PLANNING AND ENGINEERING CONSIDERATIONS FOR A 1.5 MILLION CUBIC METER LAKE DREDGING PROJECT

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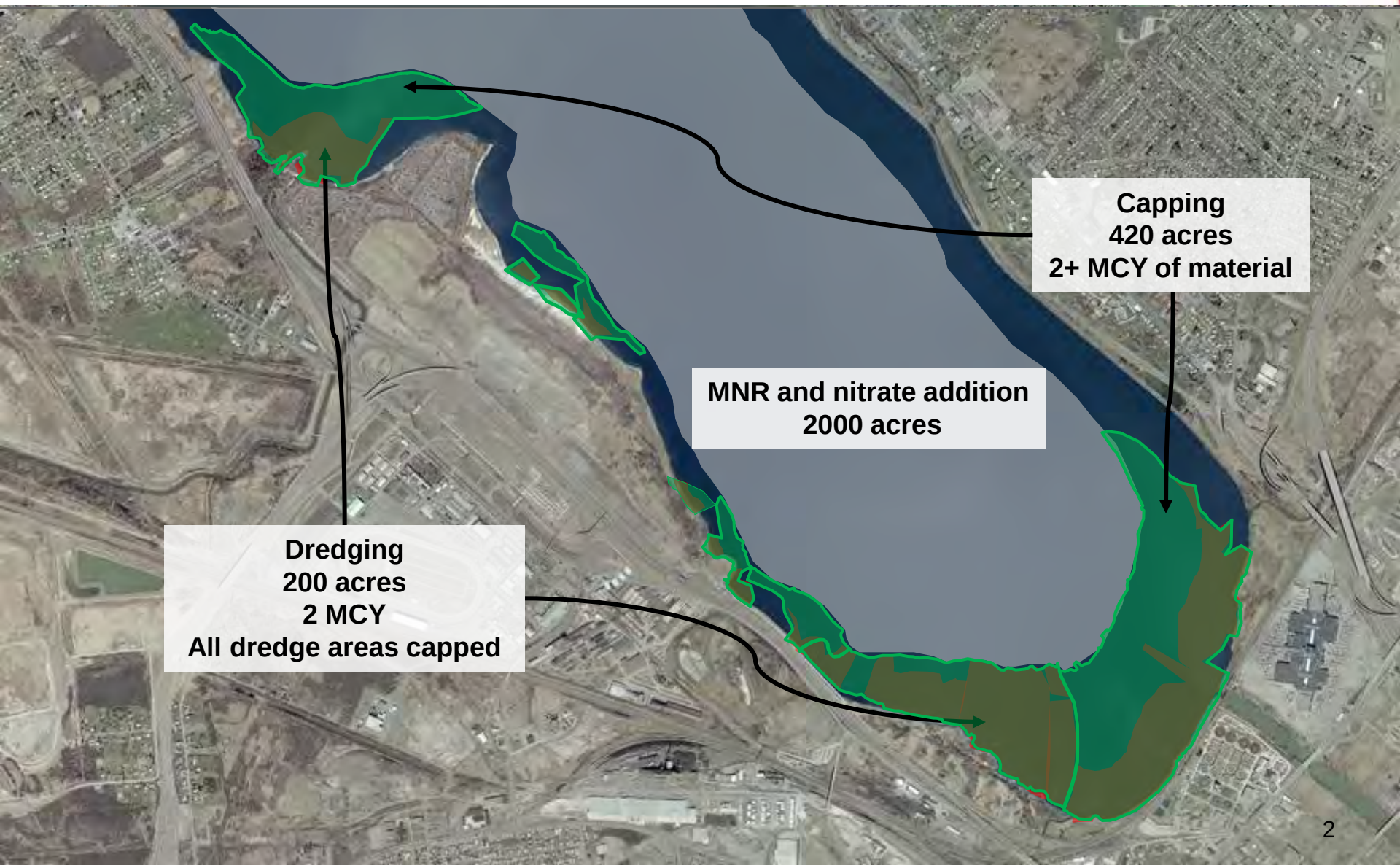
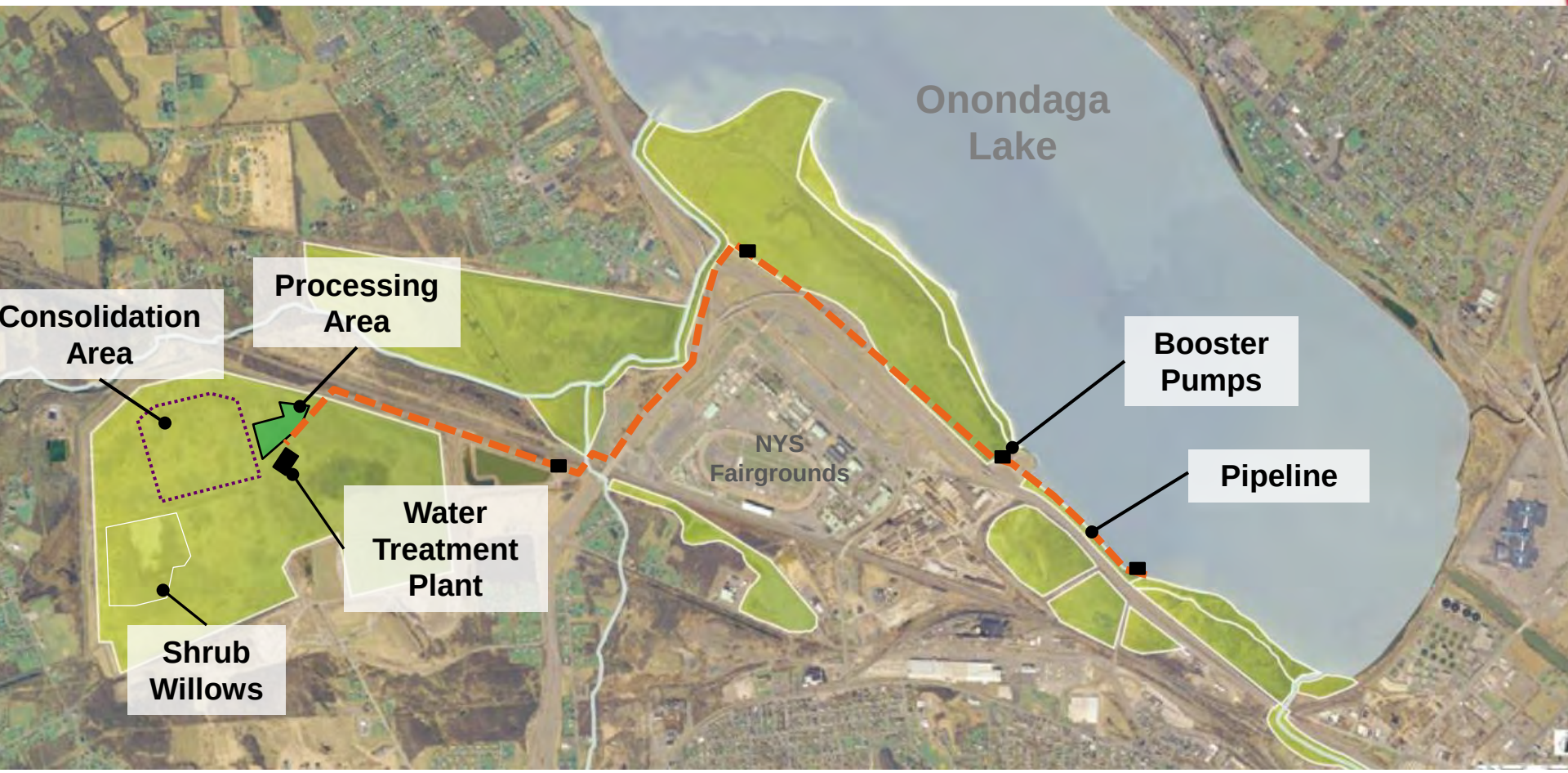
Project Overview

