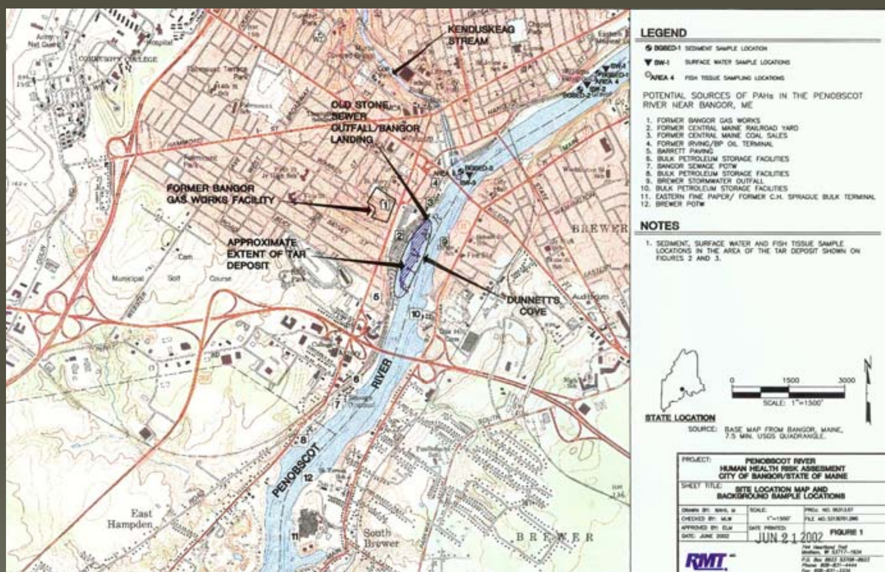
Bangor Landing
Bangor, Maine

Case Study-Sediment Remediation

Maine Department of Environmental Protection
City of Bangor, with RMT, Inc.

Site Location and Local Site Features



Bangor Landing Project Background Summary

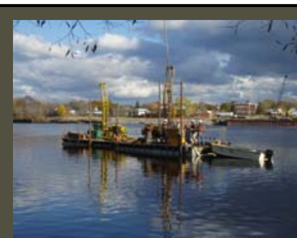
- Bangor Gas Works (BGW) operated a manufactured gas plant between 1851 and 1963
- BGW waste water, containing coal tar and oil tar, was discharged to a stone sewer, which then discharged to the Penobscot River
- Tars entrained in warm, fast moving waste water precipitated out upon entry to slower, colder water of Dunnett's Cove
- Tar is present in sediments in Dunnett's Cove over an approximate 11 acre area
- Origin of the tar was explored, and other potential sources were ruled out, BGW is the most likely source of the tar based PAHs in the river
- Source site was remediated by removal/equivalent cap and the parcel returned to productive use as a grocery store site

Tar and Sheen on River Surface

At low tide in warm weather, tar moves to surface of the river from tar deposit near the sewer, and is transported by river currents

Remedial Investigation

- Sediment, Surface Water, Fish Tissue Characterization-2002-2003
- HHRA/BERA-2002, 2004
- Remedial Action Objective-2005
- Feasibility Study-2005
- Pre-Design Studies 2007-2008
  - Bathymetry
  - Hydrodynamics and tidal flux
  - Groundwater interaction
  - Ice impact study
  - Geotechnical Investigation
  - Waterway use and infrastructure



