## Bangor Landing Bangor, Maine



#### Case Study-Sediment Investigation

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



## 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
  - Addendum-supplemental investigation-2002
- > HHRA/BERA-2002





## RI Studies, cont.



- Additional Source Area/Sediment Sampling-2003
- > Addenda-HHRA, BERA-2004
- Remedial Action Objective-2005
- Feasibility Study-2005



#### **Pre-Design Sediment Investigations**

#### > Physical Site Characterization

- Bathymetry
  - Develop detailed maps, determined slopes, obstacles present in sediments
    Rod Probe soft sediment thickness
- Hydrodynamics and tidal flux
  - Assess hydraulic impact of proposed remedy
- Groundwater interaction
  - Assess impact to GW flow from proposed remedy
- Ice impact study:
  - Assess ice jam potential
  - Predict potential for ice damage to cap by floe, scour
  - Sizing armor stone
- Geotechnical Investigation
  - Characterization and extent of tarry sediment
  - physical and chemical properties of tarry sediment
- Waterway use and infrastructure
  - Bulkhead and public boat landing
  - USACOE navigational channel



#### **Sediment Investigation**

#### Physical Sediment Characterization

- Gas flux
  - box sampler, tent sampler
- Atterberg limits
- Specific gravity
- Grain size distribution and variability
- Shear strength and bearing strength
  - Evaluate impact of proposed remedy cap settlement
    Sediment compressibility
- NAPL/Gas Migration
  - Nature and extent of contamination
  - Evaluate and quantify gas and tar migration-field study
    - Bubble and trap observation
    - Corral sampler
  - Test proposed remedy, calculate gas and tar flux-lab study
    - Bulk samples from site
    - Sandbox testing, column testing



## **Sediment Investigation**

#### > Biological Sediment Characteristics

- Sediment toxicity
- Endangered species identification
- Abundance/diversity study
  - benthic species
  - fish species
  - higher trophic species
  - emergent/submerged vegetation
- Contaminant bioavailability
- Identify indicator species



## 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**











#### Human Health Risk Assessment

- Evaluated risk to recreational users and workers from the tar
- Applied protective assumptions
- Found increased risk of cancer and of other, non-cancer health effects for site workers and recreational users, based on contact with sediment and surface water at and near the tar deposit.







## 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 recolonization

#### Dredge and Cap-Primary Active Area



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.