- 4.6 square-mile (12-km^2) lake located in Syracuse, New York
- Decades of industrial activity led to contamination in the lake
  - Mercury, VOCs, and SVOCs
- 2005 Record of Decision
- Selected remedy
  - Dredging of 2 million cy (1.53 million m^3) of 200 acres (80 hectares)
  - Geotube® dewatering in 24-hectare lined sediment consolidation area (SCA)
  - In situ capping of 450 acres (180 hectares) of lake bottom
  - Habitat restoration
  - Monitored Natural Recovery
- Dredging completed in 2014, one year ahead of schedule
- Capping anticipated to be completed on-schedule in 2016

Onondaga Lake



Project Overview



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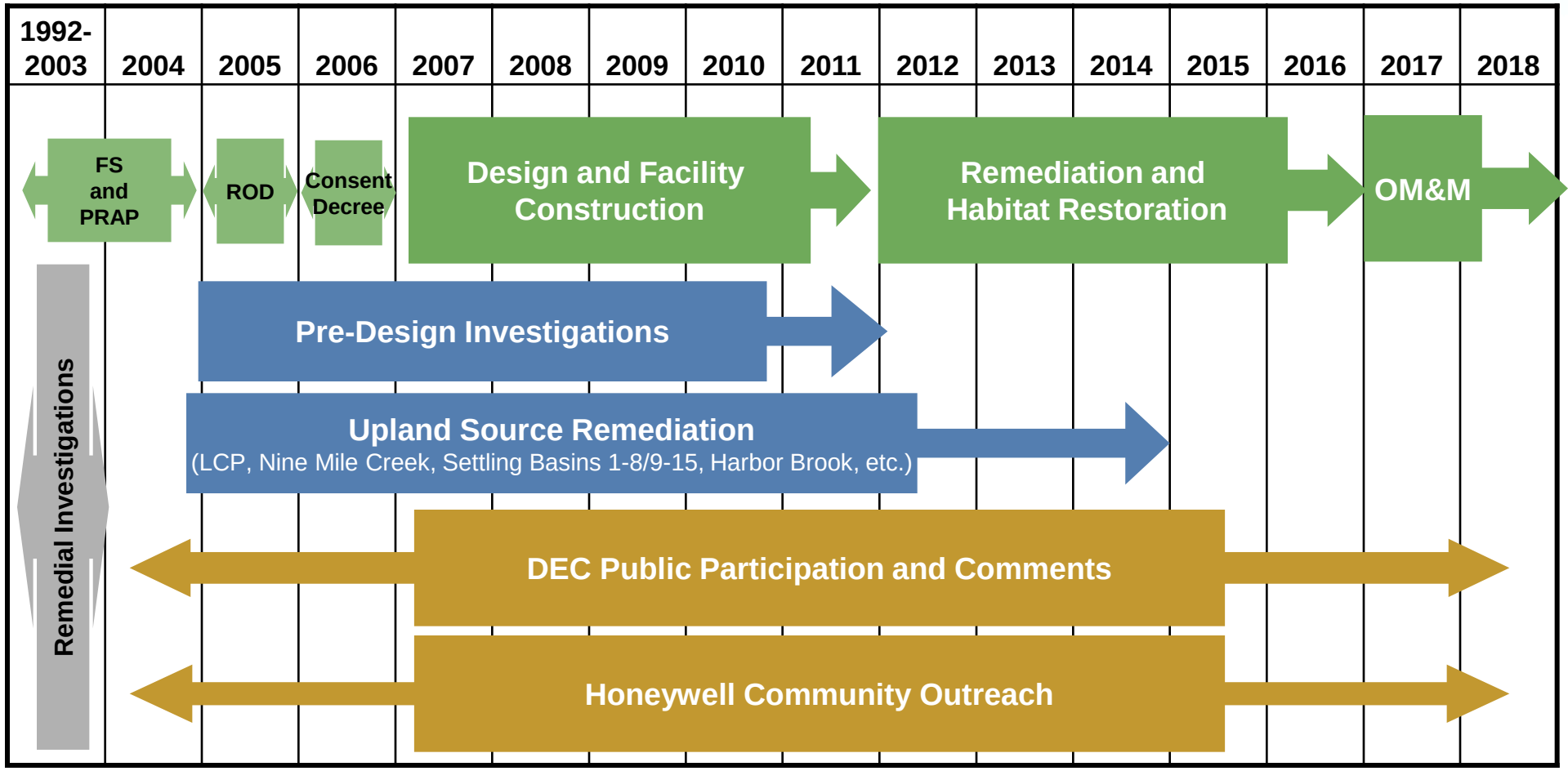
Background

