Estimating Remedial Volumes for a GLLA Project on the Milwaukee River

Mike Ciarlo, Jamie Beaver, Mike Powell, Jason Byler
EA Engineering, Science, and Technology, Inc.

Marsha Burzynski, William Fitzpatrick
Wisconsin Department of Natural Resources

Kevin Haley
Milwaukee County Parks

Acknowledgements

- Brenda Jones & Diana Mally, U.S. EPA Great Lakes National Program Office

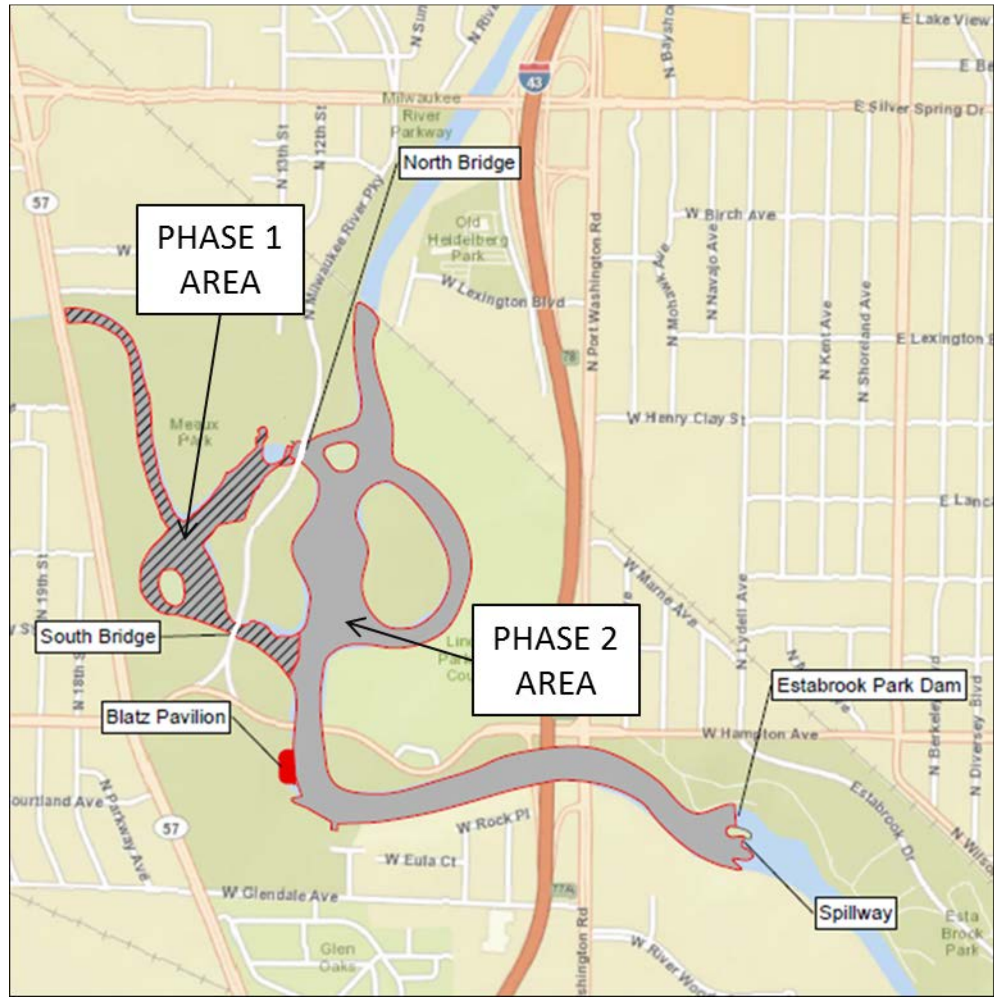
- Rebecca Murphy, Jason Byler, Jon Trombino, EA Engineering, Science, and Technology, Inc.

