Quarterly Progress Report

June 2025

Project Title

Sediment Mercury Concentrations in the Closed Area of Lavaca Bay and the Risk to Wildlife from Mercury Remobilization During Dredging

Contract # 041

Submitted to

Matagorda Bay Mitigation Trust

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Project Summary

The Closed Area of Lavaca Bay is a mercury (Hg) Superfund site that is undergoing long-term environmental monitoring. The proposed Matagorda ship channel expansion project will dredge in the Closed Area and could remobilize Hg stored in sediment back into the bay. This study will investigate how sediment Hg concentrations vary with depth throughout the proposed dredging area and undertake lab-based toxicity and bioaccumulation experiments to determine whether the Hg-rich sediment is toxic to benthic organisms. Agencies can use the data to make informed decisions about how to dredge and dispose of the Hg-rich sediment to minimize its environmental impact.

Project Goals and Objectives

The goal of this project is to investigate sediment Hg concentrations in the Closed Area of Lavaca Bay (with a focus on the area that will be dredged) and determine whether sediment Hg concentrations are high enough to pose a threat to the health of benthic organisms if Hg is remobilized during the proposed dredging activities. This study can be broken down into six objectives:

Objective 1: Investigate how THg concentrations change with sediment depth to determine 1) at what depth the greatest THg concentrations are found; 2) how thick the Hg layer is; and 3) how THg concentrations vary spatially throughout the Closed Area.

Objective 2: Map the bay floor and investigate the relationship between sediment THg concentrations and sediment characteristics (grain size and organic matter content).

Objective 3: Use radioisotopes (^{210}Pb and ^{137}Cs) to create sediment age-depth profiles and determine sedimentation rates.

Objective 4: Speciate THg in the surface and Hg layer sediment to determine the MeHg concentration and percent MeHg and determine the bacterial composition of the sediment.

Objective 5: Calculate how much Hg could potentially be released into Lavaca Bay from the proposed dredging activities.

Objective 6: Determine whether sediment Hg concentrations are high enough to cause toxicity to benthic organisms (polychaete worms, amphipods, bivalves, gastropods) using laboratory-based toxicity tests and bioaccumulation experiments.

Project Update

This quarter we completed work on Objectives 1, 2, 3, 4, and 6.

Objective 1

All sediment cores for this project have been collected. 32 cores were collected in June 2023 and 28 cores were collected in May 2024 (Fig. 1). All the cores have been sectioned into 1 cm or 2 cm depth intervals and each depth interval has been subsampled for different analyses.

