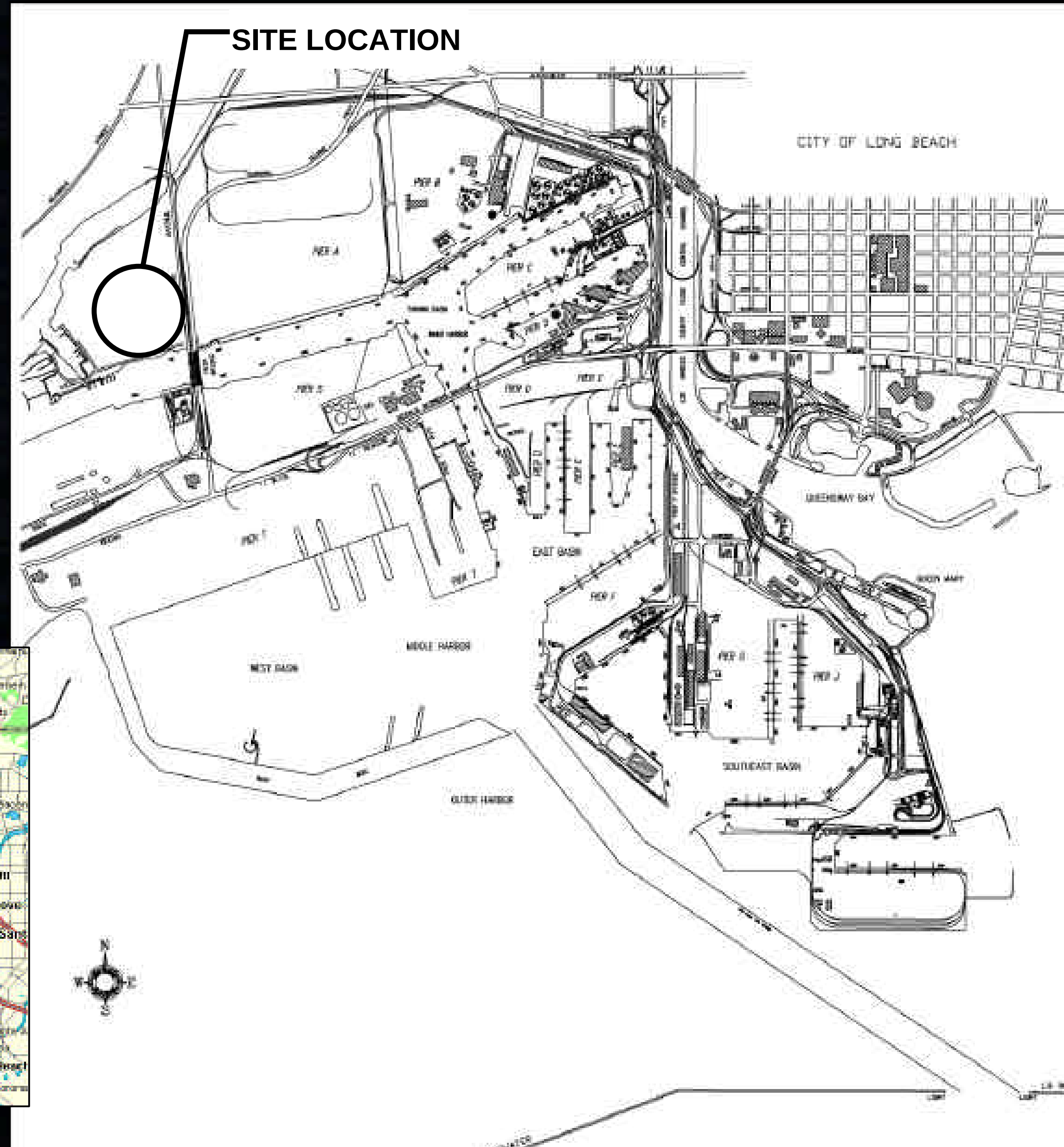
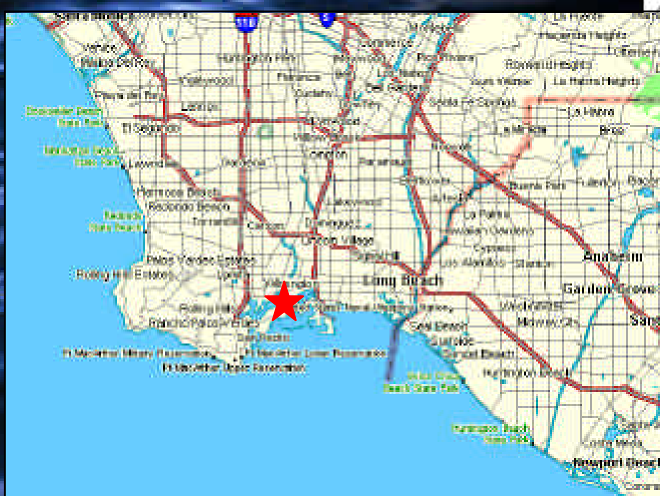