- Primary stakeholders and project team
  - Honeywell International Inc.
  - New York State Department of Environmental Conservation (NYSDEC)
  - U.S. Environmental Protection Agency (USEPA)
  - Contractors and consultants
    - Sevenson Environmental: Dredging and Capping contractor
    - Parsons: Remedial Design, Quality Control (QC), Construction Manager
    - Anchor QEA: Remedial Design, Quality Assurance (QA), Water Quality
    - O'Brien & Gere: SCA Design, Water Treatment, and Air Monitoring
    - Geosyntec: SCA Design, Geotechnical Evaluations of Cap Stability
    - de maximis: Program Management
  - Local community

Onondaga Lake Cleanup Timeline



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Remedial Design Process

- To achieve the aggressive schedule, the design was divided into four subareas with separate submittal schedules:
    1. SCA where dredged sediments would be placed
    2. Dredging, sediment transport and management, and water treatment
    3. Sediment capping and definition of dredge areas and depths
    4. Thin-layer capping, nitrate addition/oxygenation, and monitored natural recovery
- Separating the design allowed for early initiation and completion of critical infrastructure, such as the SCA and WTP

Pre-Design Investigations

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Site Investigations

- Remedial Investigation (RI) in 1992
- Pre-Design Investigations (PDI)
  - 8 phases between 2005 and 2012

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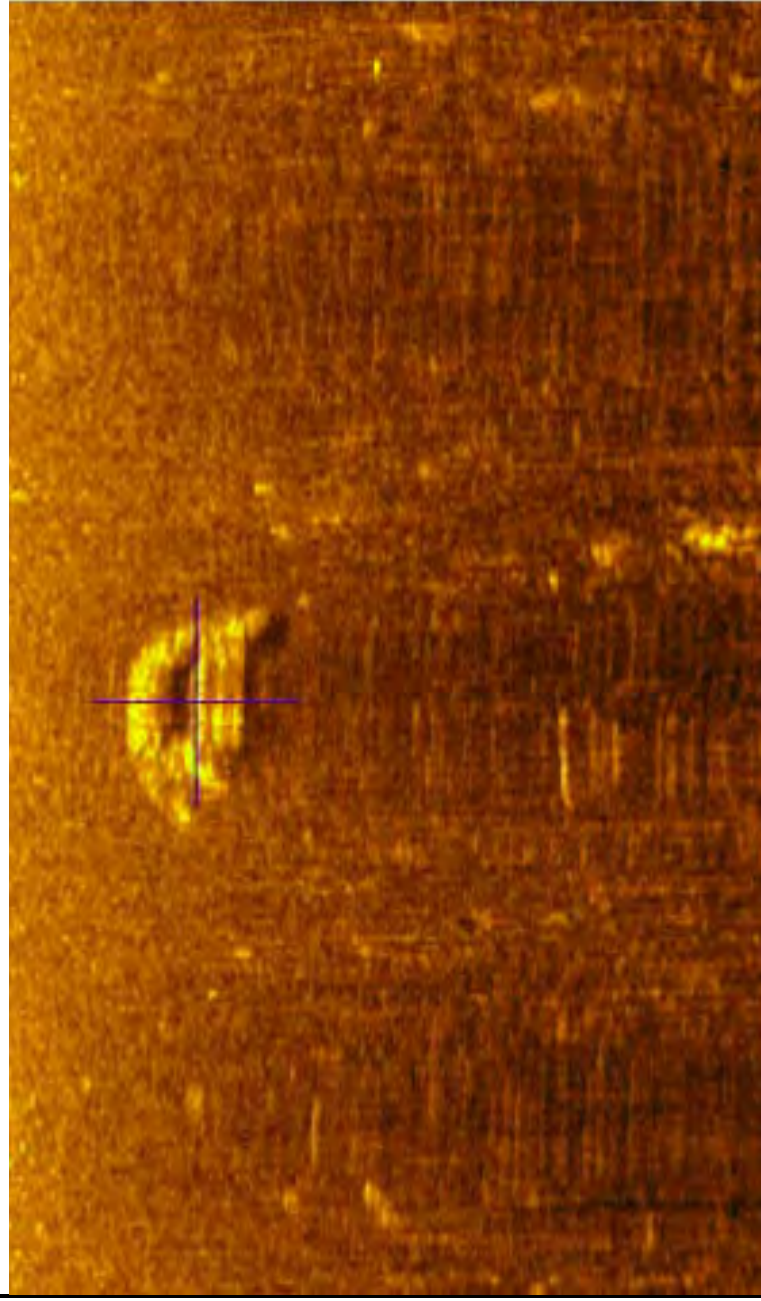
PDI