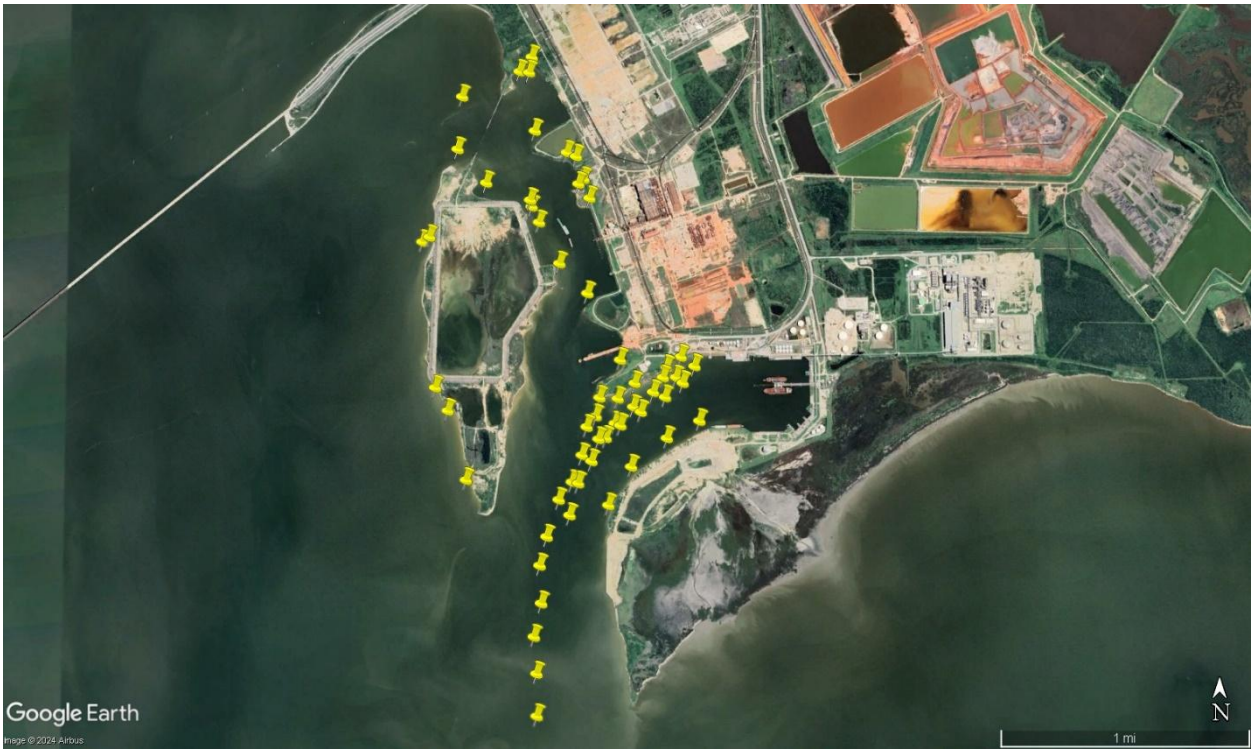

Figure 1. 2023 and 2024 sediment core collection locations. The yellow pins show the location of each core.

Out of the 60 cores, Hg analysis has been completed for 83.3% (n = 50) of them. The breakdown by year is as follows:

2023

- Number of cores subsampled for the different analyses = 32
- Number of cores that have been freeze dried = 28
- Number of cores that have had the Hg concentration measured in each depth interval = 28

2024

- Number of cores subsampled for the different analyses = 28
- Number of cores that have been freeze dried = 22
- Number of cores that have had the Hg concentration measured in each depth interval = 20

The Hg concentration in each sediment sample (190 – 220 mg) was measured using a Direct Mercury Analyzer (DMA-80; Milestone Inc., Shelton, CT) which utilizes thermal decomposition, amalgamation, and atomic absorption spectrophotometry. One set of quality control, including a blank, certified reference material (either MESS-4 marine sediment; PACS-3 marine sediment; DORM-5 fish protein; or ERM CE-464 tuna), and duplicate sample was included with every 10 samples analyzed.

Objective 2

CHIRP profiling and detailed grain size analysis

The two sets of CHIRP profiles that were collected in June 2024 from greater Lavaca Bay and from the Superfund site (Closed Area) in Lavaca Bay (Fig. 2) have undergone basic processing including bandpass filtering, automatic gain control, and preliminary depth conversion.

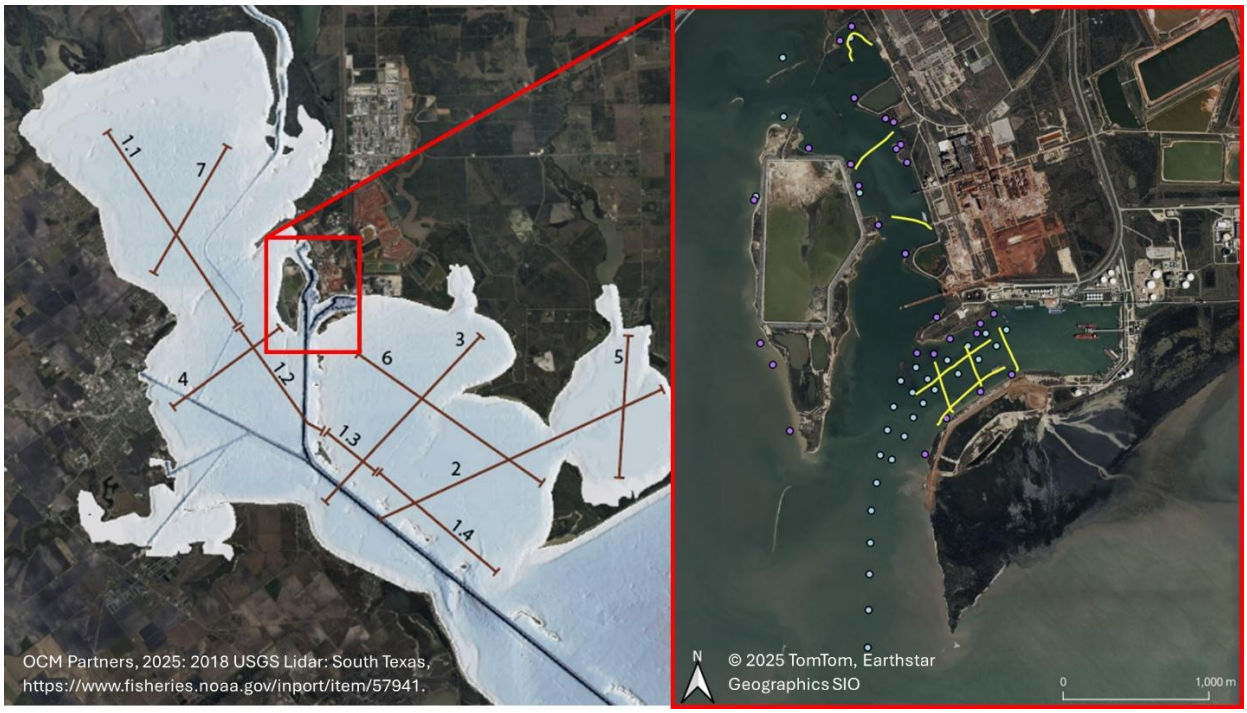

Figure 2. Location of greater Lavaca Bay CHIRP profiles (left) and Closed Area (Superfund site) CHIRP profiles displayed with 2023 core locations in blue and 2024 core locations in purple (right).