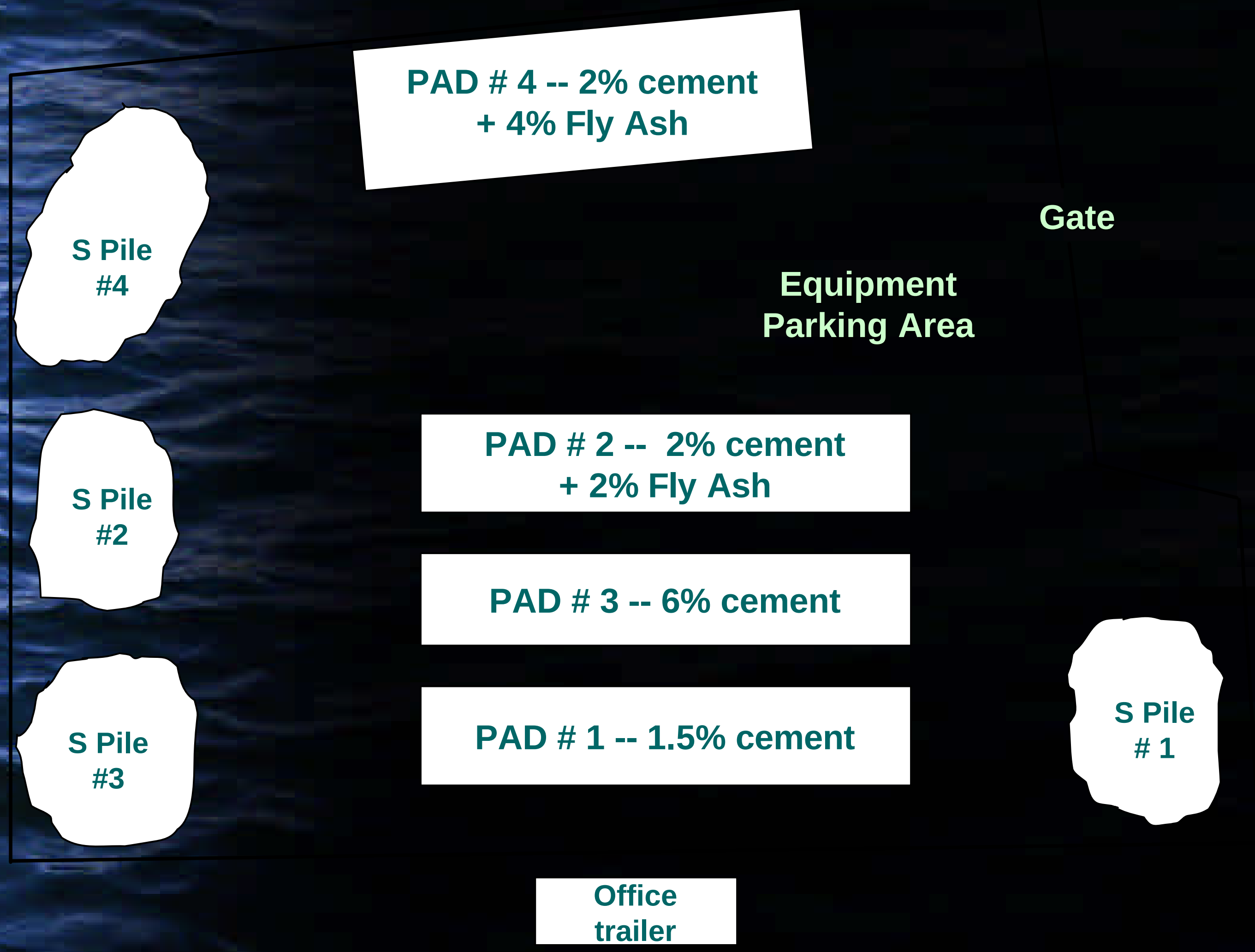
Site Map