- Geophysical surveys
  - Bathymetric survey
  - Side-scan sonar to characterize debris, obstructions, and other surficial features
  - Sub-bottom profiling assess subsurface stratigraphy
  - Magnetometer data to identify fired debris and obstructions



PDI

- Sediment sampling for chemical and geotechnical analyses
- In situ geotechnical testing
- Surface water sampling and analysis
- Porewater sampling and analysis
- Groundwater discharge and sediment stability evaluations
    - Seepage meter and Geoprobe measurements
    - Sediment cores
    - Drilling

PDI

- Sediment cores and drilling to delineate extent of non-aqueous phase liquid (NAPL)
- Bench-scale testing
  - Cap design and placement
  - Odor control
  - Water treatability
  - Column settling testing
  - Cap amendments
  - Dredged sediment dewatering
- 2 meteorological stations

Dredging

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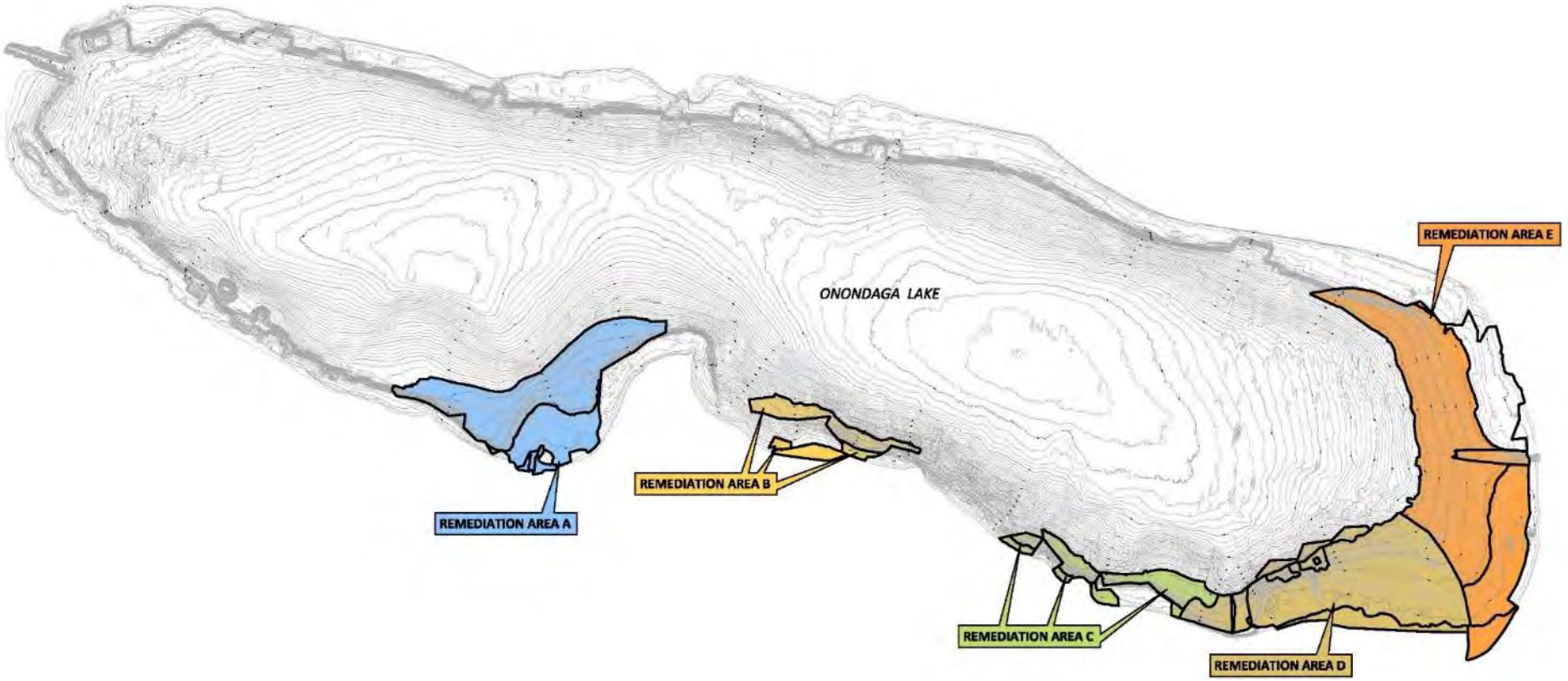
Dredging

- Dredging ~2M cy over 200 acres (80 hectares) of the site
  - Including in-lake waste deposit (ILWD)
  - Other areas to allow for the subsequent cap placement, resulting in desired post-remedy water depths based on habitat considerations
- All dredged areas were subsequently capped
  - No dredge areas designed to achieve a numeric cleanup criteria

