



### Project Background

Mackworth designed a turbidity containment and fish exclusion barrier as an alternative to a temporary sheet pile cofferdam as part of a shoreline remediation project in Portland, Maine. The remediation took place in Portland Harbor along a selection of the Fore River and included installation of an impermeable bulkhead to contain a seep area, excavation, and stabilization of impacted soil and sediment (Figure 1).

An important aspect of design for any type of aquatic barrier is to calculate the loads on various segments of the barrier, and then to absorb those loads with various anchoring methods. Load calculations for this site were based on the tidal prism at the enclosure for each tidal cycle and the ambient current at that point in the harbor. The in-and-out flow of the tidal prism induces head loss across the filter fabric, which in turn produces load on the system. The ambient current produces drag forces which add to the load. At the Portland site, the two sources of load (additive) were comparable in magnitude. Primary considerations and challenges for the design of the Fore River barrier and anchoring system were:

- Adequate barrier structural strength to withstand high loading from currents and tides plus passage nearby of tankers and tugs
- Durability to withstand these forces for up to 6 months or longer
- Establishment and maintenance of a bottom seal, seal to the shoreline rock wall, Flotation to prevent overtopping under loading and with waves and wakes so that sediments and contaminants are contained, and winter flounder are excluded
- Effective filtering capacity
- Passage of the barrier alignment through / under an old pier system.



Figure 1. Portland Harbor, Maine. The system contains sediments, associated contaminants, and excludes fish and marine mammals, while allowing water passage.

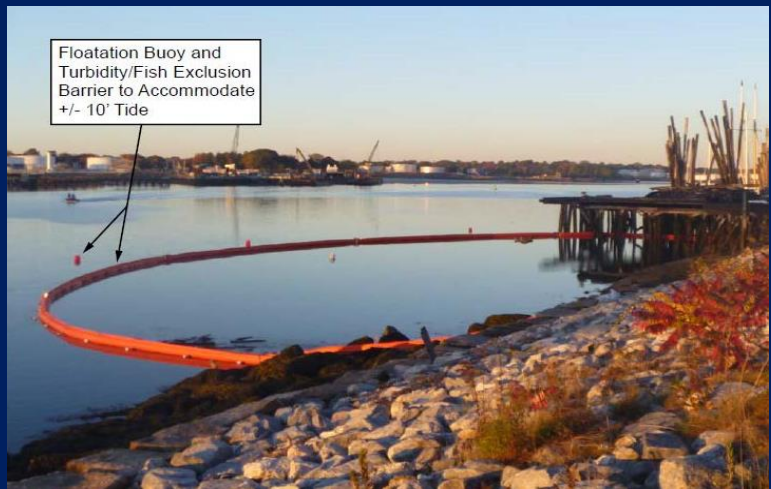


Figure 2. Close up view of the turbidity and fish exclusion system

**Design and Performance**

The design process included a bottom structural survey of the anticipated barrier alignment area as well as loading calculations to address barrier structure and anchoring requirements. The barrier was constructed of three layers. Two outer layers were designed for strength and durability, and an inner layer that worked as the primary filtration of fine sediments (Figure 3). Flotation consisted of 2 lb (0.9 kg) density polystyrene billets, 16 in (40.6 cm) in diameter. Anchoring consisted of helical anchors along the outer perimeter of the barrier. These anchors were selected due to their superior holding power and low profile to the river bottom. The bottom seal was achieved by incorporating an impermeable “T” bottom skirt with the outer skirt twice the length of the inner skirt. This design allowed sealing during various flow directions. At the end of each skirt a 1/2 in (1.3 cm) ballast chain was installed to ensure the skirt maintained contact with the bottom. The barrier was attached and sealed to the shoreline using a custom vertical T-shaped impermeable piece. The T-piece was connected to the seawall granite blocks with a combination of 5/8 in (1.6 cm) eye bolts which were epoxied into the blocks and ballast chain. A sorbent boom was installed from shore to shore inside of this turbidity/fish exclusion barrier.