SITE LOCATION
CITY OF LONG BEACH

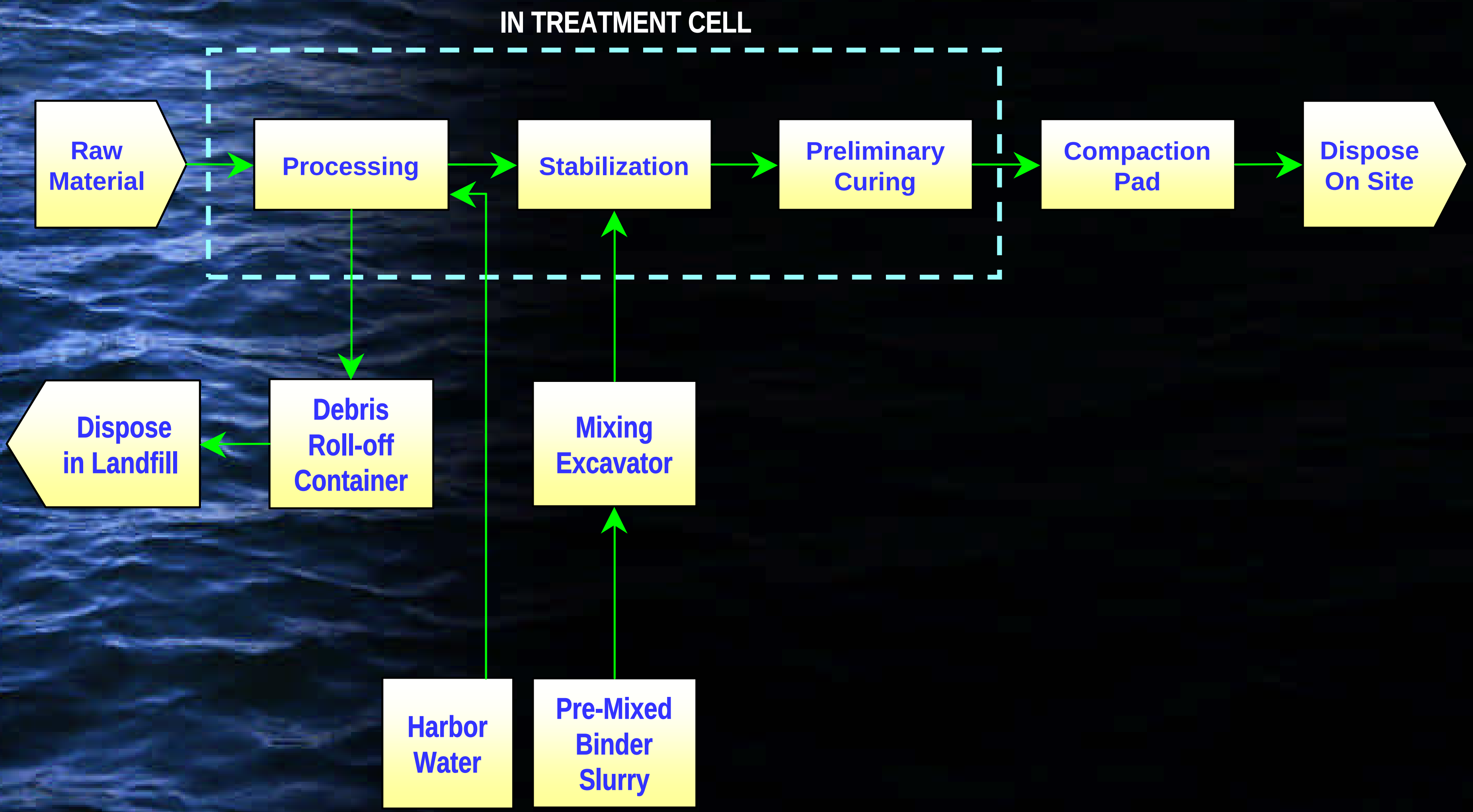

Long Beach
Anaheim
Garden Grove

Site Cell Layout

Stabilization Site Layout



Cement Stabilization Process Diagram



Treatment Cell Construction

Constructed Cell

POLA Anchorage Road Dredged Material Storage Area

Dredged Material Transfer From Storage Area to Treatment Cell

Water Addition in Treatment Cell

Water Addition and Blending

Debris Removal

Removed Debris

Debris Disposal

Pre-Treat Material Sampling

Sample Compositing

Reagent Introduction

Mixing by Mixer

Post-Mixing Initial Curing

Initial-Cured Material

Initial-Cured Material

Excavation and Transfer of Treated Material for Stockpiling

Stockpiling

Compaction

Disked Compaction Layer

Testing Matrix

Matrix	Chemical Tests					Geotechnical Tests									
	Bulk Chemistry	Leach: SPLP	Leach: WET	Leach: MLT	Water Chemistry	Atterberg Limits	Grain Size	Soil Classification	Moisture Content	Compaction	Unconfined Compressive Strength	Direct Shear	Consolidation	Permeability	R-Value
Raw Material	•	•	•	•			•	•	•	•					
Initial-Cured Material						•	•	•	•	•					
7-Day-Cured Material											•	•			
28-Day-Cured Material		•	•	•		•	•	•	•		•	•	•	•	•
Binder Slurry Water (Fresh Water)					•										
Raw Material Additional Water (Seawater)					•										