Gas from Sediment Brings Tar to Water Surface

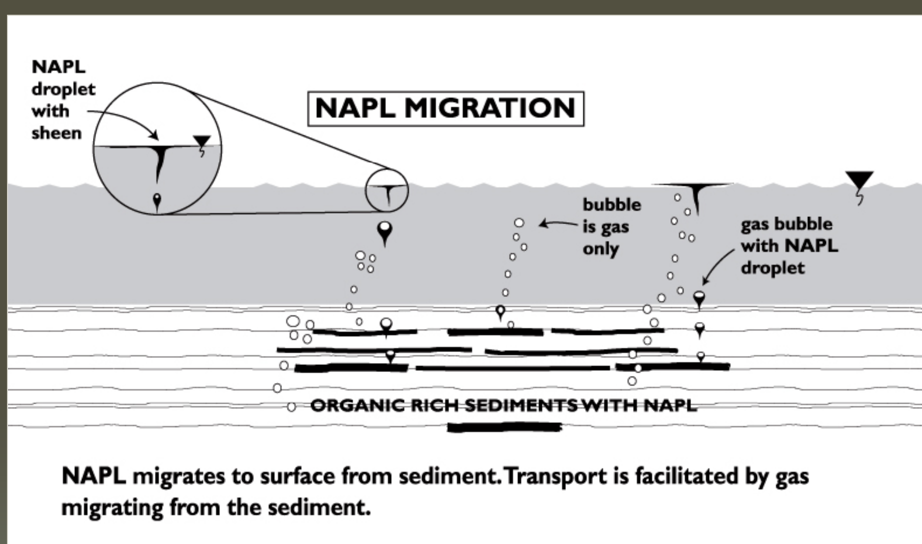


Figure by RMT, Inc.

Longitudinal Cross Section of Tar Deposit

Sewer outfall Penobscot River **Barrett's Paving**

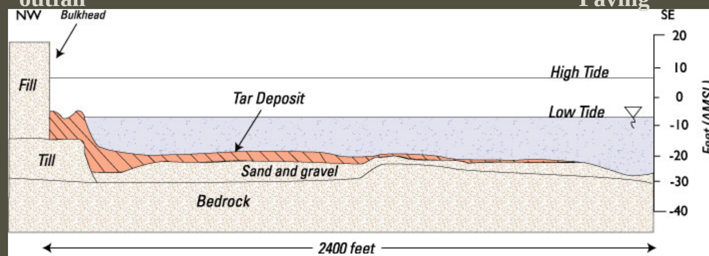


Figure by RMT, Inc.

Tar deposit thickest near sewer outfall (14 ft) and thins downstream

(4 ft thick 1,000 feet from sewer outfall)

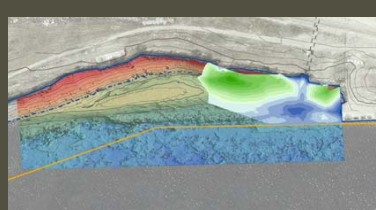
Findings

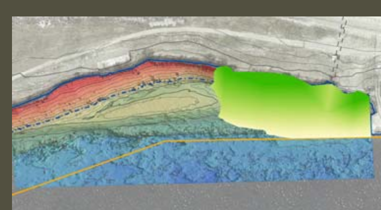
- human health/eco risk from PAHs, including benzo (a) pyrene
- ~11 acre tar deposit in sediment
- tar within the deposit is more mobile at upper end of the cove, more weathered at lower end of the cove
- Three remedial action areas
  - Primary Active Zone (PAZ)
  - Secondary Active Zone (SAZ)
  - Inactive Area

Selected Remedy

- risk based cleanup
  - Removal-stabilization and disposal of mobile source areas, source reduction
  - Cap remaining PAH areas in the PAZ, SAZ
  - Habitat cover over weathered tar to enhance natural sedimentation and natural re-colonization

Dredge and Cap-Primary Active Area





Figures by RMT, Inc.

The Modified Remedy for the PAZ includes the following components:

Limited remedial dredging – Approximately 6,000 to 8,000 cubic yards of sediment will be mechanically dredged from the PAZ, in order to create grades appropriate for construction of a NAPL Trapping Cap, and to perform source reduction in the areas of the "Tar Puddle" and tar rivulets. The dredging will also reduce the overall mass of tarry sediment and will increase the permanence of the remedy.

