Contaminated Sediment Assessment and Management

Trudy J. Estes[†], David W. Bowman[Ψ] and Larry M. Zanko[§]

[†]US Army ERDC, Vicksburg, MS, Email: Trudy.J.Estes@usace.army.mil
[Ψ] USAE District, Detroit
[§]University of Minnesota, Duluth

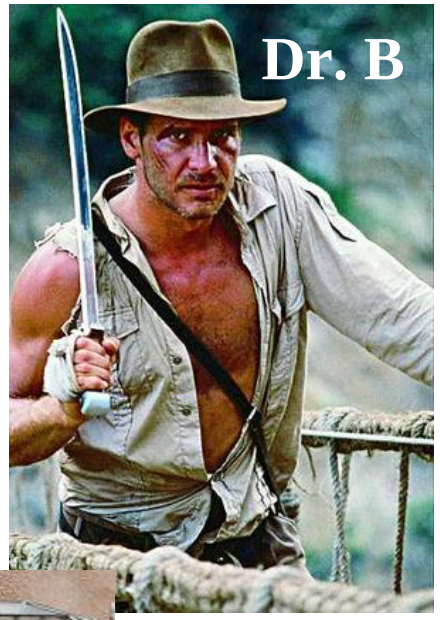
Dredged Material Assessment and Management Seminar
15-17 September 2009, Detroit, MI

Selected Regional Issues…

- Material recovery issues and options
  - Erie Pier
- Hg contaminated sediments
  - Disposal management issues
  - Impacts on material recovery and re-use

Material Recovery

- **Analogous to an Indiana Jones Movie…**
  - **Everybody's after the same thing**
  - **Differing opinions on how to get there**
  - **Many unexpected turn of events**

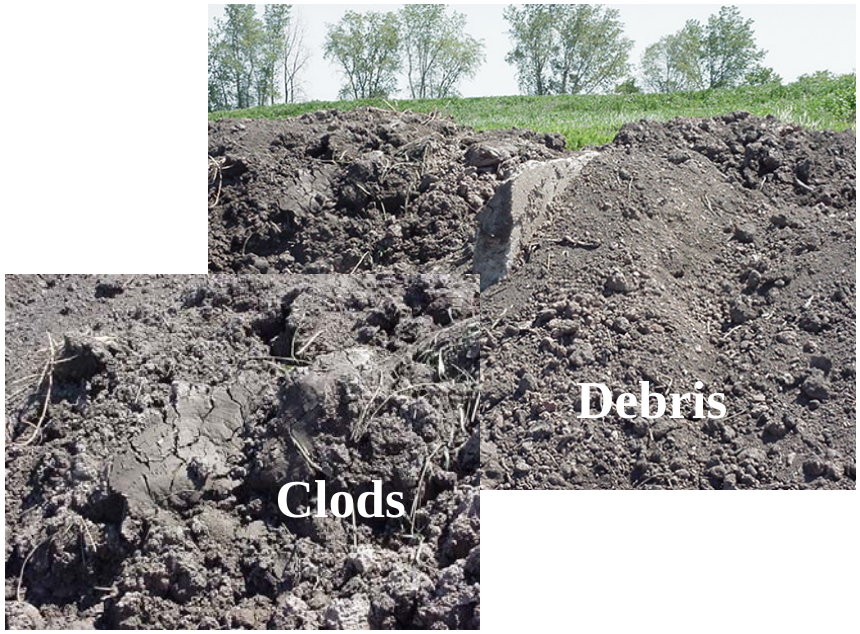


Field Demonstrations

- **Saginaw River CDF**
  - 1991-92 ARCS demo
  - Bergmann USA
  - 30yd^3/day – 300 yd^3 total
- **Green Bay**
  - 2000 1-day demo
  - GLNPO/Detroit/ERDC
  - Modular, mobile, low $$ system
  - Feasibility evaluations
  - Small scale projects

Green Bay Demo

- **Power screen**
  - Dry size separation
  - Clay clods problematic
  - Some blinding with coarse debris



Green Bay Demo

- 24 in Maximum Density Separator (MDS)
  - 1200 gpm capacity
  - Nominal 75 tons solids/hr
- 75 µm cut size
- Processing objectives
  - <10% fines in sand
  - PCBs < 1mg/kg in sand

