Developing and Implementing A Best Available Technology (BAT) For In-Water Hull Cleaning For California Waters

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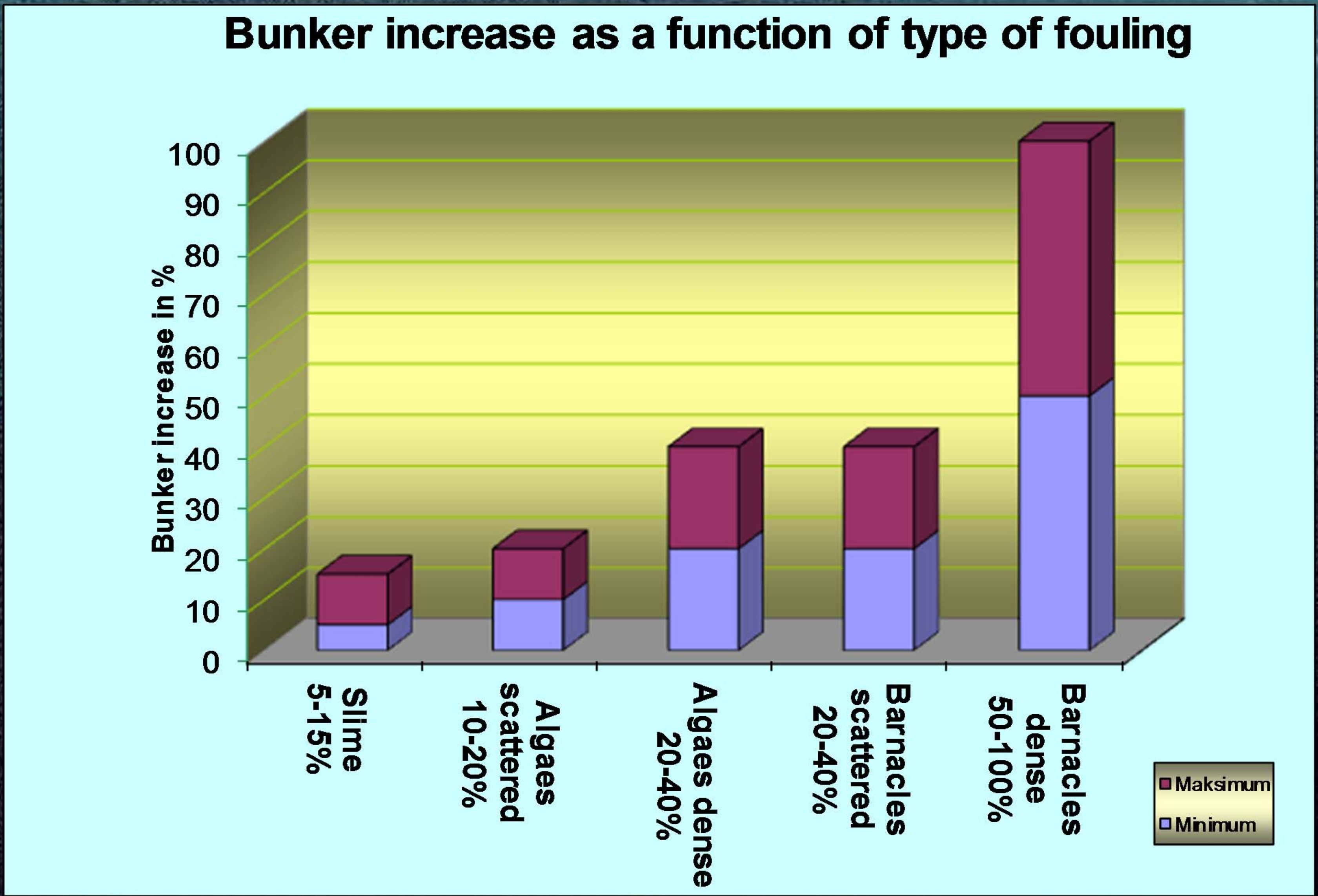
Why Do We Clean Hulls?

- Minimize Operating Cost (Fuel Use)
- Minimize Invasive Species
- Minimize Exhaust Emissions
- Safety (Under Water Hull Inspections)

Fuel Consumption Hull Fouling



Federal Law

- Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 as amended by the National Invasive Species Act of 1996
  - Remove fouling organisms from hull, piping, and tanks on a regular basis and dispose of any removed substances in accordance with local, state, and federal regulations

Federal Law (VGP)

2.2.23 Underwater Ship Husbandry Discharges

- Vessel owner/operators must minimize the transport of attached living organisms when they travel into U.S. waters from outside the U.S. economic zone or when traveling between COTP zones.

- Whenever possible, rigorous hull-cleaning activities should take place in dry-dock, or another land-based facility where the removal of fouling organisms or spent antifouling coatings paint can be contained. If water-pressure based systems are used to clean the hull and remove old paint, use facilities which treat the wash water prior to discharge to remove the antifouling compound(s) and fouling growth from the wash water.

- Vessel owner/operators who remove fouling organisms from hulls while the vessel is waterborne must employ methods that minimize the discharge of fouling organisms and antifouling hull coatings. These shall include:

- Selection of appropriate cleaning brush or sponge rigidity to minimize removal of antifouling coatings and biocide releases into the water column.

- Limiting use of hard brushes and surfaces to the removal of hard growth.

Federal Law (VGP)

- When available and feasible, use of vacuum control technologies to minimize the release or dispersion of antifouling hull coatings and fouling organisms into the water column.

- Vessel owner/operators must minimize the release of copper based anti-foulant paint into the water column when they clean their vessel. Cleaning of copper based anti-foulant paints must not result in any visible cloud or plume of paint in the water: if a visible cloud or plume of paint develops, shift to a softer brush or less abrasive cleaning technique. A plume or cloud of paint can be noted by the presence of discoloration or other visible indication that is distinguishable from hull growth or sediment removal. Production of a plume or cloud of sediment or hull growth is normal in some cases during vessel hull cleaning, but this plume or cloud should be substantially paint free (e.g. paint should not be clearly identifiable in the plume or cloud).

- Vessels that use copper based anti-fouling paint must not clean the hull in copper impaired waters within the first 365 days after paint application unless there is a significant visible indication of hull fouling.

Federal Law (VGP)

- CWA Vessel General Permit
  - Vessel discharges must be in accordance with the requirements of PRC section 72400 et seq. None of the 26 discharges covered by the VGP may contain hazardous waste as defined under California law, as well as hazardous substances listed in List of Chemical Names and Common Names for Hazardous Wastes and Hazardous Materials, Title 22, Chapter 11, Appendix X, California Code of Regulations
  - Vessel discharges must comply with California State Lands Commission (SLC) requirements for ballast water discharges and hull fouling to control and prevent the introduction of nonindigenous species, found in PRC section 71200 et seq. and in the CCR sections 2270 through 2291 (California State Lands Commission's Ballast Water Performance Standards).
  - Propeller cleaning is allowed until January 1, 2012, after which, propeller cleaning is allowed as specified in regulations adopted by SLC. All other in-water hull cleaning is prohibited unless conducted using the best available technologies economically feasible, as determined by both SLC and the State Water Board. This prohibition includes underwater ship husbandry discharges (Discharge #25).