Case Study for Volume Estimation: Lincoln Park Phase 2

- Lincoln Park is part of the Milwaukee River and Harbor AOC
- Site is being remediated to address TSCA level PCBs that contribute to BUIs as well as PAHs and NAPL
- Volume estimation for the Phase II FS and design presents challenges common to many sediment remediation projects
  - Scattered deposits with interspersed layers of target material
  - Multiple target chemicals of concern (COC) with overlapping footprints
  - Specialized disposal requirements for a subset of material
  - Spatial and temporal variation in concentrations at a scale small enough to create uncertainty regarding final volumes
- Volume is one of the major determinant of disposal cost and handling efficiency, forming a basis for alternative selection and remedial design

Lincoln Park & Milwaukee River Channels Site

- Cooperative partnership under GLLA by EPA GLNPO, WDNR, Milwaukee County
- Potential source of PCBs to downstream; exceed 50 ppm (TSCA); influence BUIs
- Lincoln Creek and 1.7 miles of the Milwaukee River in Milwaukee, Wisconsin
- Channel and oxbows upstream of Estabrook Park Dam and Spillway
- Phase 1 and Phase 2 areas; Blatz Pavilion
- Baltz Pavilion & Phase 1 areas remediated (2008 & 2010-11)



Conceptual Model

- PCBs spread over 10 deposits
  - Exceedences of 50 ppm - TSCA
  - Most volume has 1-10 ppm PCBS
- NAPL discovered in Phase I
  - Near North & South Bridges
  - Associated with PAHs
- Water levels & flows vary; dam open since 2008
- Sediments are relatively low moisture (70%-90% solids); mostly silts, but areas of gravel, organic matter, debris
- Sediments underlain by compacted silts or bedrock

Goals & Objectives

- Project Goals
  - Remediate PCBs to 1 ppm total Aroclors
  - Remediate PAHs to 20 ppm total PAHs (sum of 17)
  - Remediate all NAPL encountered
  - Habitat restoration for those areas affected by remediation
- Objectives for volume estimation
  - Define in situ and disposal volumes to support effective selection (and design) of a remedy
  - Define separate volumes for TSCA specialized disposal and non-TSCA
  - Capture specific contingencies on volume to the extent possible.
- Focus on removal as primary GRA: excavation behind coffer dams or hydraulic dredging

Components of Volume Estimation

1. TOTAL SEDIMENT VOLUME (IN SITU)
- "Soft" sediment
- Potentially contaminated lithologies

→ Bounds the potential horizontal and vertical extent of dredging

2. TARGET VOLUME (IN SITU)
- TSCA
- Combined PAH/PCB/NAPL

→ Basis for remedy implementation. Defines geometry & endpoint for non-target volumes.

3. NON-TARGET VOLUME (IN SITU)
- Overburden
- Horizontal & vertical overdredge
- Side slopes

→ Additional volume requiring handling, disposal, or re-use. Defines remedial footprint.