Green Bay Demo

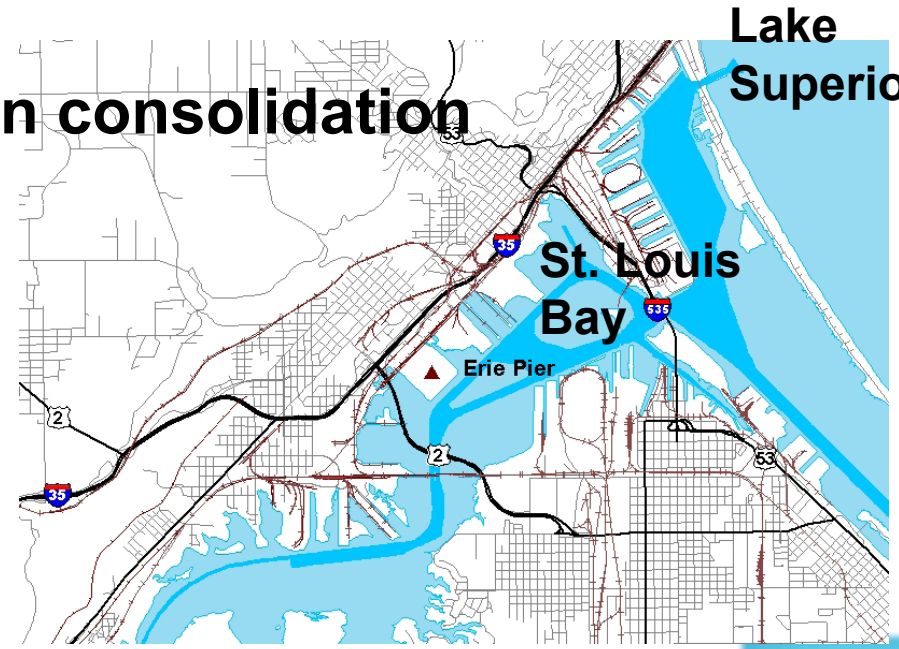
- **Eductor pump**
  - Fed from decant pond
  - Fairly effective in vegetated areas
  - Problems with woody debris
  - Variable feed solids

Green Bay Demo

- PCBs reduction
  - Higher than predicted
  - ~8% fines by volume
- Available equipment
  - 12 in mobile MDS
  - Wet screen
- Take away lessons