California Law

- CALIFORNIA COSTAL ACT - PUBLIC RESOURCES CODE – DIVISION 20.
- CALIFORNIA CODES PUBLIC RESOURCES CODE SECTION 71200-71202.
- CALIFORNIA CODES PUBLIC RESOURCES CODE SECTION 71203-71210.5.
- CALIFORNIA CODES PUBLIC RESOURCES CODE SECTION 72400-72401.
- CCR Title 2, Div. 3, Ch.1, Articles 4.5 thru 4.7.

California Waters

- California’s position is to require vessels entering its waters to have clean hulls
- Just don’t clean them in our back yard (NIMBY)
- This is a problem because
  - Regular scheduled traffic can be inspected and cleaned here before it becomes a problem, or vessels can be cleaned at next port before re-entry
  - Many US vessels are in a static condition here in CA waters and then must depart for other ports and require hull cleaning before departure

Hull Cleaning in California Waters

- Better equipment and technologies to clean hulls
  - How does the state motivate this capital expenditure?
- Coatings that have been approved for cleaning with existing technologies
  - How can the state accomplish such approvals?

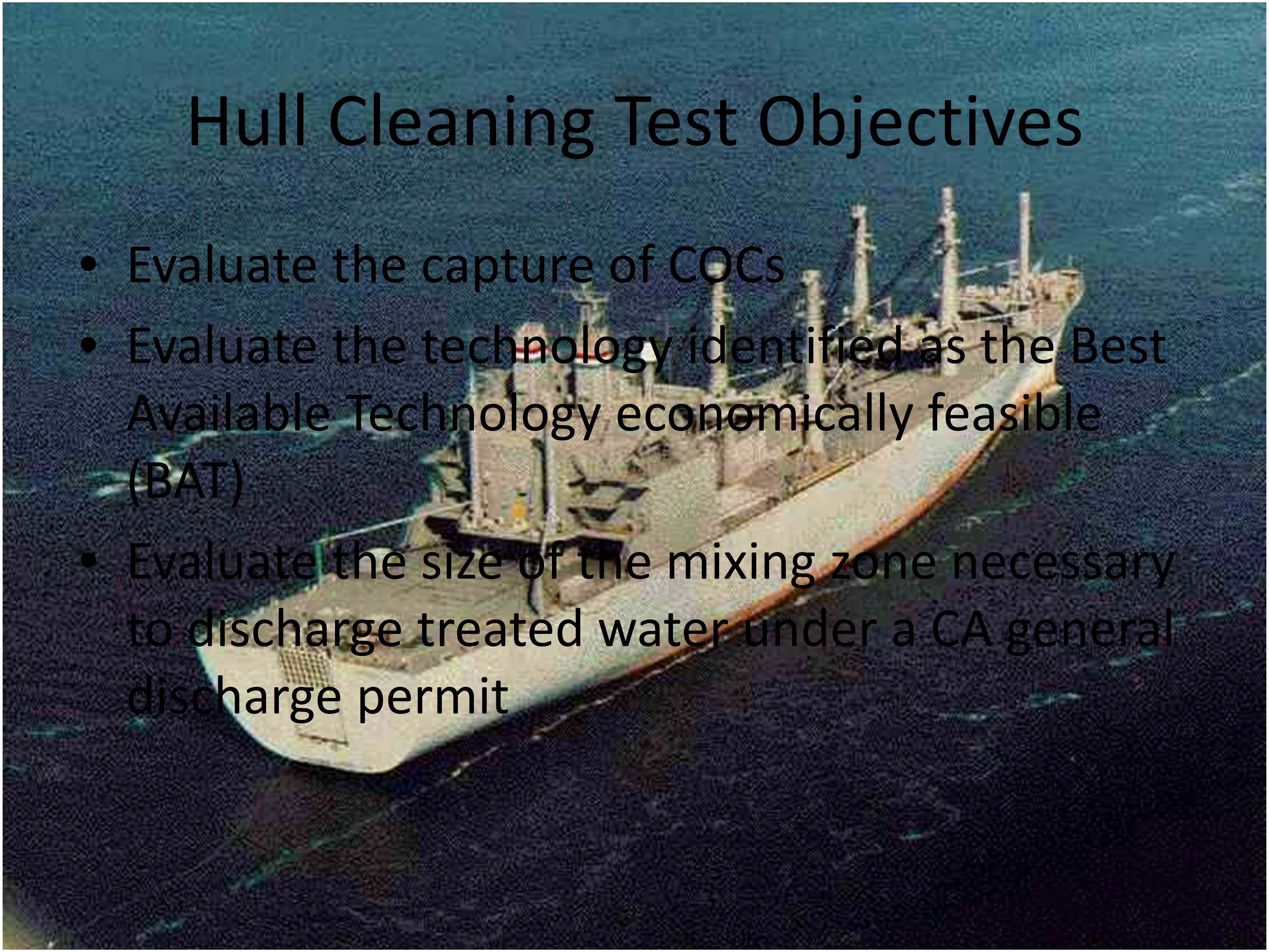
Current Methodologies For Hull Cleaning

- Scamping by metal or nylon brush (direct discharge)
- Scamping by metal or nylon brush (capture system)
- Scamping by metal or nylon brush (capture system and particulate filter)
- Scamping by metal or nylon brush (capture system, particulate filter and heavy metal filter)
- Thermal shock
- Water jetting (capture system and particulate filter)