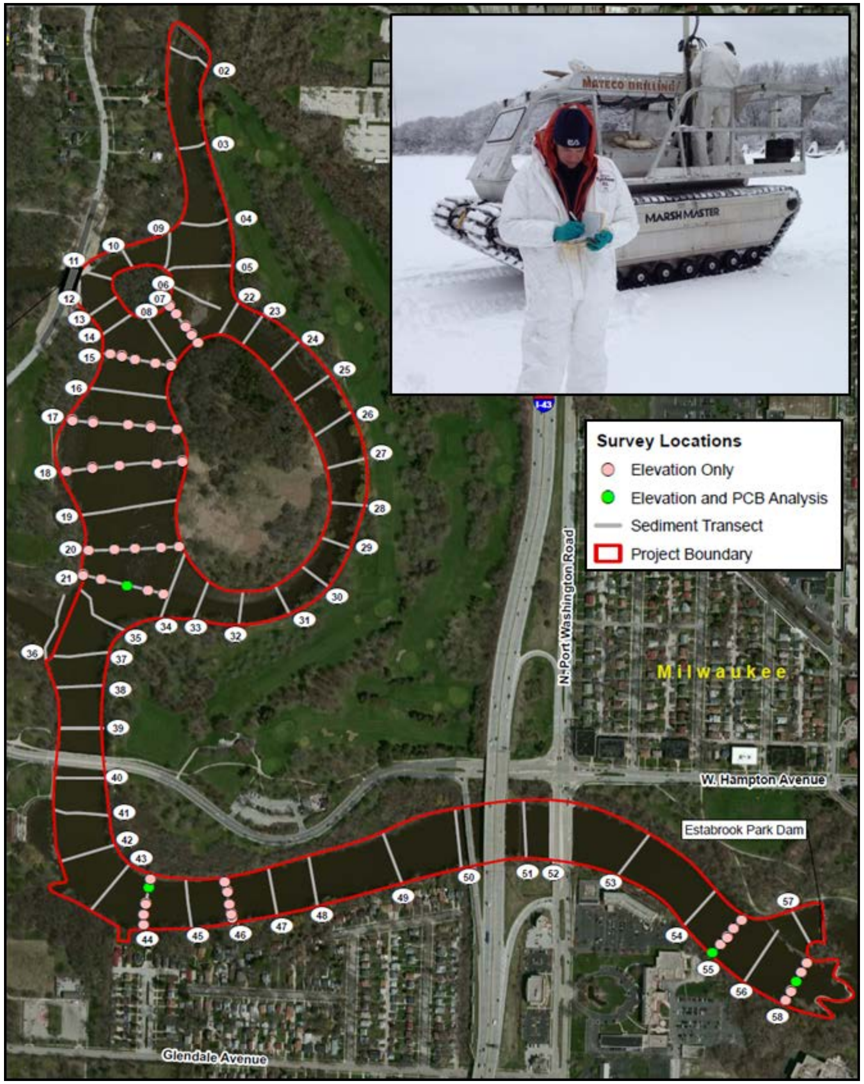
4. HANDLING & DISPOSAL VOLUME
- Volume for dewatering & on-site transport
- Volume for disposal

→ Defines transport & handling requirements. Determines final disposal volumes and masses.

Approach: Total Sediment Thickness

- Establishes bounds on the total amount of sediment that is removable – “soft” sediments
- Define as the volume between the top of sediment surface and the depth to bedrock or compacted sediments (i.e. silt & clay)
- Presence of bedrock as well as compacted sediments of pre-channel origin facilitated delineation
- Field component included bathymetry transects & sediment probes
- Also attempted to develop correlation between lithology and zone of contamination – moderate success