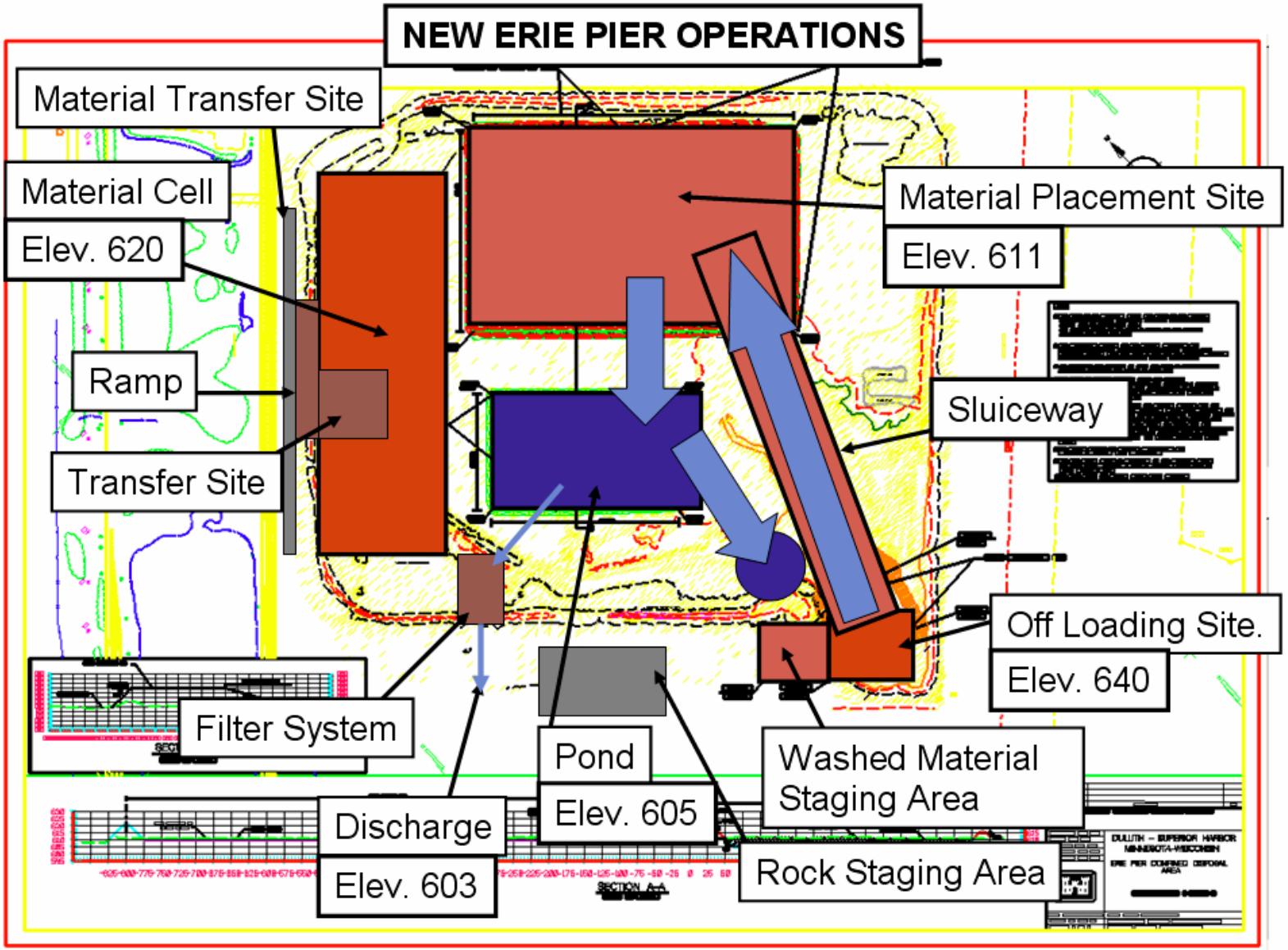
Erie Pier

- 89 Acre site constructed 1978-79
- 1.1M yd^3 capacity, 10 year life expectancy
- As of 2007….
  - Over 2.2M cubic yards placed in Erie Pier
  - Dike raising
  - Material and foundation consolidation
  - Sand recovery
  - 10 year remaining life



Erie Pier Replacement?

- One prospective site identified in DMMP
- $6-8M projected cost, excluding
  - Land acquisition cost
  - Social or environmental costs
- 1-1.3M yd^3 capacity
- 10-13 year life expectancy
- 20 year disposal option required for DMMP


NEW ERIE PIER OPERATIONS
Material Transfer Site
Material Cell
Elev. 620
Material Placement Site
Elev. 611
Ramp
Transfer Site
Sluiceway
Off Loading Site.
Elev. 640
Filter System
Pond
Elev. 605
Washed Material
Staging Area
Discharge
Elev. 603
Rock Staging Area

Cost of Transitioning to Re-use

- **Estimated $250,000/yr initial cost**
  - **Infrastructure**
  - **Material staging**
- **FY2006**
  - **100K yd^3 fines material staged for removal**
  - **~$500K**

Water Management Issues

- 8-10M gallons
- Limited discharge to municipal WWTP
- Other management options
  - Land application
  - Discharge to surface water
  - Other recycling/reuse offsite
- NPDES discharge permit needed for discharge
  - Pond concentrations > Hg WQC
  - Hg WQC 1.3 parts per trillion[1]

[1] Great Lakes Initiative for mercury

Effluent Hg Treatment

- Needs
  - Long-term
  - Low-cost
  - Low-tech
- Taconite tailings filtration
  - University of Minnesota Duluth - Natural Resource Research Institute (NRRI)
  - Unamended
  - Amended with peat, magnetite, Hg sorbents
  - In combination with electrodes
  - Single gradation, tailings source, flow rate

Taconite and Hg

- Taconite – low grade iron ore
  - Hg(II) converted to elemental Hg(0) during firing
  - Most volatilizes
- Hg(0)
  - Low solubility and solids sorption
  - Remains in atmosphere until oxidized to Hg(II)
- Hg(II)
  - Readily forms non-volatile species with organic and inorganic compounds
  - These compounds are water soluble & sorb to solids
  - Inorganically bound Hg(II) quickly binds to organic carbon or sulfide in aquatic environments

Taconite Tailings

- Tailings
  - Sand size by-product of taconite processing
- Given
  - Predominance of atmospheric deposition as Hg source to water bodies
  - Comparatively low Hg concentration in tailings basins
  - Apparent Hg sorption to tailings
- Potential issues
  - Disposal and bulk of tailings used in filtration
  - Hg(II) may be dissolved, DOC or particulate associated
  - Filtration AND sorption may be needed
  - Colloid filtration/flocculation difficult
  - Potential Hg contribution of tailings unknown

Other options

- **Multi-media filter preceding magnetite filter**
  - Remove colloidal materials
  - Extend life of magnetite filter
  - Potentially disposable in CDF
- **Zeolite filtration**
  - Microporous, aluminosilicate minerals
  - Commonly used as commercial adsorbents
  - Ion exchange metals
  - Porous capture of organic compounds
  - Relatively inexpensive

Legacy Act Sediments

- Impact on additional volume on CDF useful life
- High sediment Hg concentrations
  - 40 ppm range
- CDF surface placement
  - Exposure risk due to Hg(II) solubility
- CDF subsurface placement
  - Methylation risk

Hg Methylation

- Methyl-mercury
  - CH_3Hg^+ or "MeHg"
- Produced from Hg^{2+} present in environment
- Associated with bacterial reduction of $So4^{2-}$ to S^{2-}
- Predominant species present in fish tissue
- Persistent, bioaccumulative
- Highly toxic
  - Kidneys and central nervous damage

Summary

- Material recovery not straightforward
  - Logistical
  - Economic
  - Regulatory
- Erie Pier case study
  - Dissolved Hg limiting water management and material recovery
- Legacy Act sediments
  - Impact CDF service life
  - Management requirements to minimize Hg mobility and methylation are contradictory

References

- *US Environmental Protection Agency (1994). "*Pilot-Scale Demonstration of Sediment Washing for the Treatment of Saginaw River Sediments," *EPA 905-R94-019. Chicago, Ill.: Great Lakes National Program Office.*
- *Minerals Coordinating Committee 2003. "Mercury and Mining in Minnesota – Final Report", Michael E. Berndt, Minnesota Department of Natural Resources, St. Paul, MN.*