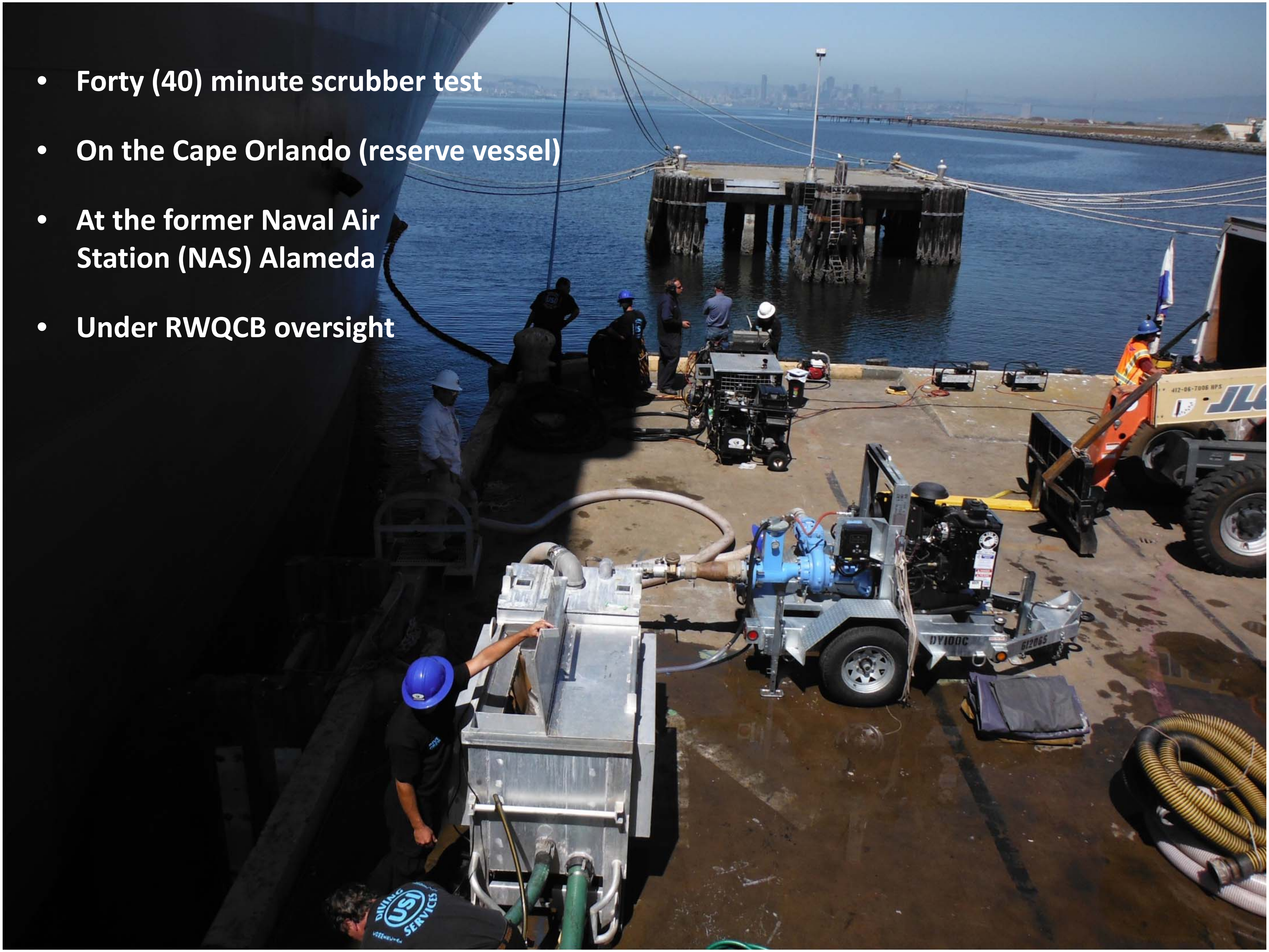
Water Jet System

Hull Cleaning Test Objectives

- Evaluate the capture of COCs
- Evaluate the technology identified as the Best Available Technology economically feasible (BAT)
- Evaluate the size of the mixing zone necessary to discharge treated water under a CA general discharge permit