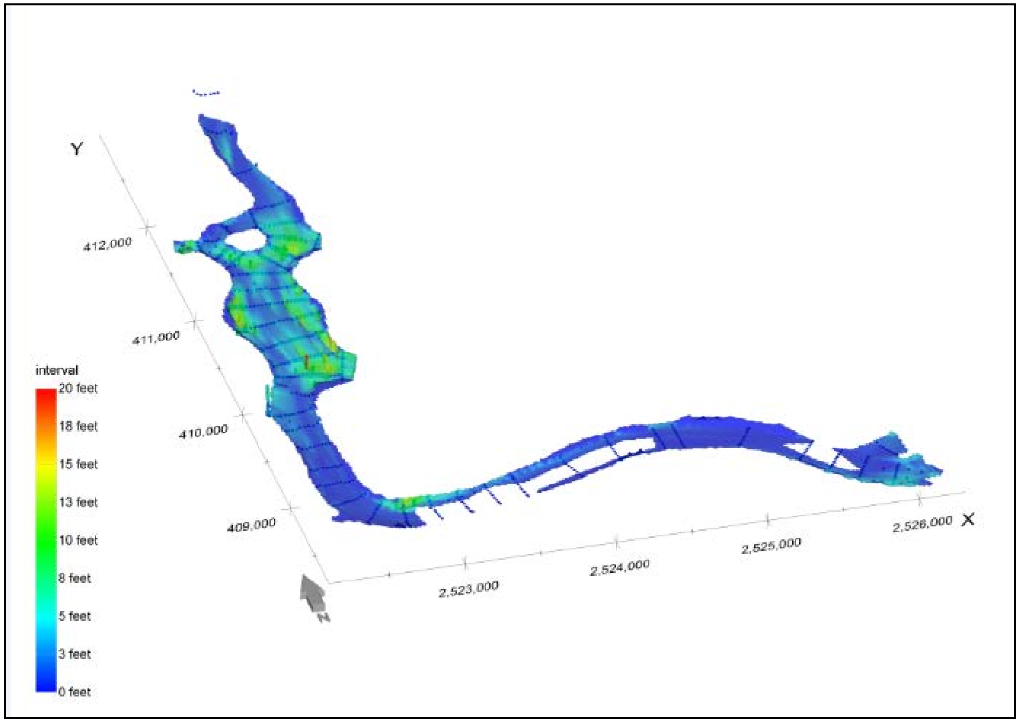
Sediment thickness surveys



- RI surveys (2009) of bathymetry & sediment thickness via hand poling & direct push at 58 transects
- Major storm event in 2010
- For FS, resurveyed bathymetry & thickness for >15% of transects to look for differences; sample PCBs for $\geq$1 foot variance
- RTK DGPS for elevations
- Use of direct push mounted on an amphibious tracked vehicle to measure sediment depth

Total Sediment Volume Estimation

- Compiled transect bathymetry & thickness survey data with shoreline surveys and LIDAR; harmonized datum
- Explored both krigging & linear interpolation; Used linear interpolation between transects
- Adjusted based on sediment surface & refusal for cores
- Found greater thickness due to different methods
- Modeled volume bounded other models
- Some correlation between PCBs & lithology



Approach: Target Volume Modeling

- Target volume forms the basis for remediation and affects other volumes
- Past data provided an initial indication of extent
- Additional field investigation was used to
  - Refine extent of PAHs, PCBs and PCB TSCA volume
  - Search for NAPL
- Challenges to 100% core recovery included areas of cobble/gravel, woody debris behind dam, and sahllow bedrock; handled using contingency

Sediment Coring

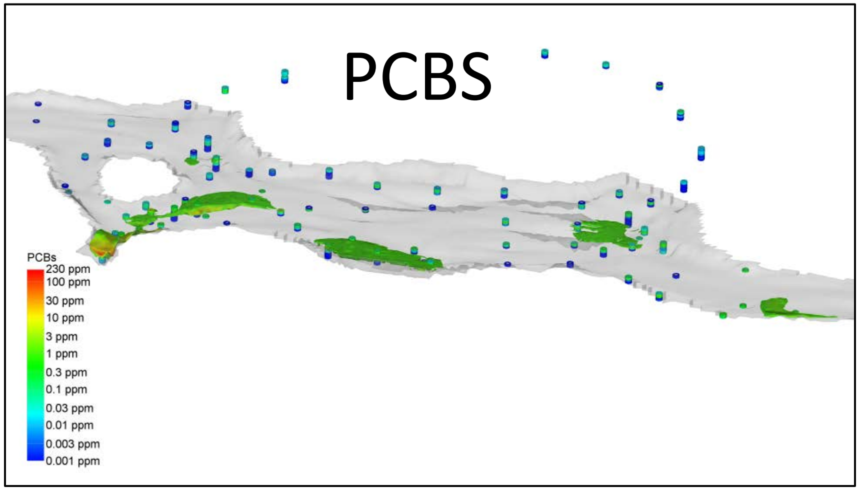
- RI included sampling at over 80 core locations & identified nine PCB deposits
- Pre-FS sampling was designed to
  - Bound PCB deposits using 16 coring locations
  - Examine potential for NAPL & PCBs with 15 coring locations near North Bridge
- Core recoveries typically 80% or greater, but ranged from 60% to 100% dependent on deposit