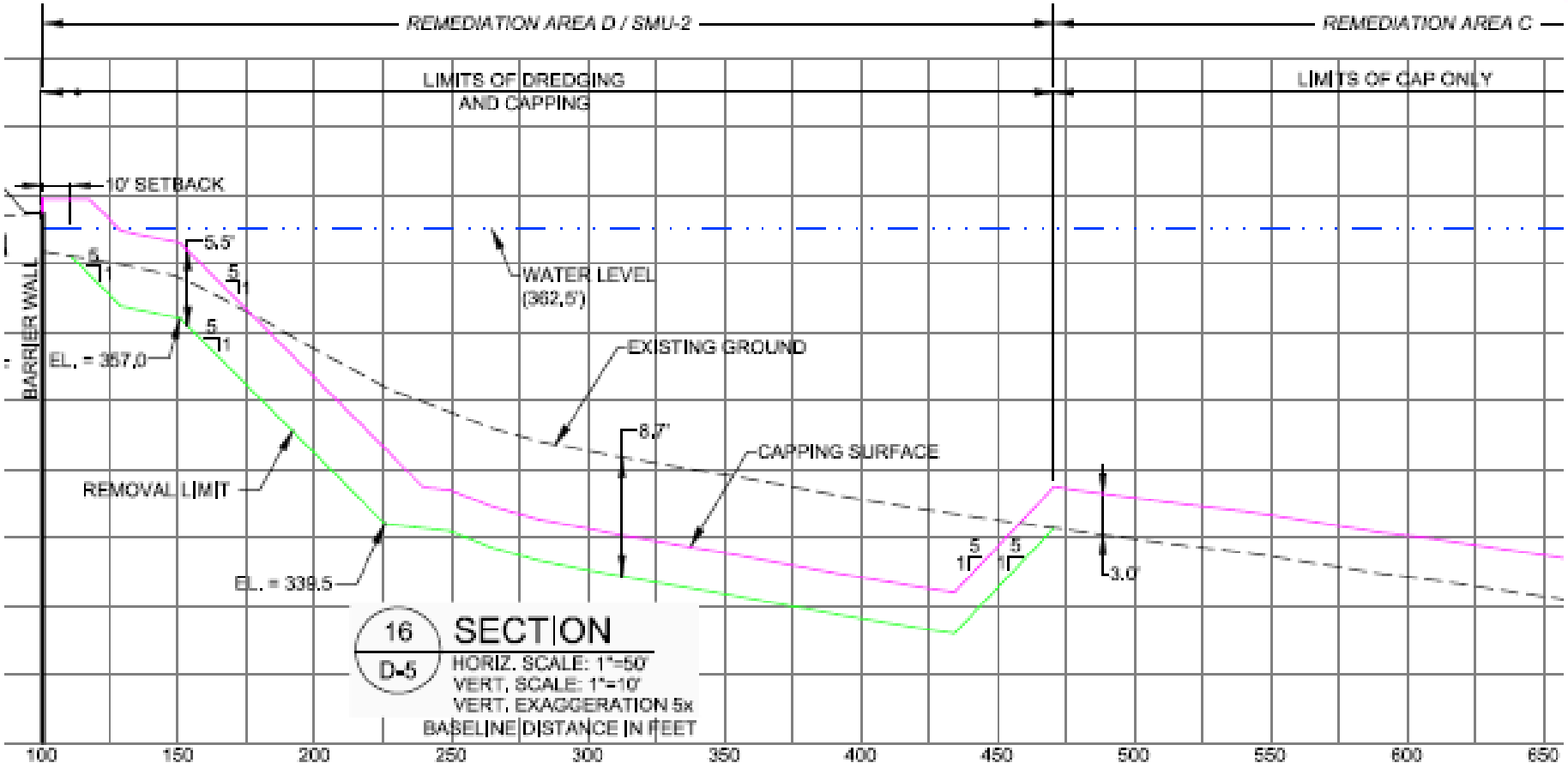
Dredging – Remediation Areas



Dredging Template Design

- ILWD dredging
  - Dredging designed to remove an average depth of 2 meters
  - Additional 1 meter of removal in hot spots
  - No over-dredge allowance; targeted elevation with tolerance of ± 6 in. (15 cm)
- Dredging to achieve a habitat-based post-capping elevation
  - Dredging designed to achieve post-capping water depth based on habitat considerations and to ensure no net loss in lake surface
  - Dredging template based on the thickness of the cap and the desired post-capping water depth
  - 6-in. (15-cm) payable over-dredge allowance