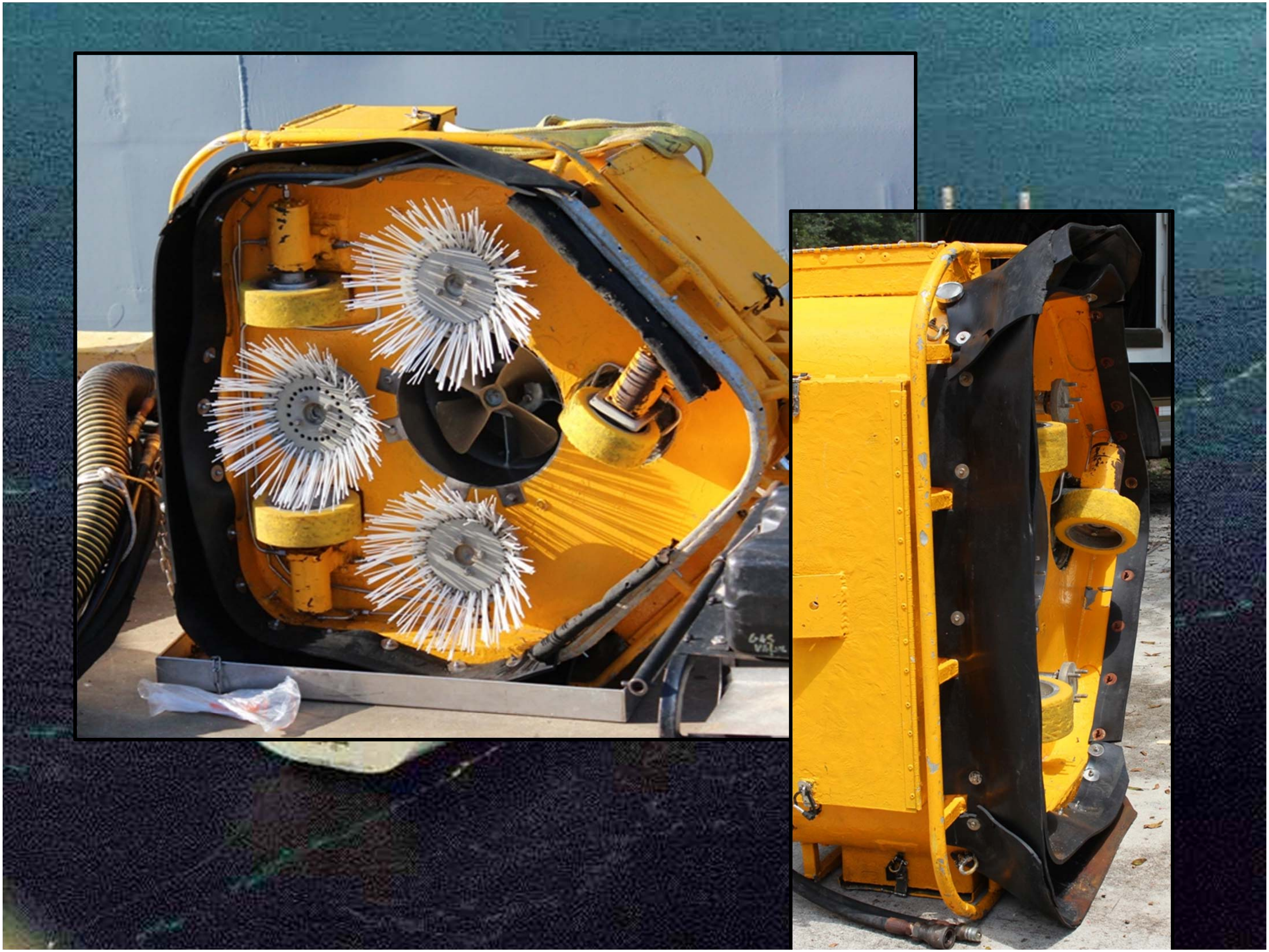


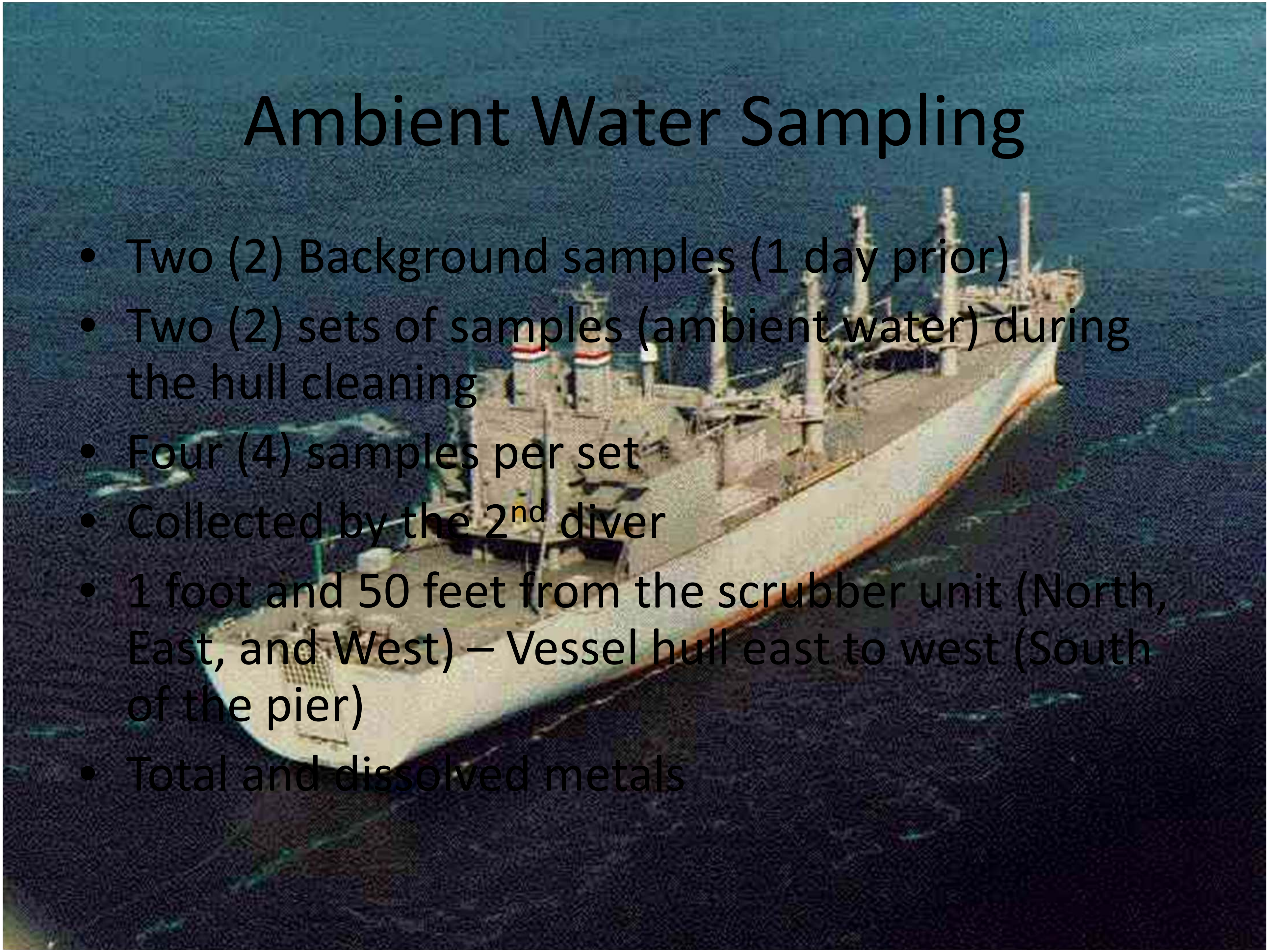
- Forty (40) minute scrubber test
- On the Cape Orlando (reserve vessel)
- At the former Naval Air Station (NAS) Alameda
- Under RWQCB oversight



In-Water Hull Cleaning Scrubber Unit

- 5’ by 5’ hydraulically controlled unit
- Operated by a diver
- Three (3) rotating brushes (polypropylene bristles)
- Bristles set at 30 degrees
- Rubber edging creates seal to the hull
- Brushes operate independently from wheels
- Propeller provides suction to the hull
- Discharge of removed material in process water