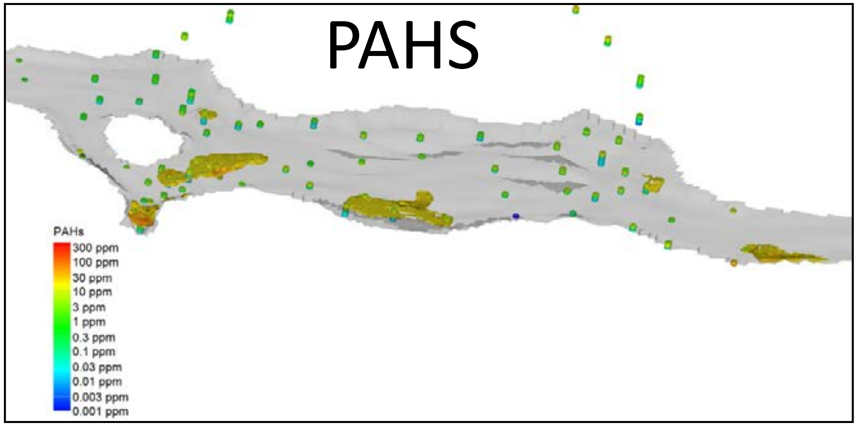
Chemistry & NAPL Surveys

- Collected samples from set intervals & analyzed for PCBs and PAHs
- For NAPL survey areas:
  - Attempted LIF surveys, but poor response of NAPL
  - Instead, collected cores for PID/FID survey and visual survey using Sudan dye testing