Dredging Template



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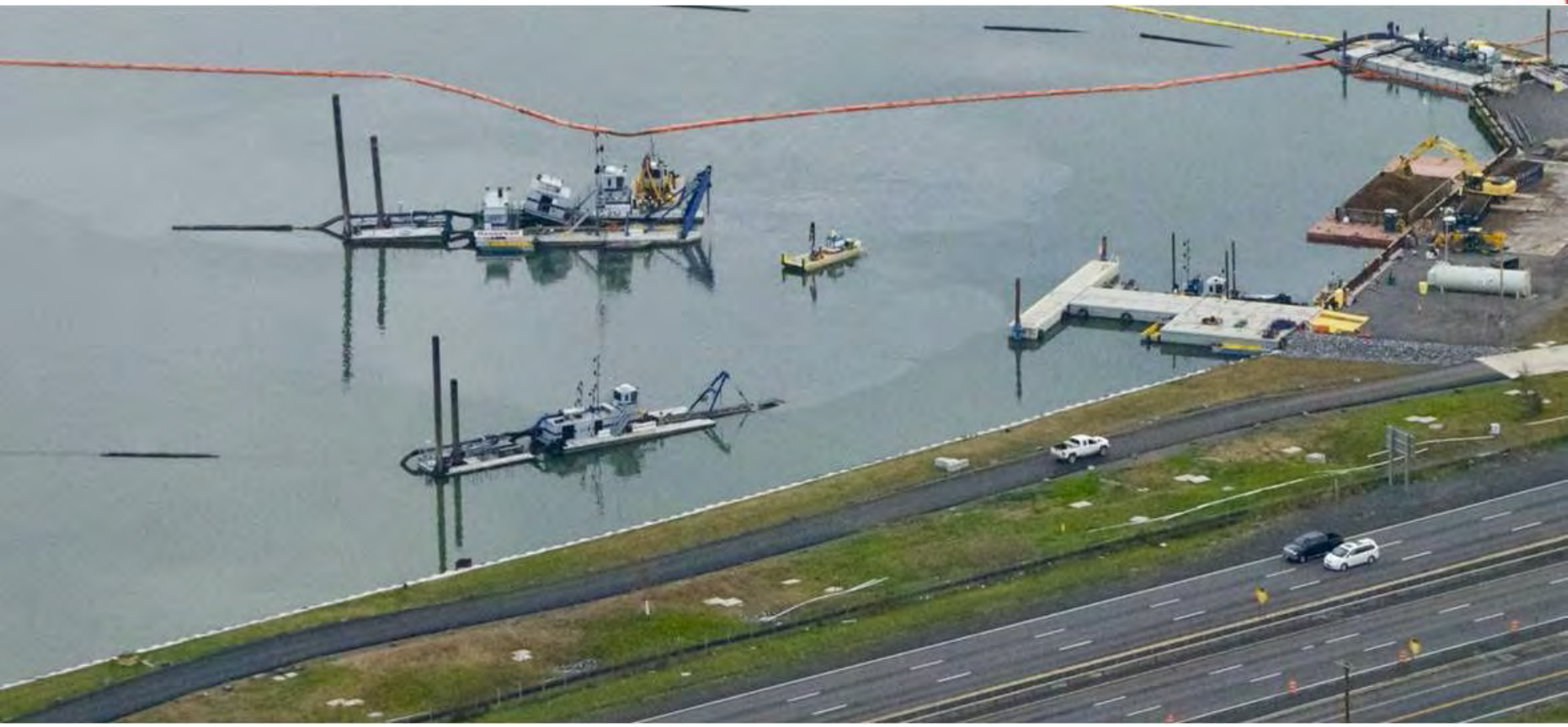
Dredge Equipment

- Multiple dredges to maintain productivity and to address different dredge areas and cut thicknesses
  - Allowed contractor to complete the dredging 1 year ahead of the anticipated 4-year schedule
- 3 hydraulic dredges were used on the project
  - Dredging Supply Company (DSC) Marlin 7650D dredge with a 16-inch diameter discharge line and a 30-foot spud carriage
  - DSC Shark 75450D dredge with a 14-inch diameter discharge line and a 30-foot spud carriage
  - DSC Moray 2000D swinging ladder dredge with an 8-inch diameter discharge line

Dredge Equipment



Sediment Transport, Processing, and Long-Term Management

- Dredged sediments pumped through a 4-mile-long (6.5-kilometer) double-walled pipeline, to the 60 acre (24 hectare) SCA
- Four 600-HP (450-kW) electric booster stations
- Once at the processing area, the dredge slurry was:
  - Screened to remove coarse material
  - Thickened to remove a portion of the carriage water
  - Treated with polymer before being pumped into 1,000+ Geotubes for dewatering
- On-site water treatment plant followed by discharge to POTW
- SCA ultimately capped and closed

Booster Pump and Pipeline

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Sediment Consolidation Area

Habitat Restoration and Enhancement

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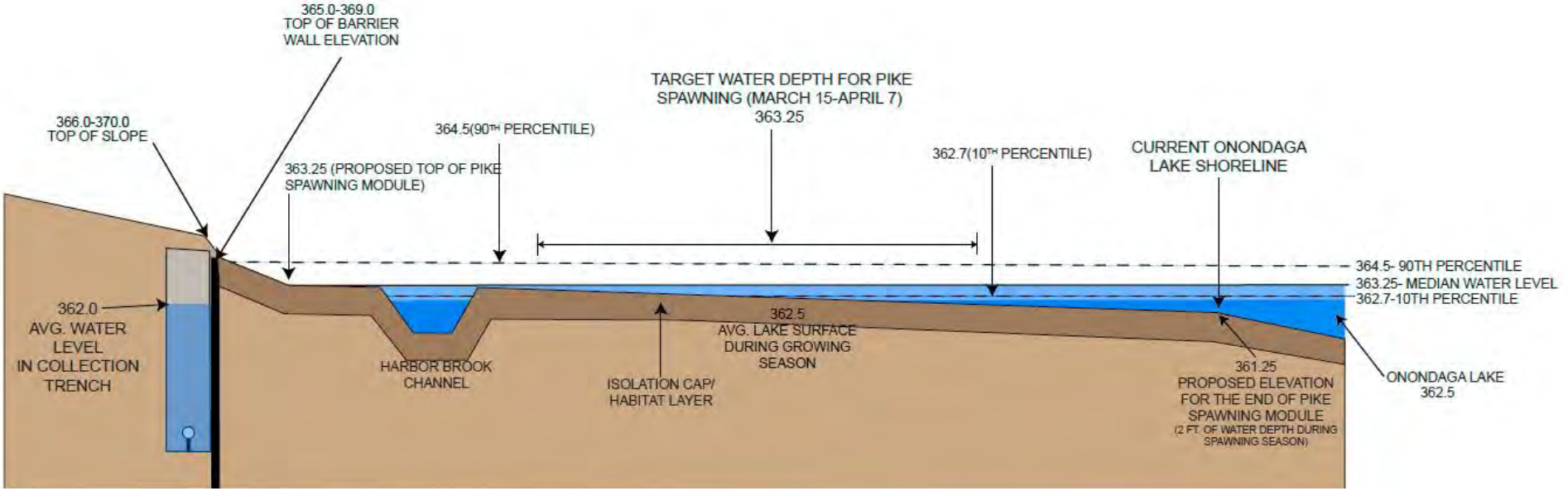
Overarching Goals of Habitat Plan