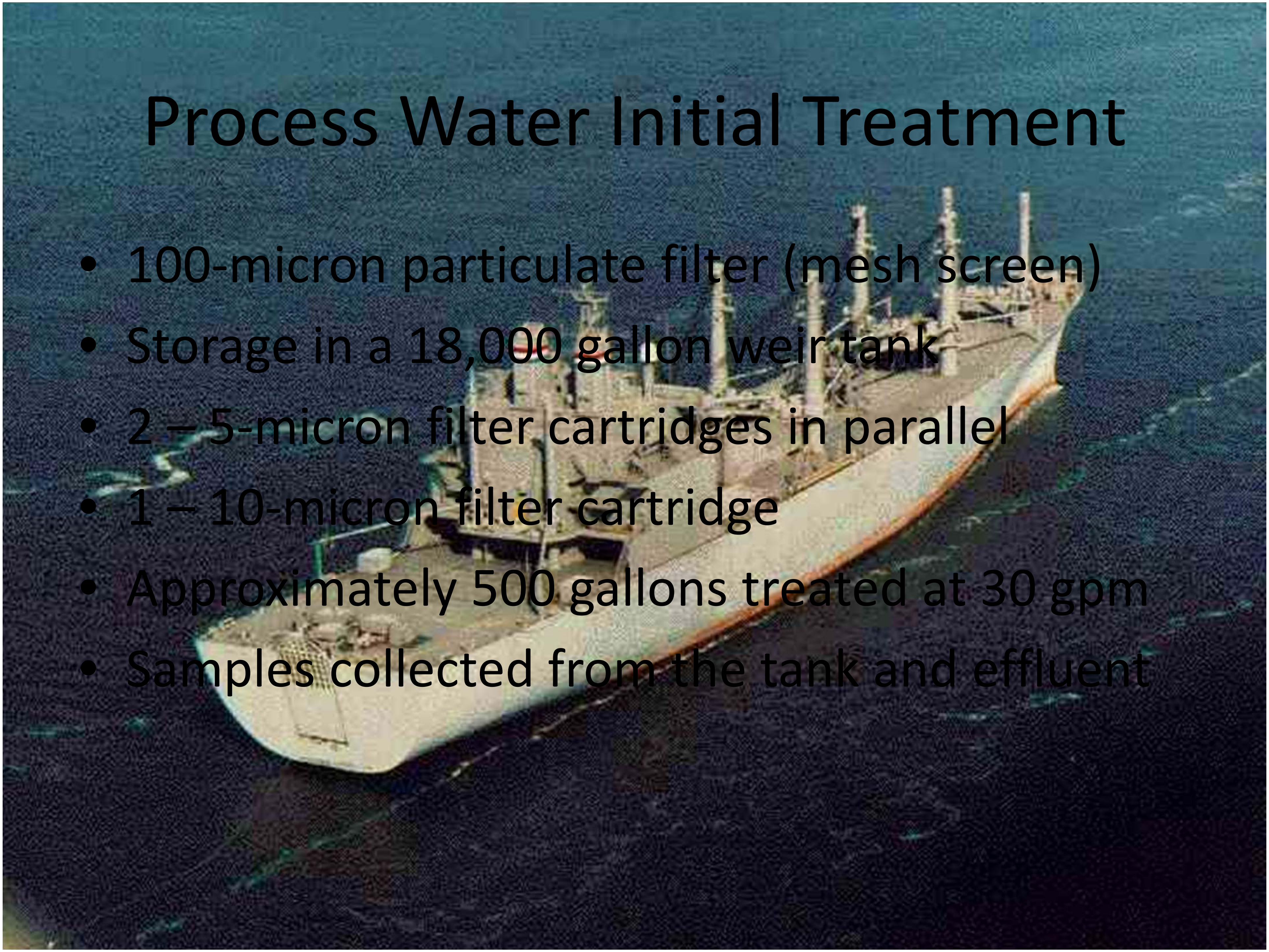
Ambient Water Sampling

- Two (2) Background samples (1 day prior)
- Two (2) sets of samples (ambient water) during the hull cleaning
- Four (4) samples per set
- Collected by the 2nd diver
- 1 foot and 50 feet from the scrubber unit (North, East, and West) – Vessel hull east to west (South of the pier)
- Total and dissolved metals

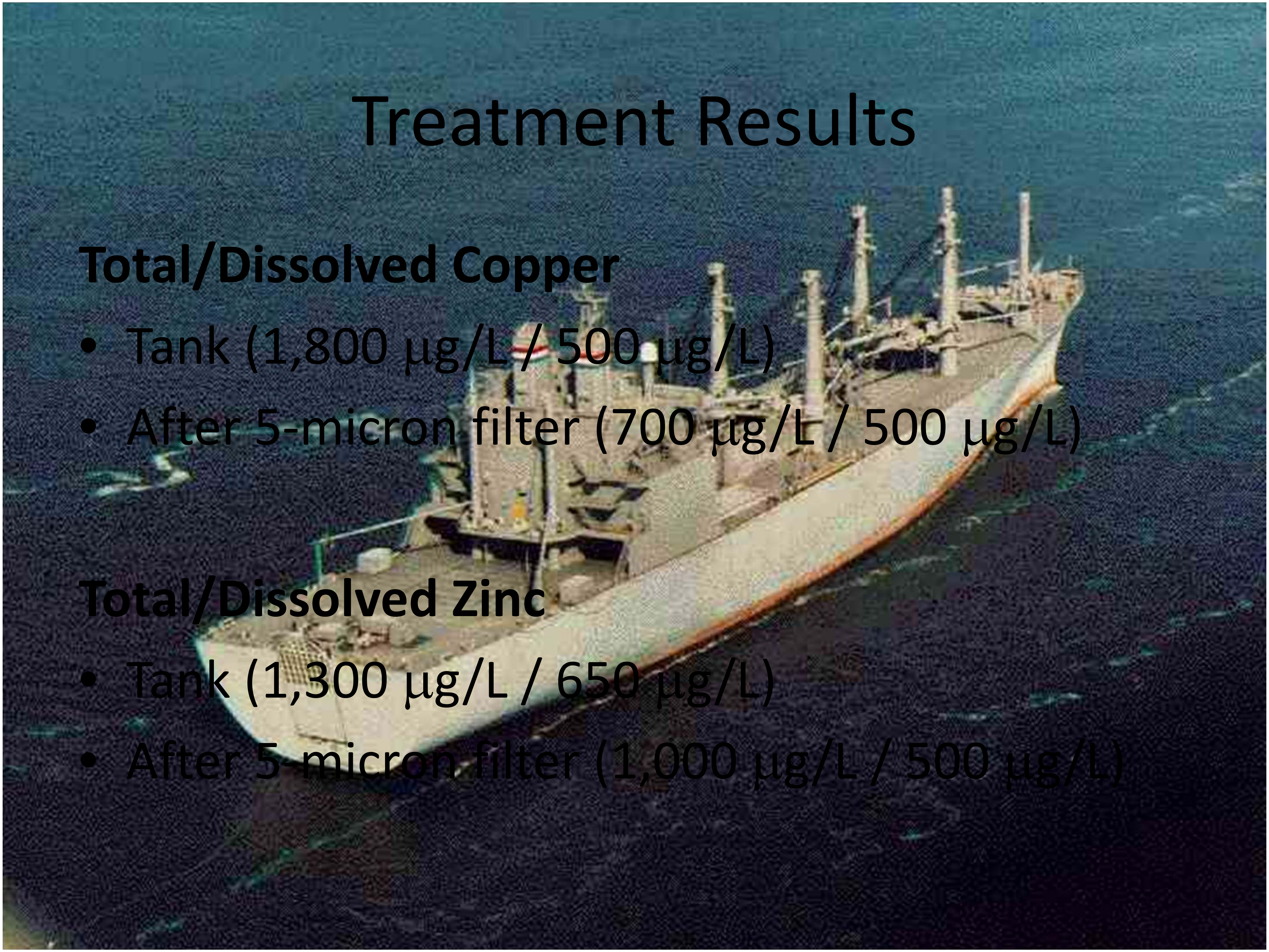
Process Water Capture

- Suction line connected to outlet
- Centrifugal pump on the pier conveys water to the treatment system
- Pumped at 400 gpm
- Storage in a 18,000 gallon weir tank

Process Water Initial Treatment



- 100-micron particulate filter (mesh screen)
- Storage in a 18,000 gallon weir tank
- 2 – 5-micron filter cartridges in parallel
- 1 – 10-micron filter cartridge
- Approximately 500 gallons treated at 30 gpm
- Samples collected from the tank and effluent



Treatment Results

Total/Dissolved Copper

- Tank (1,800 µg/L / 500 µg/L)
- After 5-micron filter (700 µg/L / 500 µg/L)

Total/Dissolved Zinc

- Tank (1,300 µg/L / 650 µg/L)
- After 5-micron filter (1,000 µg/L / 500 µg/L)

Metals Removal Technology Considered

- **<u>Resins</u>** – 3x to 4x more expensive than organo-clay, unknown reaction in seawater
- **<u>Organo-clay</u>** – commercially available, unknown in seawater, relatively inexpensive, can operate at the design flow rates
- **<u>Reverse osmosis</u>** – expensive, have concentrated reject water
- **<u>Electrocoagulation</u>** – very expensive for design flow rates, power requirements
- **<u>Chemical precipitation</u>** – inexpensive, space constraints, length of reactions, other constituents