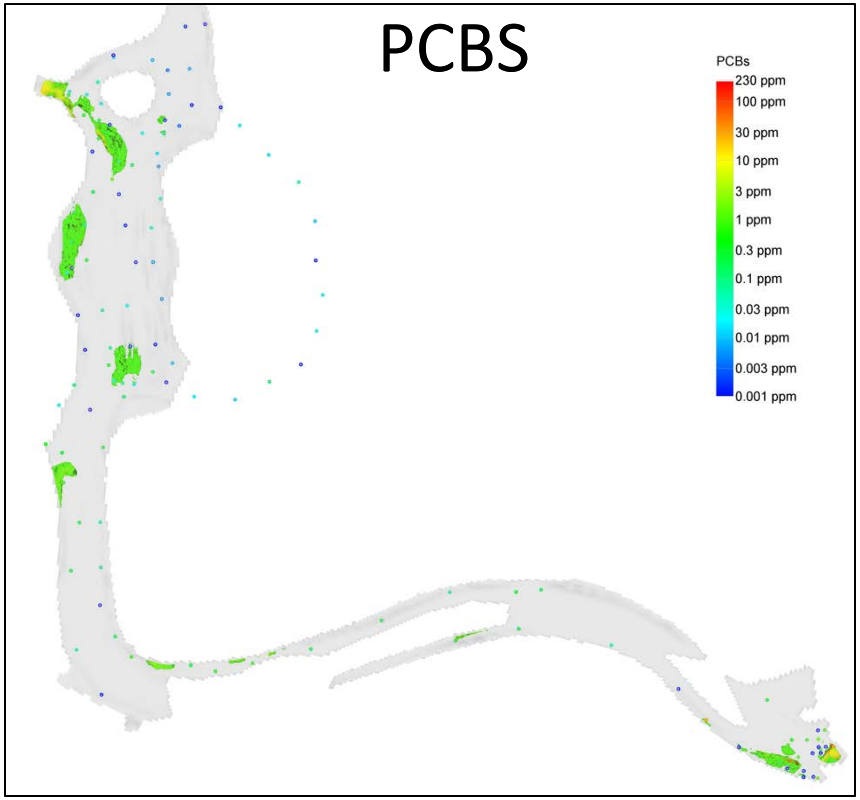
Modeling Target Volumes

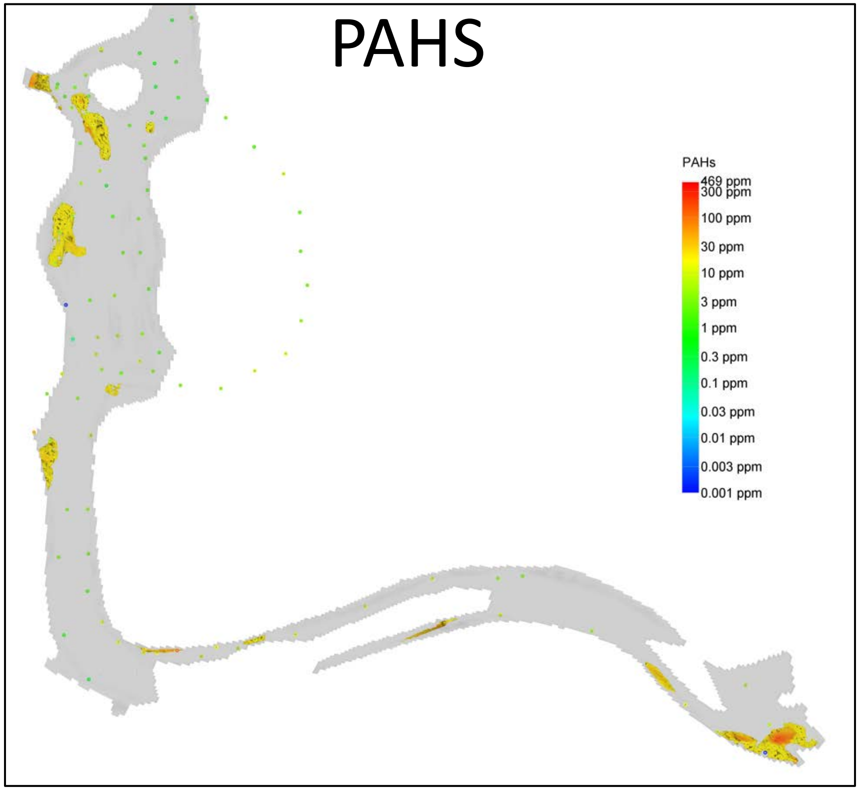
- Used data from past and current efforts; broke down intervals to harmonize between efforts
- Modeled based on recovery
- Created 3-D models using using C-Tech Environmental Visualization System (EVS) Pro Version
- Bounded models by sediment thickness
- Data review indicated horizontal/vertical anisotropy ratio of 100