Testing Results: Geotechnical

- **Grain Size**
  - Coarsening after treatment (more apparent with increasing binder content)
  - Reduction in fines by 8-19% (clay cemented to larger particles)
  - Gravel fractions created in cured, compacted material (compaction effect; represents field condition)

Testing Results: Geotechnical

- **Atterberg Limits and Soil Classification**
  - Liquid and plastic limits (LL, PL) increase with higher binder content
  - LL and PL increase with cure time (more apparent with higher binder content)
  - Sandy silt (inorganic silts, very fine sands, silty/clayey fine sands)

Testing Results: Geotechnical

- Moisture Content

  - Reduced by 3.7% in first 12-24 hours, and 32% in next 27 days
  - Initial drying rate >3.7% per day. Average drying rate 1.2% per day

Testing Results: Geotechnical

- Compaction
  - Maximum dry density slightly decreases and optimum moisture content increases immediately after treatment (reasons unknown)
  - Compatibility of freshly treated material comparable to that of raw material; mid-range among typical soils

Testing Results: Geotechnical

- **Unconfined Compressive Strength**
  - Strength increases with binder content
  - Large percent (72%) of final strength developed during later part (7-28 days) of curing period
  - Portland cement more effective than fly ash in increasing strength
  - Higher binder content (e.g.>5-6% cement)needed for unconfined application (UCS>39 ton/m^2)

Testing Results: Geotechnical

- Shear Strength
  - Strength and friction angle increases, cohesion decreases with increasing binder content and curing time (correlate well with coarsening)
  - Portland cement more effective than fly ash in increasing strength (consistent with UCS findings)

Testing Results: Geotechnical

- Consolidation
  - Settlement consistently decreases with increasing binder content
  - Fly ash particularly effective in reducing settlement

Testing Results: Geotechnical

- **Permeability**
  - Permeability generally decreases with increasing binder content (accounting for moisture/dry density differences among samples; trend weak)
  - Fly ash effective in reducing permeability

Testing Results: Geotechnical

- **R-Value**
  - **R-value increases with binder content**

Testing Results: Geotechnical

- **Summary**

  - **Treated material tends to coarsen**
  - **Treated material exhibits consistent, pronounced increase in strengths (UCS and shear) and decrease in settlement and lateral deformation**
  - **Permeability, plasticity, and compaction patterns less certain from data**

Testing Results: Chemical

- Raw Sediment Chemistry
  - 4,4’-DDE and 4,4’-DDT exceed ER-M
  - Lead, mercury, zinc, PCBs, PAHs, chlordane exceed ER-L
  - Four cells similar in chemical characteristics
  - Lead, mercury, zinc as target constituents for treatment (common in dredged material; prior experience used as guide for binder and mix ratio selection)

Testing Results: Chemical

- **Process Water**
  - **Mostly non-detect except for metals at low levels**

Testing Results: Chemical

- SPLP and WET Leach Tests
  - Successful in binding zinc, lead, and cadmium

    (zinc by 1-2 orders of magnitude; lead and cadmium to below detection limits)
  - Some metals mobilized (can not bind all at single pH; method metal-specific)
  - Ability to bind organics uncertain
  - Certain irregularities in solubility-pH relationship (effects of differences in sample gradation, etc.)

Testing Results: Chemical

- Monolithic Leach Test (MLT)
  - NaCl selected for high solubility and threat to groundwater for upland placement. MLT selected for approximating field conditions.
  - 53% reduction in leached NaCl at 5.7% cement (minimal leach expected with higher, more common field range of mix ratios)
  - Leach of any constituents lower than predicted by SPLP/WET under field conditions (NaCl as a highly soluble tracer)

Cost

- Full Scale Cost = $46/m^3$
  - Dredge 100,000 m^3
  - Treat in 5 cells at 4,000 m^3/day for 25 days
  - Place at receiver site within 4 miles

Conclusion

- Effectiveness
  - Enhances engineering properties
  - Reduces leachability of targeted metals and chlorides
  - Contaminant-specific. Bench necessary for binder/mix ratio design

Conclusion

- Implementability
  - Proven implementable in the Region
  - Full-scale project site to be selected opportunistically due to short period of usage
  - Receiver site needs be identified

Conclusion

- Environmental Impact
  - Escape of volatiles during treatment not expected to be significant based on field observation. Quantification of volatilization requires further study.
  - Impact from spill not expected with rigorous implementation of Spill Prevention Plan

Lessons Learned

- Success of method relies on identification of targets. Bench necessary before project
- Ability to treat organics uncertain. Method not appropriate for material with high organic contaminant levels
- Binder in slurry form desirable to minimize emission
- Mix ratio may impact schedule and cost through setting time. Optimize.