Process Water Additional Treatment

- Added a pressure vessel with 2,000 pounds of organo-clay
- Approximately 750 gallons treated @ 25 gpm
- Samples collected from the influent and effluent to the pressure vessel

Before Treatment

After Treatment

Treatment Results

After First Pass

- Dissolved copper = 200 µg/L
- Dissolved zinc = 700 µg/L

After Second Pass

- Dissolved copper = 100 µg/L
- Dissolved zinc = 600 µg/L

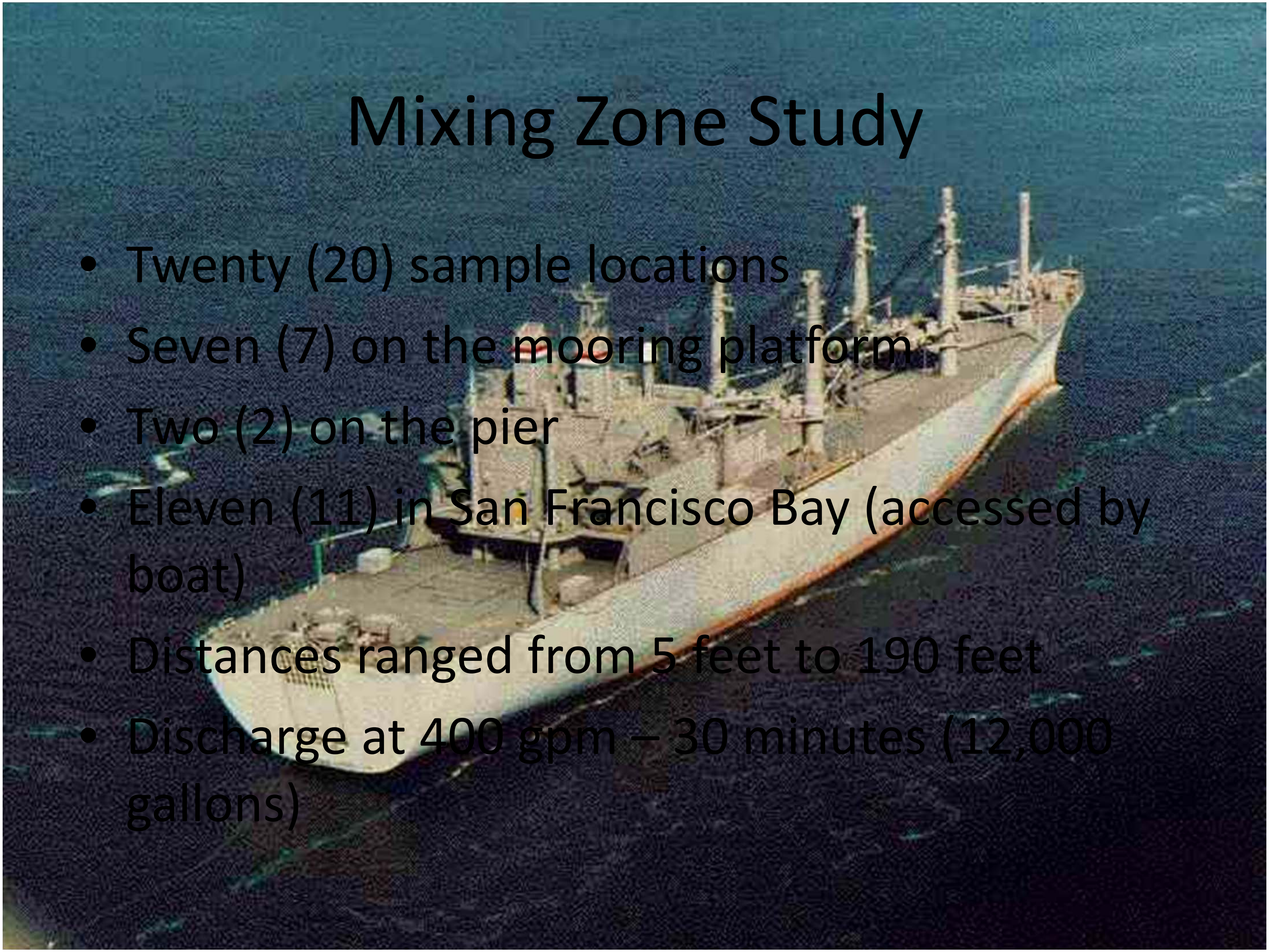
Basin Plan Receiving Water Limits

- Dissolved Copper 9.4 µg/L
- Dissolved Zinc 90 µg/L

Needed to Use a Mixing Zone or Dilution Credit to Attain Receiving Water Limits

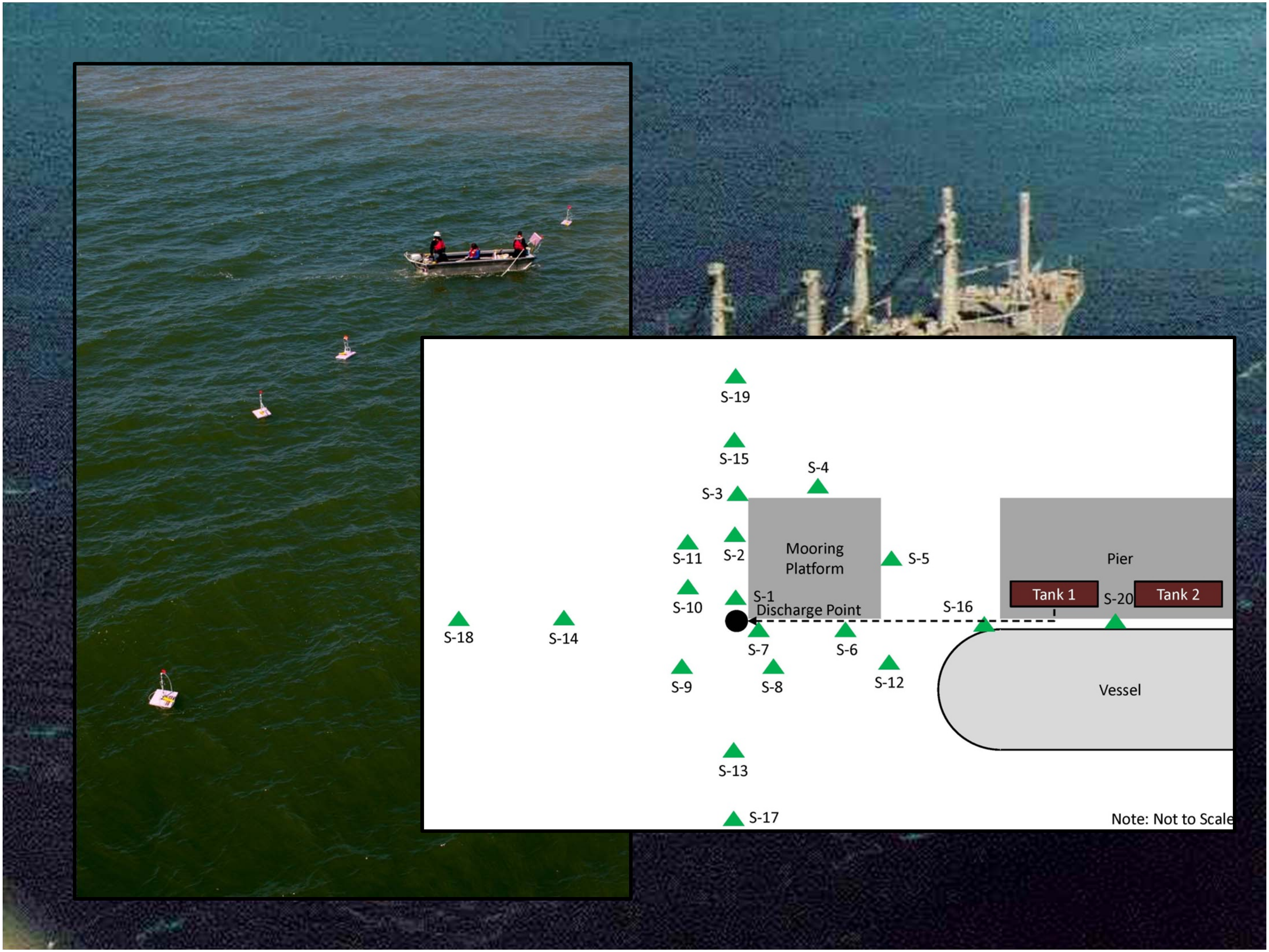
Treatment

- 12,000 gallons at 50 gpm from Tank 1
