Environmental Easement

IMPLEMENTATION

- 0 to 7 - 10 ft bgs - Excavate and stockpile for Surficial Reuse, Restricted Reuse, or disposal based on comprehensive pre-design characterization
  - Except hazardous Northern corner where ISS completed from 2 – 10 ft bgs
- ISS performed via 200 CY cells
- Auger mixing for increased QA/QC control
- QA/QC samples performed at the lesser of 1 per 1,000 CY or 1 per grout batch
  - ~45,500 CY of 50,000 CY mixed to date with over 100 samples (100% pass rate)

Single Auger Soil Mixing Drill Rig Report



COST COMPARISON

- Site Specific costing is confidential
- ISS was approximately 60% the estimated cost of excavation for this site when factoring all costs (disposal, clean backfill, dewatering, etc.)
- Additional benefit of:
  - swell reducing the overall fill required for the site
  - enhanced and elevated perimeter monolith to preclude shoring or sloping
  - predefined limits of monolith with regulators due to ISS's limited visibility of treated impacts
  - Eliminated lengthy haul of hazardous waste to TSDF
  - Limited disturbance and release of H2S gas trapped beneath target zone

Key Takeaways

ISS AND EXCAVATION COMPARISON

Excavation		ISS
Exposed sidewalls for visual observation of product	→	Pre-determined area & “blind” process
Disposal requires additional backfill	→	Swell reduces amount of total fill required
Production rates ~450 CY/day	→	Production rates ~800 CY/day
Additional waste characterization cost & schedule	→	Additional upfront design
Unpredictable release of H2S gas from open cut	→	Significantly reduced release of H2S gas
Lengthy hazardous waste haul	→	Approval to treat hazardous waste in-place
Required Shoring or Sloping for Deep Excavation	→	ISS Monolith can be enhanced around perimeter to provide support of shallow excavation
Minimal engineering approval prior to backfill	→	QA/QC sampling, evaluation & timeframe for backfill approval

ISS ADVANTAGES

- Nearly half the cost when considering excavation, transportation, disposal, dewatering, and clean backfill.
- On-site in-situ treatment with typical construction equipment, similar to excavation.
  - No lengthy haul to hazardous TSDF.
- Minimized ex-situ soil management.
- Potentially 65% reduction in trucks utilized to reduce the project's carbon footprint and minimize impacts to neighborhoods.
- No requirement to dewater.
- No need to perform waste characterization sampling reducing cost and minimizing risk.
- Reduced release of H2S gas compared to open-cut excavation
- Implementable with many geotechnical applications with the potential to be combined with geotechnical improvement for maximum site value.

Questions?

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