- Overarching goals of Habitat Plan
  - Maintain or improve the quality and diversity of habitat in the lake
  - Discourage the establishment of invasive species
  - Promote public access and use and minimize future maintenance
- Holistic approach considering habitat as an integral component of the remedial design
  - Resulted in improved conditions for a wide variety of species
  - Led to increased stakeholder involvement and community acceptance



Capping

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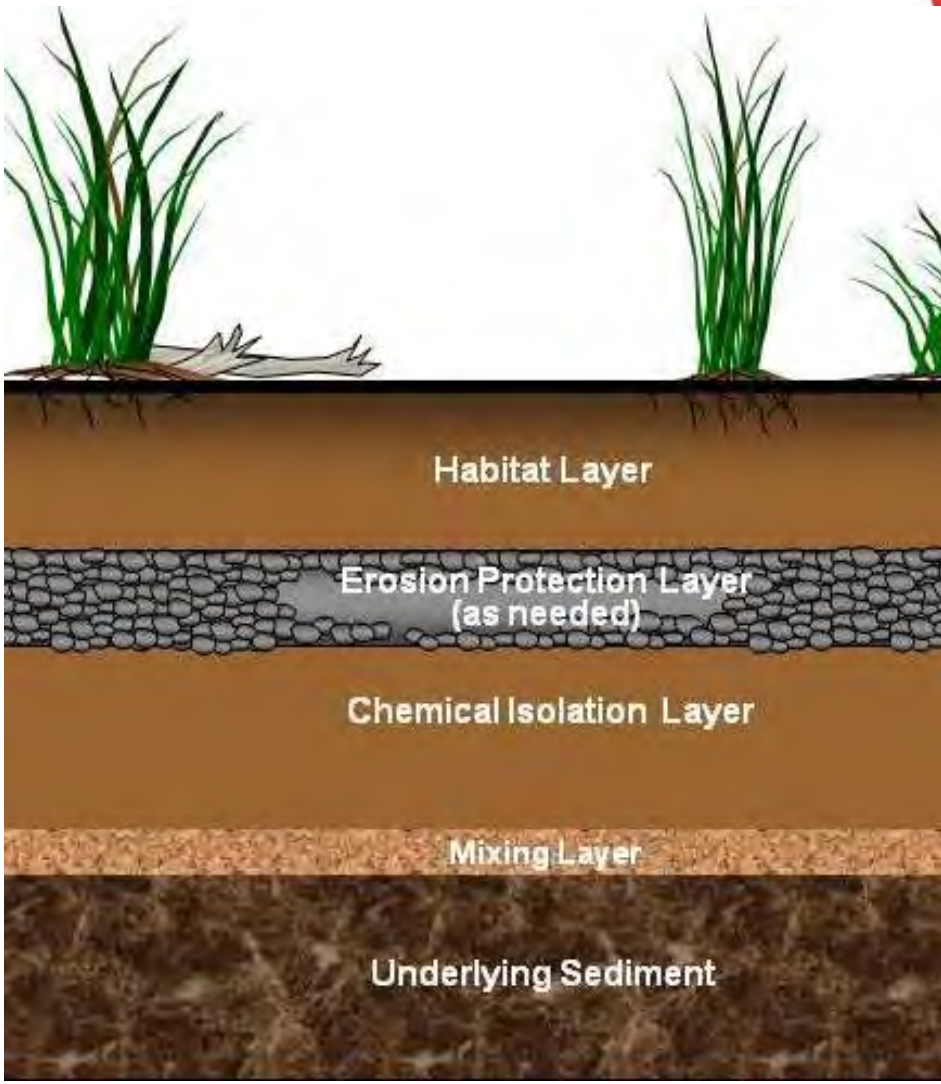
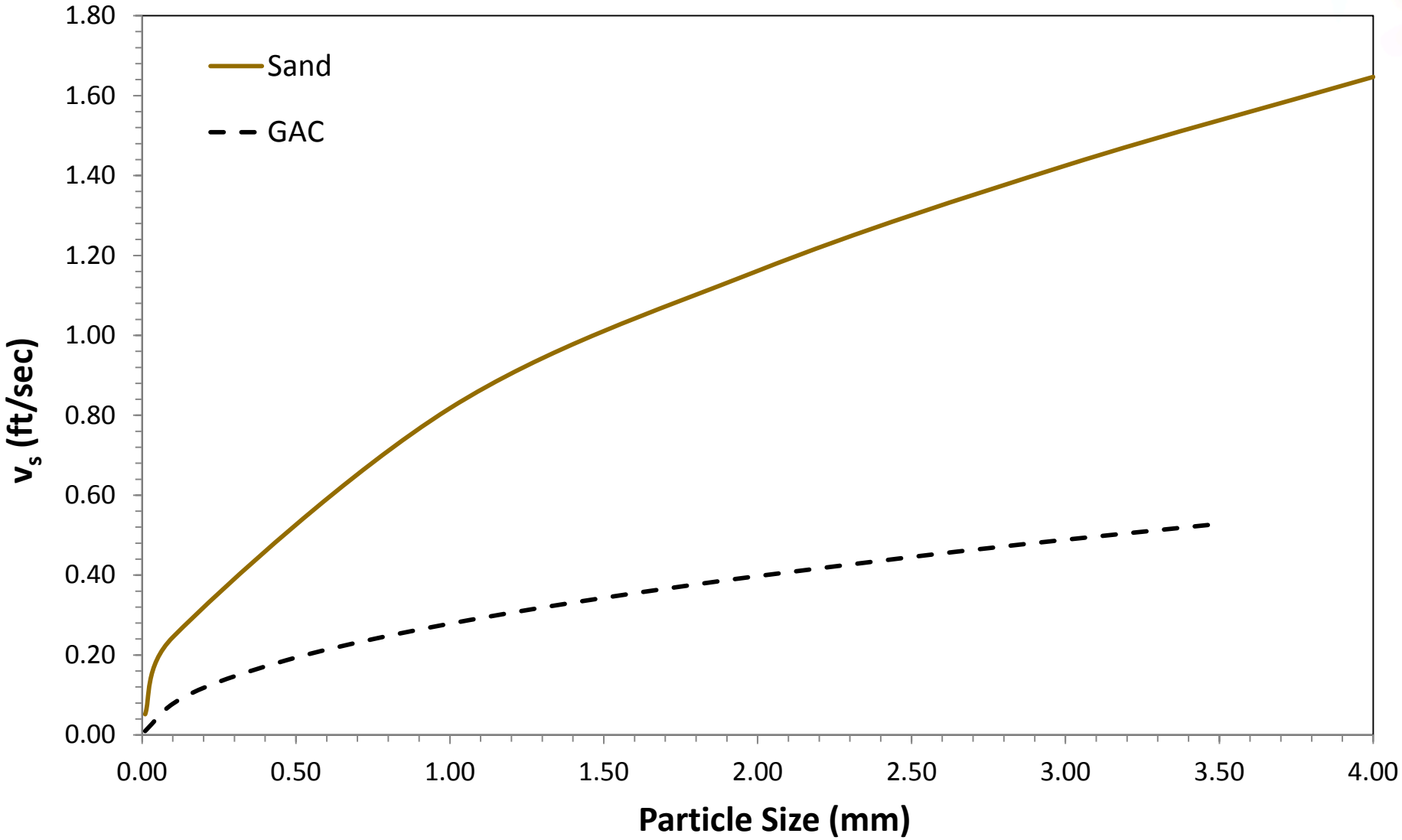
Typical Cap Detail Section