Combined Volumes for PCBs & PAHs

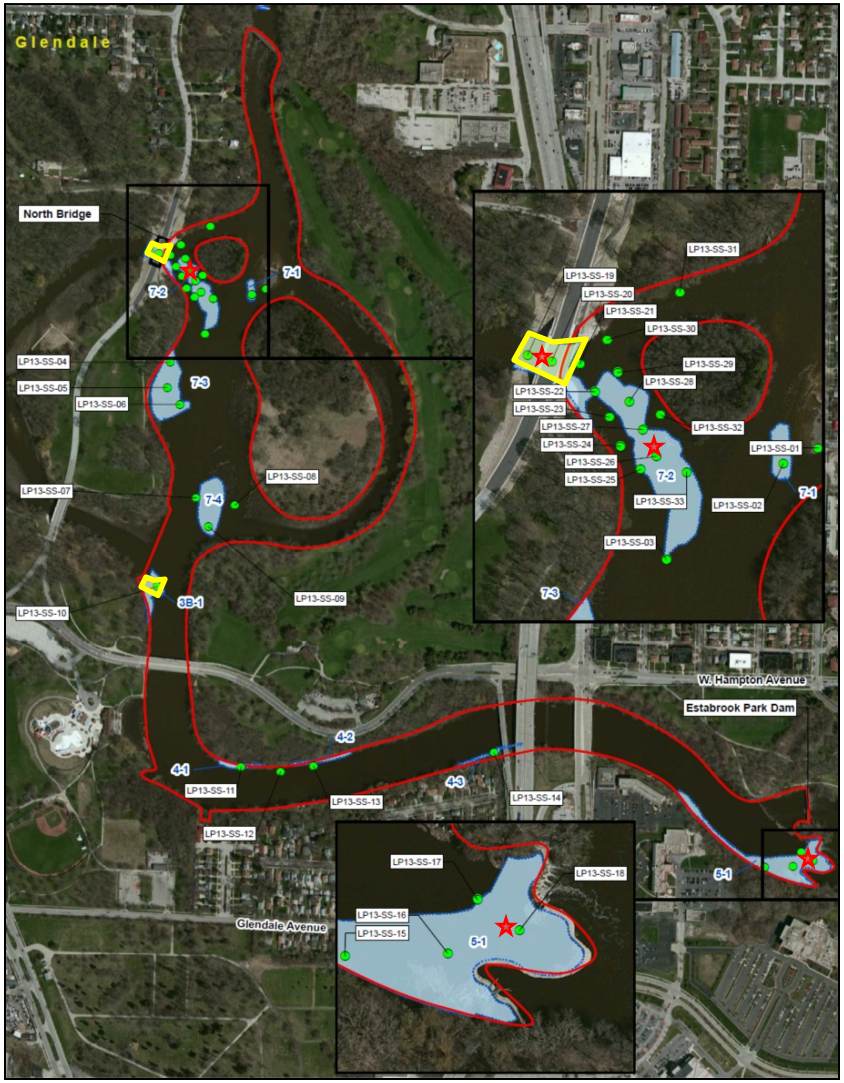




- Areas and volumes for each COC were combined to produce a single target volume

Target Volume Results

- Applied a contingency based on core recovery – source of uncertainty (i.e. Lotter, Merkt & Sturm 1997)
- Increased number of deposits from 9 to 10
- Refined boundaries & volumes
  - Approx. 7,000 CY for non-TSCA
  - Approx. 120 CY for TSCA
- Two areas of NAPL near bridges
- Expanded footprint for TSCA



Approach: Non-Target Volumes

- In the case of Lincoln Park Phase 2, non-target volumes make up a significant portion of total volume
  - Thin layers of target sediments
  - Active area of erosion and deposition
- Explored re-use & segregation
- Coordinated on relationship between TSCA volume & overburden
- Three major components:
  - Overburden – Overburden was modeled using a combination of CAD and MVS
  - Vertical over-dredge – Vertical over-dredge accounted for based on removal technology, with less for dry excavation
  - Horizontal over-dredge, side slopes, and chasing– Based on geotechnical results, assumed 3:1 slopes. Applied a percentage of volume to account for dredge cell geometry, chasing, and minimal slough