Operational challenges included substantial forces from tanker and tugboat traffic, river currents, and severe tidal fluctuations. The passage of one tanker at a speed exceeding what was standard for the reach (as evidenced by extensive damage from its passage to a nearby marina dock) pulled a large seawall rock from the seawall along with an end of the barrier a few feet into the river. This rock was replaced, and a daisy chain set of onshore helical anchors set up in the event such an event occurred. Also, a particularly high tide accompanied by onshore winds led to passage of water above the height of the rock wall. To avoid the possibility that a recurrence might result in an open flow of water during operations, an additional custom termination piece was added and bolted into the section terminating at the wall.

Subsequent inspections, including periodic dive inspections confirmed that the containment barrier stayed intact throughout the operations. The turbidity / fish exclusion barrier met all requested objectives, including: 1) prevention of winter flounder or other fish from entering into the remedial construction zone thus providing partial relief from time-of-year restrictions due to spawning; 2) protecting the Fore River waterway from contamination; and 3) providing a substantial cost savings over sediment excavation behind a temporary cofferdam. No exceedances, violations or breaches in the integrity of the barrier occurred after the early replacement and re-securing to the shoreline.

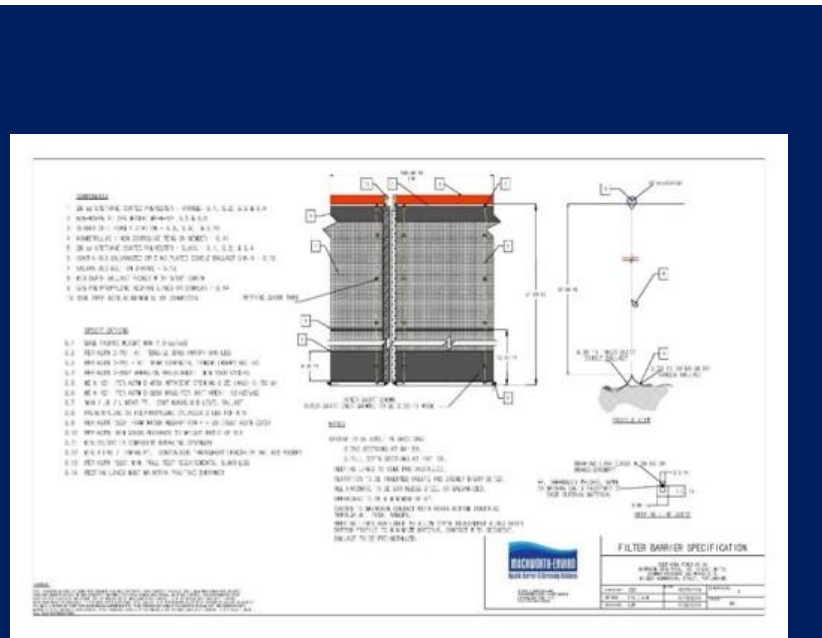


Figure 3. Filter barrier specification drawing

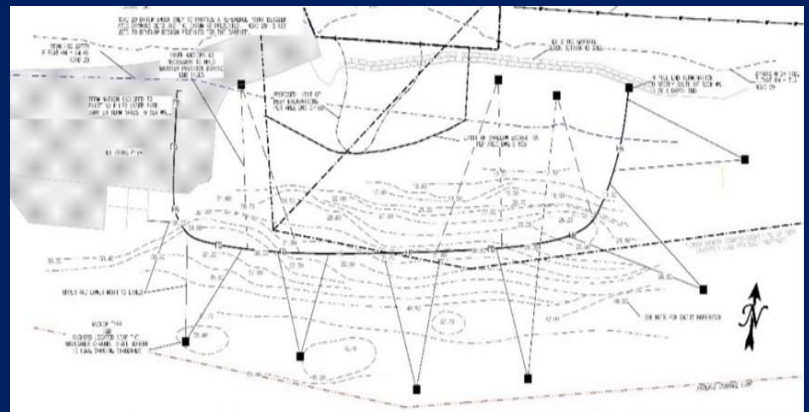


Figure 4. Drawing of system with anchor lines

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