- Through two (2) 10-micron filter cartridges in parallel
- One (1) 5-micron filter cartridge
- Pressure vessel with 2,000 pounds of organo-clay
- Into Tank 2, Tank 1 cleaned
- 12,000 gallons at 50 gpm from Tank 2 through pressure vessel into Tank 1



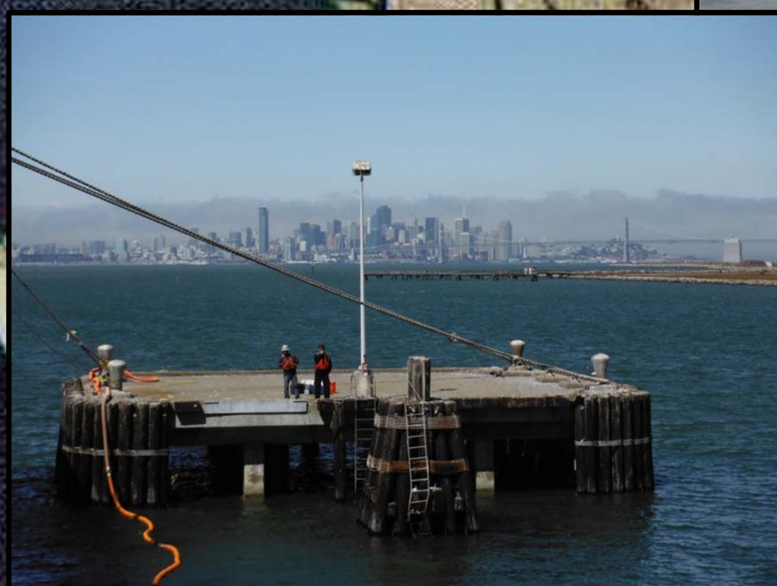
Mixing Zone Study

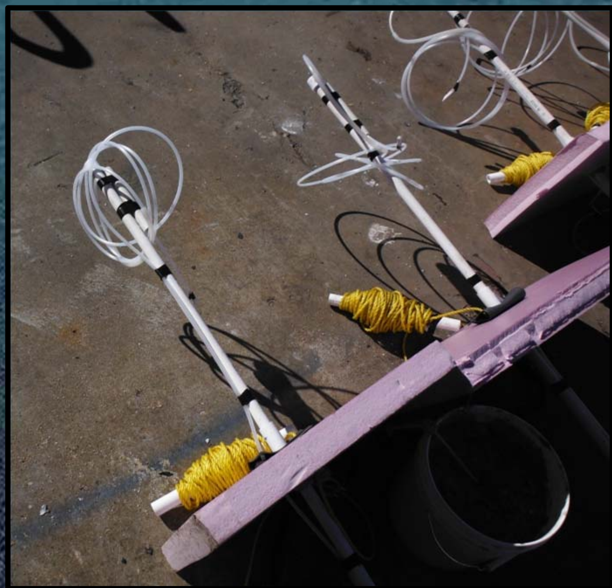
- Twenty (20) sample locations
- Seven (7) on the mooring platform
- Two (2) on the pier
- Eleven (11) in San Francisco Bay (accessed by boat)
- Distances ranged from 5 feet to 190 feet
- Discharge at 400 gpm – 30 minutes (12,000 gallons)


S-19
S-15
S-4
S-3
S-2
S-11
Mooring Platform
S-5
Pier
S-10
S-1
Discharge Point
S-16
Tank 1
S-20
Tank 2
S-18
S-14
S-7
S-6
S-9
S-8
S-12
Vessel
S-13
S-17
Note: Not to Scale