NAPL Trapping Cap (**patent pending**) – Following the completion of dredging, a NAPLTrapping Cap (patent pending) will be constructed, which will consist of a gas transmission zone (permeable materials), a gas control zone (impermeable materials), and armor stone, which will be sloped toward shore in order to guide migrating gas and tar to a near shore vent area where the tar will be trapped and the gas will be released to the atmosphere.

Considerations for Dredging Remedy

- Access, navigational traffic
- Background/downstream TSS
- Buried debris/boulders
- Currents/tides
- Dredging depths, side slopes
- Slope stability at shoreline, navigational channel
- Work area, sediment handling area
- Transport routes
- Endangered species considerations
  - Atlantic salmon
  - Short nosed sturgeon

Considerations for Capping Remedy

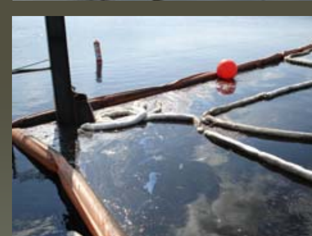
- Water depths/slopes
- Slope stability, erosion
- Currents, tides
- Access and navigation demands
- Groundwater flow
  - Seepage/upwelling
- Sediment gas

Site Preparation

- Install H-piles, dolphin piles
- Erect stabilization building, build stabilization pit
- Construct crane pad
- Move barge into place
- Install turbidity/fish curtain
- Stabilize Bulkhead - Install pins
- Manufacture Aquablok

Sediment Dredging

- Primary Active Zone (PAZ) ~ 1.3 acres
- Total Volume Tar Impacted Sediment – 21,000 cubic yards
- Sediment Dredged ~ 7,000 cubic yards (approx 100,000 gal NAPL)
- Stabilized Sediment Disposed ~9,500 tons



Stabilize Dredged Sediment

Lessons Learned-Dredging Operation

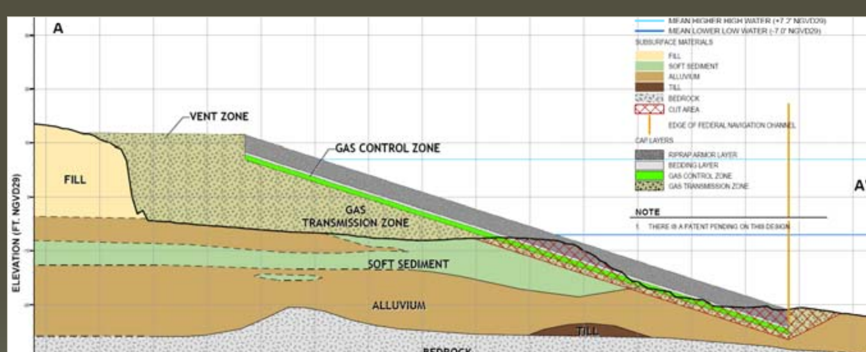
- Double boom often necessary to contain NAPL, turbidity
- Tide cycle proved very limiting to use of long arm excavator
- Uneven dredge surface made survey difficult
  - In field efforts to smooth cap layers
    - Crane bucket drag
    - I-beam rake

Lessons Learned - Stabilization

- Spec'd stabilization agent QuickSolid 50 ineffective
- Lime as a stabilizing agent created unregulated airborne dust– applied 20% opacity not to exceed standard
- Water spray for dust control generated high pH surface water runoff
- Air scrubber system, installed to handle VOCs, not needed and not applicable to lime dust
- Water handling system, installed to de-water sediment for stabilization, not needed
- Odor control not needed

Remedial Cap Design Components

Cross Section of NAPL Trapping cap



- Vent the gas, trap tar, transmit water
- Patent pending

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Cap Installation

- cap installed in layers
  - cast with long arm excavator
  - dropped with crane bucket
  - cast with stone slinger
- each layer surveyed
- Layers “stepped” to avoid butt end joins