Three long profiles (1.1, 1.2, 1.3; Fig. 2) from greater Lavaca Bay have been further refined and corrected, with noise and artifacts processed out, and are ready for formal interpretation. Another six profiles are currently being refined and corrected.

Eight cores have been chosen for more detailed grain size analysis that align well with CHIRP profiles and should assist with regional correlations. Subtle lithologic changes identified by this analysis may help to explain the trends seen in other datasets generated by this study. Five of the cores (1, 4, 6, 14B, 36) have been fully subsampled for analysis by Sedigraph (mud fraction) and detailed sieving (sand fraction) and are now in the preparation stage. Three of these cores (4, 6, 14B) have several samples that are fully prepped and are actively being analyzed on the Sedigraph, and one core (14B) has begun detailed sieve analysis.

Grain size analysis

To date, basic grain size analysis (coarse vs fine fraction) has been completed for 26 cores collected in 2023 and 22 cores collected in 2024.

Basic grain size analysis was completed by washing sediment through a 63 µm mesh sieve to determine the percent coarse (sand and larger sized particles) versus fine (silt and clay sized particles). Between 5 and 5.5 g of dried sediment was rehydrated for 24 hours and washed through a 63 µm mesh sieve, after which the retained coarse fraction was dried at 105°C for 18 to 24 hours and weighed. Samples that had particles > 2 mm (e.g., gravel, small shells, or shell fragments) were passed through a 2 mm mesh sieve and the sediment retained in the mesh weighed. The weight of the coarse fraction (< 2mm) was then divided by the weight of the bulk sediment prior to rehydration to determine the percent coarse fraction. The percentage difference between the coarse fraction and 100 was the percent fine grain sediment. Quality control included a duplicate sample for one depth interval in each core.

Organic matter content

To date, organic matter content has been determined for 26 cores collected in 2023 and 20 cores collected in 2024.

The organic matter content in each depth interval from each core is determined using the loss-on-ignition (LOI) method. Freeze dried sediment is heated in an oven at 105°C for 1 hour to make sure there is no residual moisture. 3 – 3.5 g of weighed sediment is then burned in a muffle furnace at 550°C for 4 hours and allowed to cool overnight, after which it is weighed again. The percent organic matter content is then calculated using the following equation:

$$\% \text{ organic matter content} = [(\text{weight}_{105} - \text{weight}_{550})/\text{weight}_{105}] * 100$$

where weight_{105} is the sample weight prior to burning and weight_{550} is the sample weight after burning. Quality control included a duplicate sample for two depth intervals in each core.

Objective 3

All depth intervals from two cores (16, 25) were shipped to the Science Museum of Minnesota for ^{210}Pb and ^{137}Cs dating in April 2025. Prior to shipment, the salt was removed from all samples, and the samples were freeze dried, powdered, and packaged into individual tubes. They are currently in the queue for analysis. Two other cores (4, 5) are currently being prepared for shipment in July 2025.

Objective 4

Sediment microbial community

The sediment microbial composition is being investigated in 10 cores collected in 2023. For each core, depending on the thickness of the Hg layer, between five and 11 different depths have been investigated. In total, 68 samples have been included in the study and each sample has been analyzed twice. The forward and reverse primer sequence data has been collected, and data analysis is ongoing.

Mercury speciation to determine percent methylmercury in the sediment

43 of the samples used to determine the sediment microbial community composition have been shipped to the USGS Mercury Research Lab in Madison, WI to determine the methylmercury (MeHg) concentration. The MeHg analysis should be completed early fall 2025.

Objective 6

Now that the Hg concentrations have been measured in most of the cores, PI Dutton's group have started planning the laboratory-based toxicity tests and bioaccumulation experiments. The sediment toxicity tests using the benthic amphipod *Leptocheirus plumulosus* are scheduled to begin in July 2025.

Goals for the Next Quarter

- Continue to measure the Hg concentration in the remaining sediment cores (Objective 1)
- Complete the processing of the CHIRP data and collection of the detailed grain size measurements (Objective 2)
- Continue the grain size analysis and organic matter content analysis (Objective 2)
- Prepare and ship at least two more cores for ^{210}Pb and ^{137}Cs dating (Objective 3)
- Finish the sediment microbial community analysis (Objective 4)
- Complete the MeHg analysis (Objective 4)
- Start the sediment toxicity tests (Objective 6)