Discharge of Treated Water

- At 400 gpm
- Ten (10) feet below the water surface



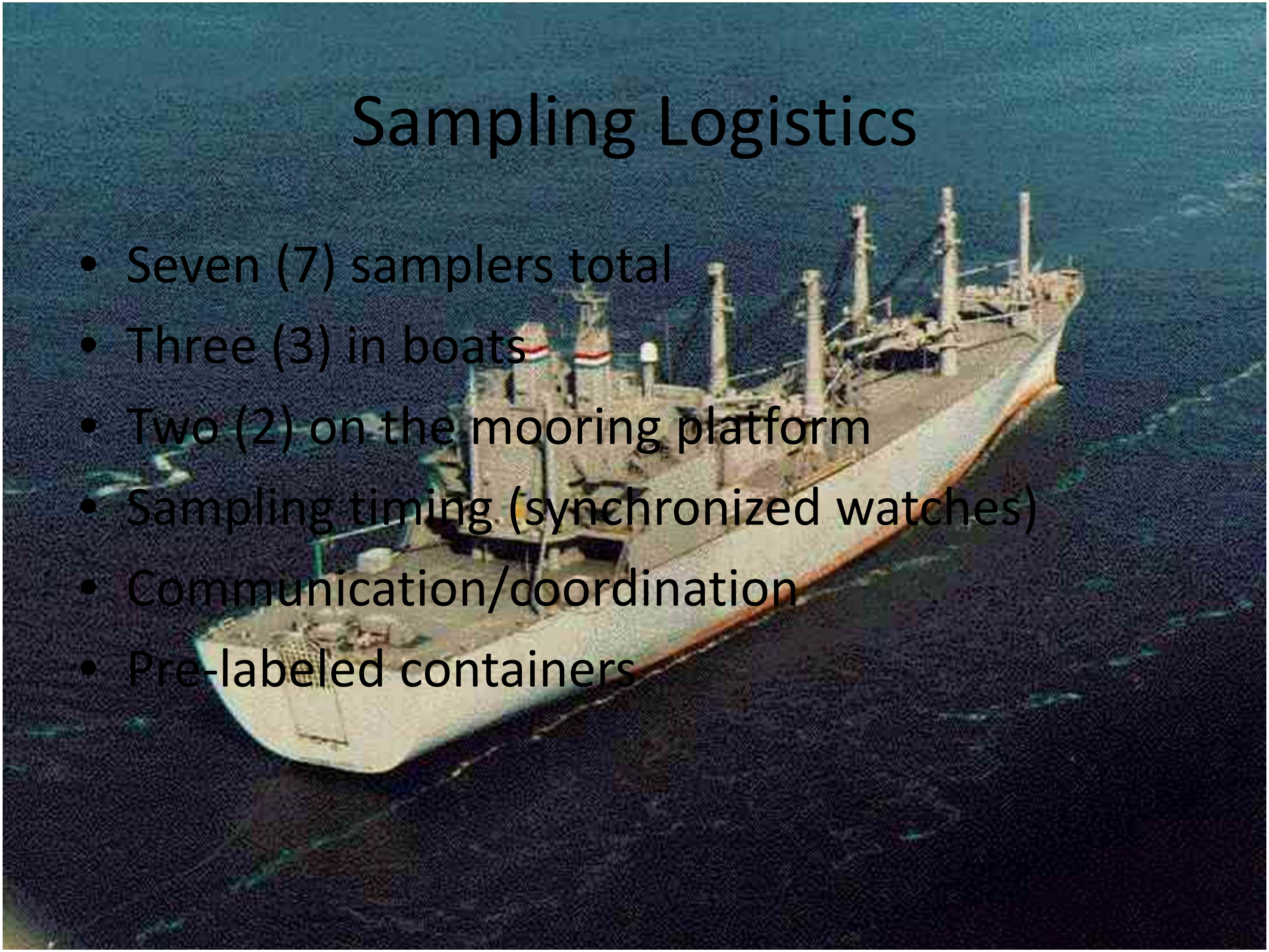


Sampling Stations

- Custom designed and constructed
- Intake of the tubing 10 feet below the water surface
- Anchored in place for repeated sampling
- Samples collected with a peristaltic pump

Sampling Logistics

- Seven (7) samplers total
- Three (3) in boats
- Two (2) on the mooring platform
- Sampling timing (synchronized watches)
- Communication/coordination
- Pre-labeled containers




FOR SAMPLE USE ONLY
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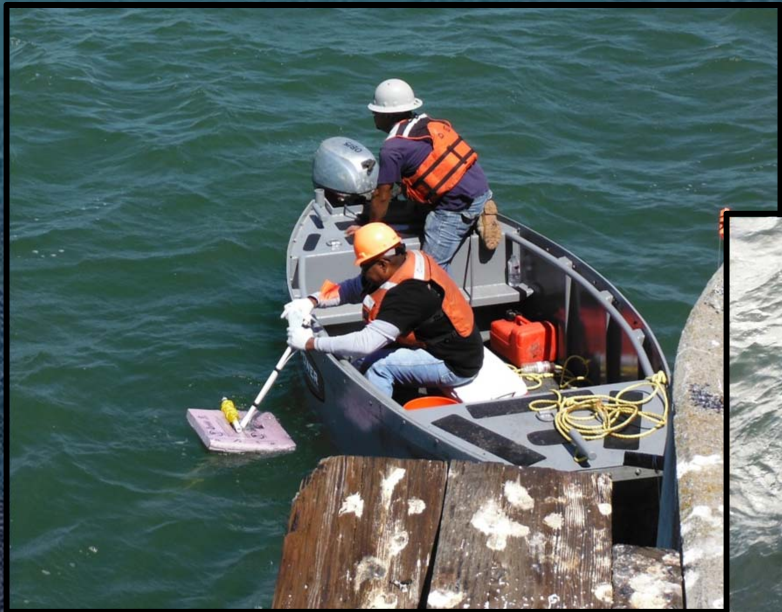
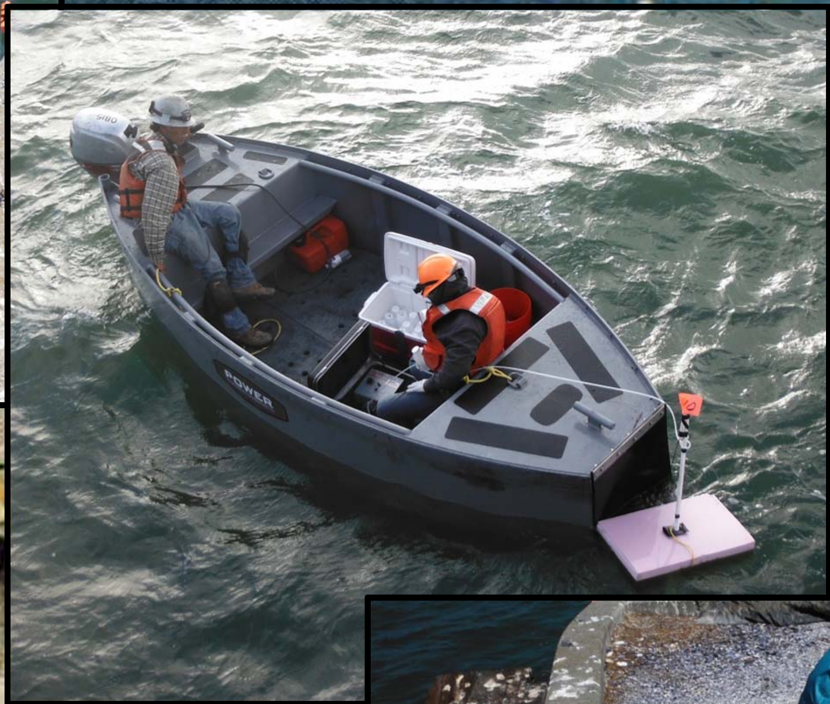
Note: Not to Scale



Sample Collection



- Background
- 20, 40, 60, and 70 minutes after discharge

Rhodamine Tracer Dye

Mixing Zone Results

- Complete mixing
- Dissolved copper and zinc below receiving water limits
- Rhodamine tracer not detected

Operational Challenges

- Sampling from boats
- Training samplers
- Vessel traffic
- Sample locations
- Timing slack tide

Proposed General Permit

- Treated water discharge into a mixing zone (dilution credit)
- BAT – rubber edging, soft brushes, capture removed material
- Pressure differential (scrubber unit)
- Minimum capture rate (400 gpm)
- Compliance sampling


Questions?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