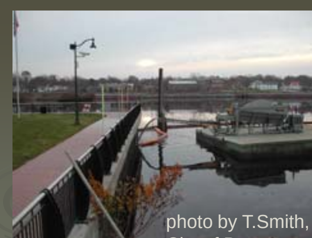
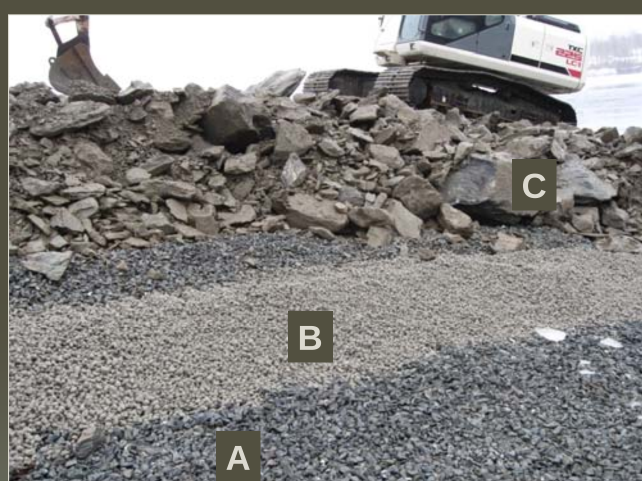


photo by T.Smith, City of Bangor

Cap Installation Cross Section



Placing Gas Transmission (A) & Control Layers (B), Armor (C) in Intertidal Zone

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Field Change Orders – Design Changes

Modified dredge depths

- Modified cap design
  - Tapered design at bulkhead
  - Change to toe of slope, toe vent
  - Change to design grades
  - Change to OSSO invert
- Changes to materials specifications
  - Substitute select stone for general fill
  - Fines in riprap
  - Change in Aquablok design mix production, storage, placement
  - Lime instead of QuickSolid50 as stabilizing agent
- Discontinue air monitoring
- Discontinue turbidity monitoring, remove turbidity curtain
- Remove temporary settlement plates from plan
- Modify construction quality control program

Lessons Learned-Cap Construction

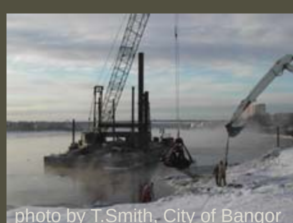
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photo by J.McCrady, MACTEC


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- Barge-based install uneven surface made survey difficult
  - In field efforts to smooth cap layers
    - Crane bucket drag
    - I-beam rake
- Ice, tides hampered near shore construction
- Silt curtain trapped ice, ice flow tore at curtain
- Rock dust turbidity bigger problem than dredging
- Flexibility and teamwork to resolve issues is key to successful project

Containment Around Construction Area

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photo by J.McCrady, MACTEC

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Lessons Learned

- Endangered species consideration restricted construction schedule, short days and unfavorable tides meant occasional night work
- Night work meant no survey data collected
- Late fall through winter construction meant flooding conditions, ice

Next Steps

- Complete construction tasks
  - gas collection trench
  - OSSO invert
  - re-survey
- Cap performance monitoring program
  - Visual observation of ebullition, tar
  - Tar flux evaluation
  - Piezometer measurements, pore water sampling
  - Observation tubes
  - Monitor vapor points at shoreline
  - Visual inspections
    - Near shore
    - Intertidal
    - Ice evaluation
    - Subtidal
  - Settlement plates

Project Team

- City of Bangor
  - Jim Ring, Director Engineering and Infrastructure
- RMT, Inc.
  - Gene McLinn - Project Manager
  - John Rice, Hans Hinke – Design, Project Engineers
- Maine Department of Environmental Protection
  - Kathy Howatt – Project Manager
  - Troy Smith – Project Geologist
  - Fred Lavallee – Project Engineer
- MACTEC Engineering and Consulting – project overseer for DEP

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