Presentation Purpose

• To provide a high-level overview of site investigations and remediation considerations for contaminated sediments
## Typical Contaminants of Concern

<table>
<thead>
<tr>
<th>Toxics</th>
<th>Bioaccumulatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metals</td>
<td>PCB</td>
</tr>
<tr>
<td>SVOC</td>
<td>Dioxins/Furans</td>
</tr>
<tr>
<td><strong>PAH, Pesticides</strong></td>
<td></td>
</tr>
<tr>
<td>VOC</td>
<td>Mercury</td>
</tr>
</tbody>
</table>
Conceptual Site Models

- Physical models
- Chemical sources
- Contaminant release mechanisms
- Ecological risk models
- Human Health risk models
Conceptual Site Models – Physical

- Site bathymetry/hydrology and sediment stability
- Effects of surrounding land use
- Surface water/sediment interaction
- Groundwater/porewater/sediment interaction
Bathymetry and Site Hydrology
Land Use
Sources and Release Mechanisms

- **Primary Source**
  - Stormwater/Urban Runoff
  - Outfalls
  - Tanks/Pipes

- **Pathways**
  - Direct Discharge
  - Leaks/Spills
  - In-situ Contaminated Sediment
  - Contaminated Soil

- **Secondary Source**
  - Re-Suspension/Bioturbation
  - Water Erosion
  - Wind Erosion

- **Tertiary Source**
  - Air Particulates
  - Eroded Soil
  - Dust

- **Exposure Media**
  - Surface Water
  - Biota
  - Groundwater
  - Sediment

- **Components**
  - Infiltration
Surface Water/Sediment Interaction
Groundwater/Sediment Interaction
Habitat Features, Example Receptors, and Flow of Contaminants
Ecological Receptors and Exposure Pathways

Sources
- Surface Water
- Sediment
- Groundwater

Exposure Pathway
- Complete and Insignificant
- Complete and Significant
- Unknown Significance

Biota
- Piscivorous Bird
- Benthivorous Bird (Killdeer)
- Piscivorous/Pelagic Fish
- Omnivorous/Demersal Fish
- Shrimp and Crab
- Benthic Infauna
- Rooted Aquatic Plants

Water
- Direct Contact
- Ingestion

Other Ingestion (e.g., shellfish, zooplankton, algae, terrestrial insects)
Human Health
Human Health Exposure Scenarios

Sources

- Surface Water
- Sediment
- Groundwater

Biota

- Water Recreation
- Beach Play
- Fish/Shellfishing for Consumption
- Industrial Worker on River

Exposure Pathway

- Dermal Sediment Contact
- Incidental Sediment Ingestion
- Dermal Water Contact
- Incidental Water Ingestion
- Drinking Water Ingestion
- Fish and Shellfish Ingestion

Water

Biota (prey)

Sediment

- Complete and Significant
- Complete and Unknown Significance
- Complete and Insignificant
- Incomplete
Typical Ecological Risk Assessment – Screening Evaluations

- Bulk sediment screening (sediment quality guidelines)
- Surface water chemistry
- Toxicological testing
- Benthic assemblage
Field and Lab Bioaccumulation Studies

In-river deployment of field exposure cages with *L. variegatus* for baseline study

Laboratory exposure test with *L. variegatus*
Typical Ecological Risk Assessment – Baseline Evaluations

- Community and Habitat Assessment
- Tissue analyses
- Porewater analyses
- Area use factors
- Biota-sediment accumulation factors
- Food web modeling
- Toxicity reference values
- Probability analyses
- Uncertainties
Typical Human Health Evaluations

- Direct contact
- Ingestion
- Inhalation
- Bioaccumulation
- Consumption/Total Daily Intake
- Uncertainties
Contaminated Sediment Remediation

• Typical technologies
  – Monitored natural recovery/enhanced monitored natural recovery
  – Dredging and disposal
  – In-situ containment/capping
  – In-situ treatment
  – Institutional Controls
  – Hydraulic modifications
Contaminated Sediment Remediation
Considerations for all Technologies

Source Control

Bed Stability
Monitored Natural Recovery/EMNR

- Considerations
  - Initial concentrations and rate of burial/dilution
  - Chemical degradation
  - “Reasonable” timeframe
  - Enhancement
Natural Recovery: Combined Sediment Core and Transport Model Results
Dredging and Disposal

• Considerations
  – Disposal options
  – Water quality
  – Treatment
  – Residuals
Sediment Dredging
Dredging and Disposal
Leachability Testing and Groundwater Transport Modeling

Nearshore Confined Disposal Facility
Slip 1 CDF – Completed Berm
In-situ Containment/Capping

• Considerations
  – Sediment strength
  – Sediment surface stability
    • Wind/waves
    • Currents
    • Propwash/vessel wakes
    • Ice gouging
    • Consolidation and slope stability
    • Human contact
  – Chemical advection/diffusion
Sediment Capping
In-situ Containment/Capping

- Typical cap elements
  - Granular materials
  - Armor layers in high energy environments
  - Recent trends
    - Amendments
    - Reactive barriers
    - Capture and treat systems
Three Layer Treatment Cap

- 4 inches coal
- 6 inches sand
- 3 inches armor
Post Placement Cores
Sediment Capping – ABM
Completed Cap
Risk Management Strategies

- Utilize adaptive management
  - Iterative approach
  - Acknowledge that there will always be uncertainty
  - Develop solutions that allow implementation, monitoring, assessment, and corrections if necessary
Fox River Adaptive Management

More dredging

All areas less than 1 ppm?

Yes

Achieved

No

1 ppm “footprint” removed?

Yes

Achieved

No

0.25 ppm SWAC* for OU?

Yes

No

Sand cover

Capping contingency

*SWAC = Surface Weighted Average Concentration

No

Yes
Risk Management Strategies
Risk Management Strategies

- Utilize probability analyses
Risk Management Example – Risk Continuum Calcasieu Estuary (LA)
Look for On-Site Restoration Projects as Part of Remedy

- Builds goodwill
- Can be used as part of NRDA settlement
Existing Conditions
Conceptual Grading Plan
Conceptual Design Plan
Risk Management Strategies

Blend remedial actions