ENVIRONMENTAL

WAKE AND SHORELINE EROSION ANALYSIS OVERVIEW

GOLDEN GATE BRIDGE® HIGHWAY & TRANSPORTATION DISTRICT

OBJECTIVE

Assess the impact of Golden Gate Bridge, Highway and Transportation District (GGBHTD) ferry wakes in Corte Madera Bay, including the Greenbrae Boardwalk Community and the Paradise Cay Yacht Harbor.

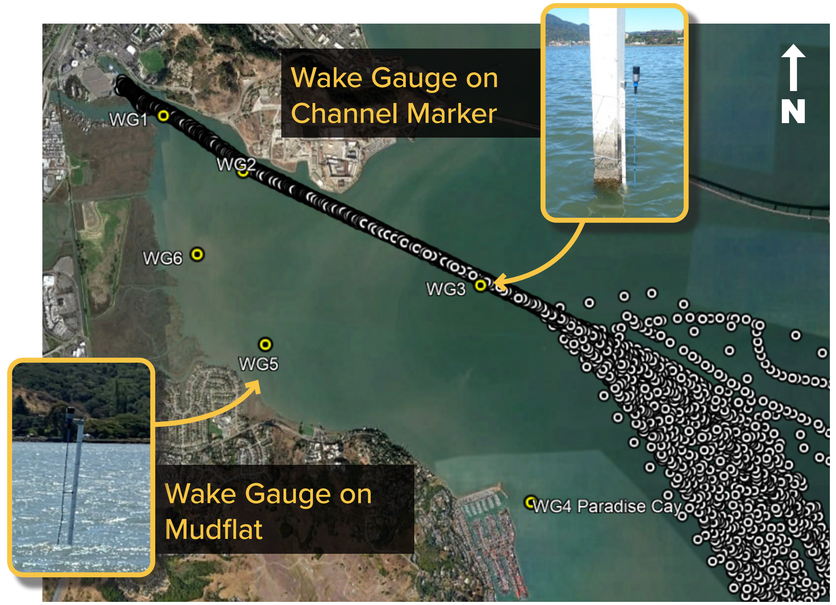
GGBHTD FERRY FLEET

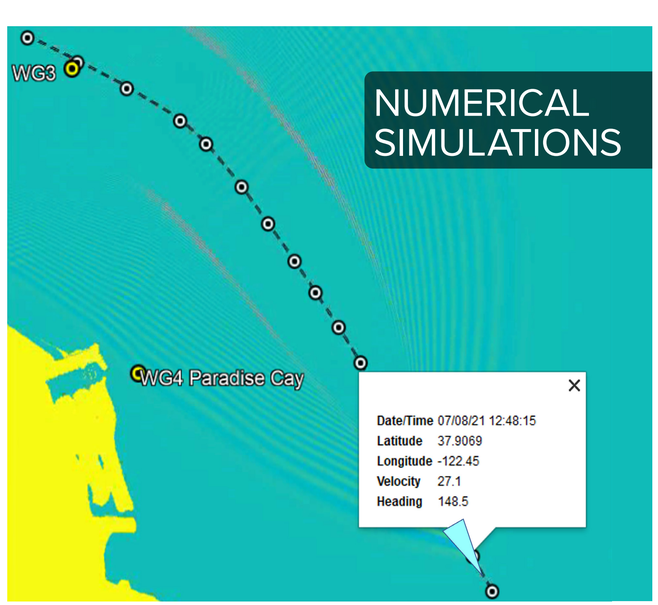
MENDOCINO

DEL NORTE

NAPA AND GOLDEN GATE

SPAULDING CLASS
(MARIN, SAN FRANCISCO, SONOMA)