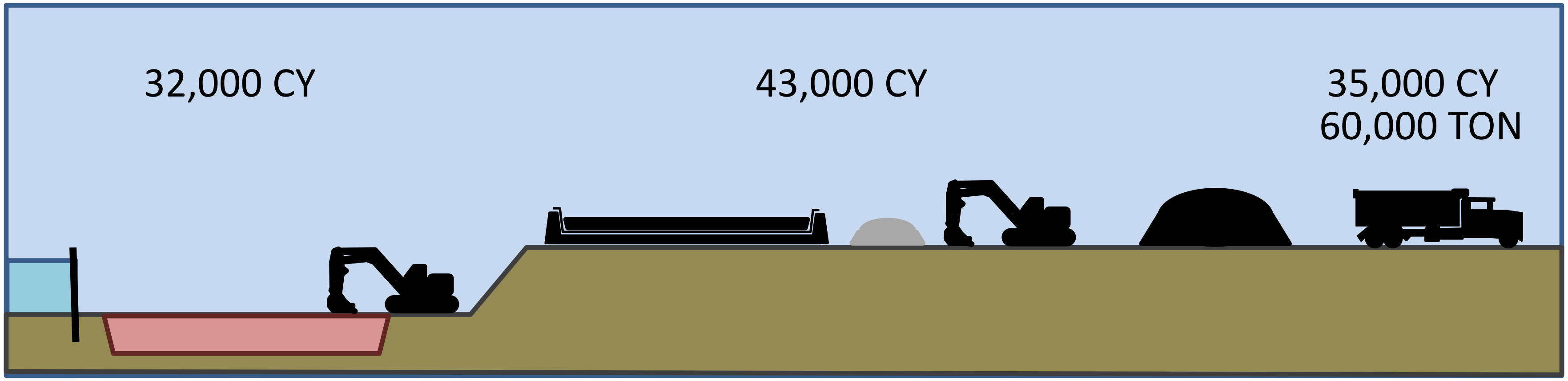
Approach: Disposal Volume & Mass

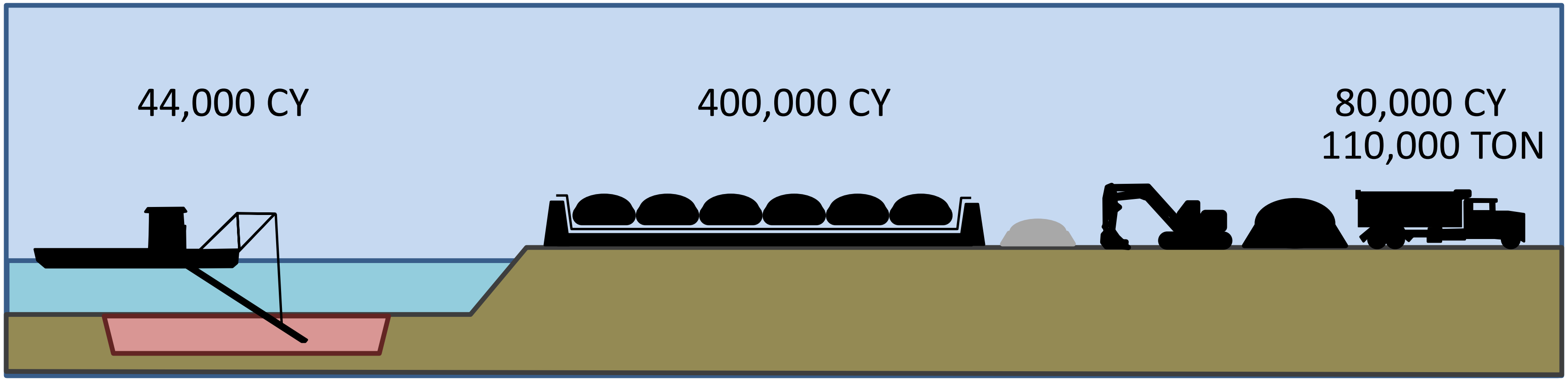
- To estimate handling volume, addition of water via the removal method was considered
  - 10% to 20% water addition assumed for dry excavation; material in situ has high solids content
  - Transition to 8% solids assumed for hydraulic dredging
- Mass balance equations were used to estimate disposal volumes
  - **Inputs:** Bulk density, percent moisture, specific gravity, moisture increase per technology, dewatering efficiency, amendment with Calciment
  - **Outputs:** Disposal volume, disposal mass, volume of water requiring treatment
- Performed field investigation to define geotechnical parameters

Geotechnical Studies

- Collected cores for geotechnical analyses at 10 locations, with at least one in each deposit
- Analyzed grain size, TOC, atterberg limits, compression, consolidation, and paint filter to identify handling characteristics
- Performed bulk density, percent moisture, percent solids to inform mass balance calculations
- Results indicate:
  - Low percent moisture/high percent solids (70%-90% solids in situ)
  - Compacted silty sediments with a few areas of high gravel content

Sediment Mass Balance Evaluation for Alternatives





Results

- Approximately 120 CY TSCA target volume, 325 CY with overburden & over-dredge
- Including recovery contingency, 16,000 CY non-TSCA target with 11,000 CY overburden
- Additional 5,000 CY volume associated with over-dredge/side slopes, geometry
- Dry excavation Handling & Disposal
  - Small increases associated with water & amendment addition
  - Total disposal volume is close to 35,000 CY
- Hydraulic Dredging Handling & Disposal
  - Large increases associated with water content changed from 80-90% to 50-60%
  - Total disposal volume is approximately 80,000 CY
- Mass balance informs disposal volumes as part of FS alternatives:
  - Dry excavation results in the lowest disposal volumes for many deposits
  - Hydraulic dredging provides advantages for access and implementation
- FS selects combined technology remedy using both dry excavation and hydraulic dredging to advantage
- Volumes updated for design

Conclusions

- Total sediment volume estimation
  - Method of measuring sediment thickness matters greatly
  - Can be refined by correlating lithology to contaminated
- Target volume estimation
  - Phased field effort allows identification of data gaps
  - Need to evaluate more than just krigging (i.e. linear interpolation)
  - Harmonization of datums, core elevations, and intervals is key
  - Subtraction of TSCA from non-TSCA volumes requires consideration of geometry
  - Adjust for core recoveries
- Non-target volume estimation
  - Highly dependent on bathymetry and accuracy of target volume estimation
  - Dependent on geotechnical parameters associated with slopes and slough
- Handling & Disposal Volume Estimation
  - Highly dependent on geotechnical parameters and process options