- Chemical isolation layers
  - Sand-Siderite
    - For pH control
  - Sand-Granular Activated Carbon (Sand-GAC)
- Erosion protection layer
  - Sand to 18-in. diameter armor stone
- Habitat layer
  - Sand
  - Topsoil



Sand and GAC Particle Settling Modeling



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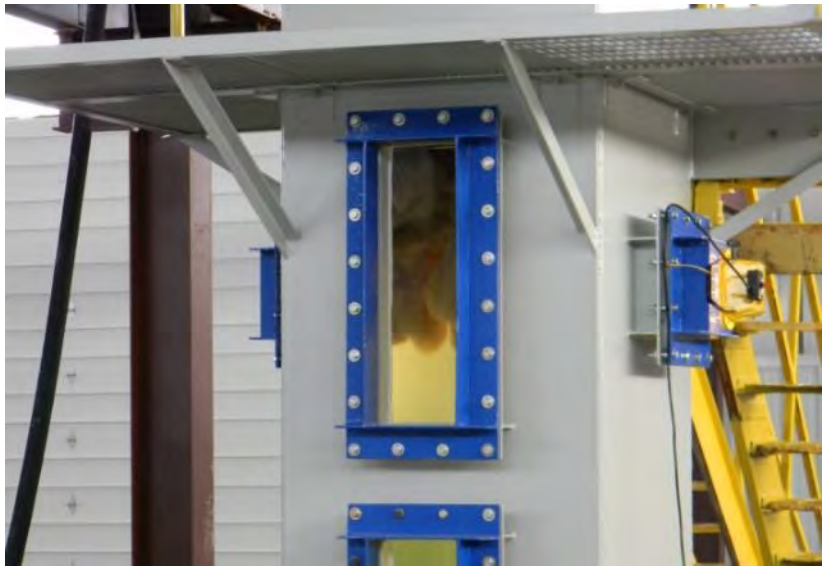
Sand and GAC Settling Bench Scale Testing

Sand and GAC Settling Bench Scale Testing

Large column testing at Sevenson's facility



Cap Spreader Barge

Sustainability

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Sustainability Measures

- General practices
  - Renewable energy sources
  - Locally produced/sourced materials and supplies
  - Effort to reduce and/or eliminate waste and efficiently use resources and energy
- Examples
  - Cap material specifications developed based on locally available materials to minimize material processing and transportation
    - Allowed project to meet the high volume placement requirements
  - Hydroelectric power supply for dredged slurry pipeline booster pumps
  - Biodiesel fuel used on all equipment when feasible
  - Process water from dewatering operations was reused/recycled
  - Solar power was utilized for air monitoring systems at the SCA

Conclusions

- Remedial Design required a multi-disciplinary team
  - Engineers and scientists
  - Industry experts from around the country
  - Community engagement to minimize potential impacts during and after the remediation
- Successful project
  - Dredging was complete 1 year ahead of schedule
  - Onondaga Lake has been reopened to public swimming and other recreational activities