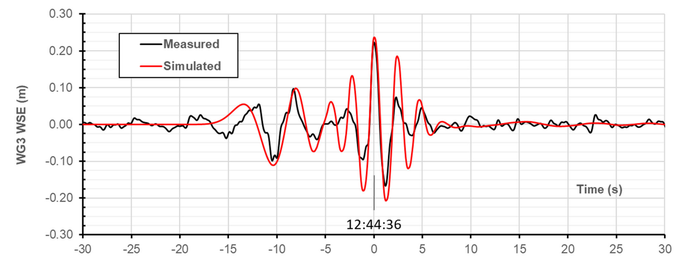


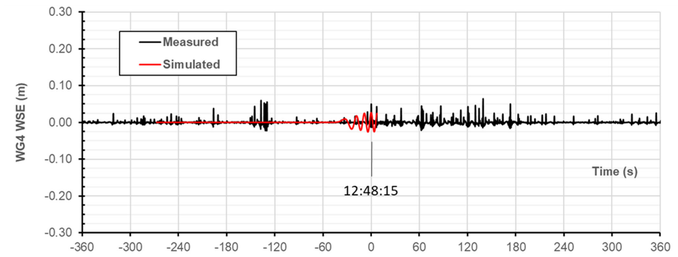


METHODOLOGY

- **Studied multihull (Napa) and monohull (Spaulding Class) ferries**
- **Performed wake measurements**
- **Collected actual ferry tracks (location, speed, and heading)**
- **Selected one inbound and one outbound track**
- **Simulated ferry passages and wakes in Corte Madera Bay**
- **Compared simulated and measured wakes**
- **Assessed wake impacts:**
  - » Bottom and shoreline erosion
  - » Boats and docks
  - » Shoreline protection structures
  - » Passive boating
  - » Benthos (flora and fauna in bottom)
  - » Water turbidity

SIMULATIONS VS. MEASUREMENTS





ENVIRONMENTAL

WAKE AND SHORELINE EROSION ANALYSIS

Corte Madera Bay, Key Features and Activities

GOLDEN GATE BRIDGE®
HIGHWAY & TRANSPORTATION DISTRICT

LEGEND:

- BULKHEAD
- CONCRETE DEBRIS
- DOCK & BOATS
- NATURAL SHORELINE
- PASSIVE BOATING
- REVETMENT

ENVIRONMENTAL

PRELIMINARY WAKE AND SHORELINE EROSION ANALYSIS | Ferry Wake Assessment

GOLDEN GATE BRIDGE® HIGHWAY & TRANSPORTATION DISTRICT

Maximum wake height measurement of outbound and inbound ferry vessels

LEGEND:

- No Impact
- Moderate Impact
- High Impact
- Not Applicable

BE: bottom erosion

SE: shoreline erosion

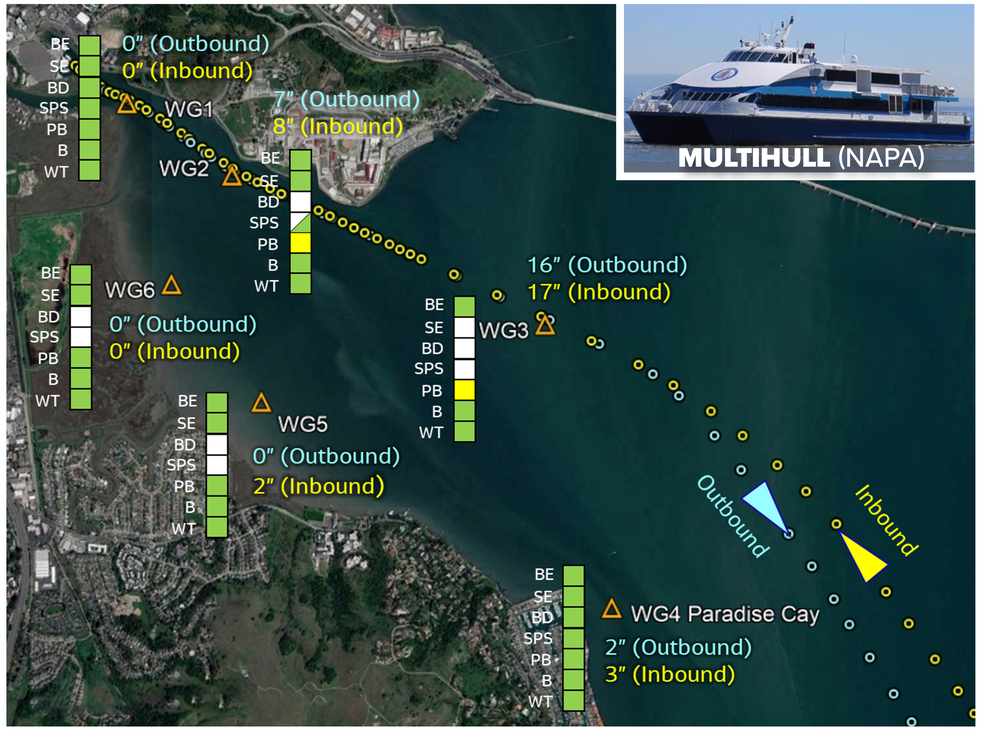
BD: boats and docks

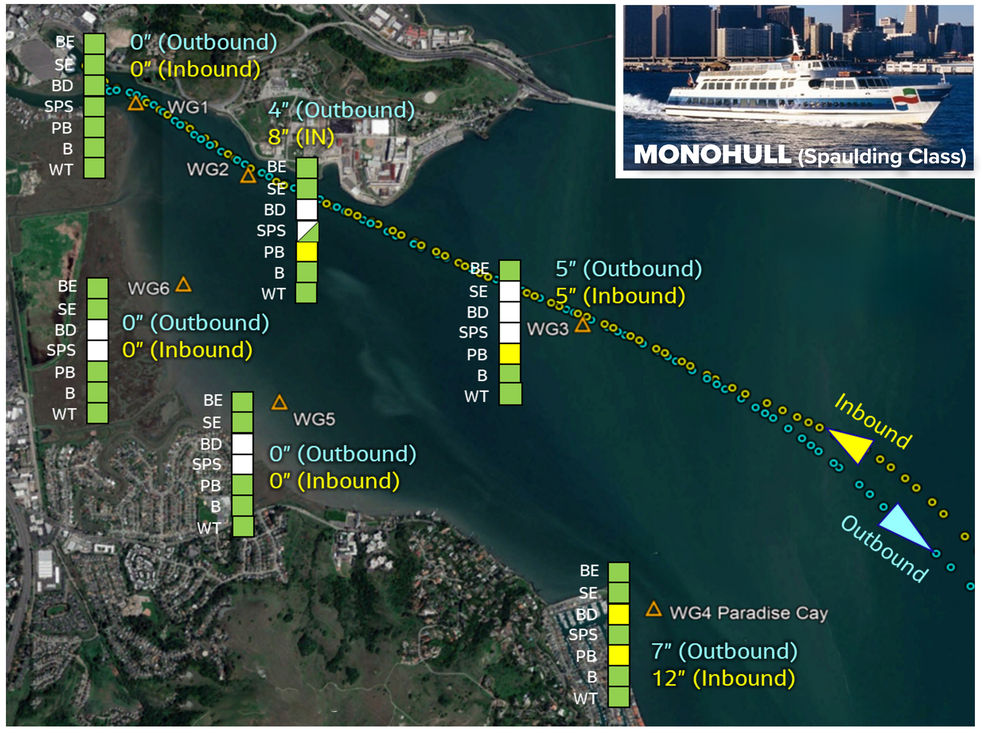
SPS: shoreline protection structures

PB: passive boating

B: benthos

WT: water turbidity





- **Bottom erosion:** no impact where wakes are small or water depth relatively deep
- **Shoreline erosion:** no impact where wakes are small or shoreline armored
- **Boats and docks:** wakes less than 1 foot
- **Shoreline protection structures:** no impact, wakes are smaller than 100-year wind wave
- **Passive boating:** no impact where wakes are less than rowing shell freeboard, moderate impact if rowing shell not heading into the wakes
- **Benthos:** no impact, wake-induced bottom shear stress does not erode bottom
- **Water turbidity:** no impact, naturally high suspended sediment levels

ENVIRONMENTAL

FUTURE FERRY FLEET

GOLDEN GATE BRIDGE®
HIGHWAY & TRANSPORTATION DISTRICT

October 2023 Board Action: Move Toward Multihull (Catamaran) Ferries Only

CURRENT FERRY SERVICE

No wake and shoreline erosion impacts

42 TRIPS PER DAY

FUTURE FERRY SERVICE UNDER STUDY

MULTIHULL

CATAMARAN FERRY

- Up to 56 trips per day (2040)
- No change in ferry types, routes, speed
- No wake and shoreline erosion impacts expected

Multihull (Catamaran) Ferry Characteristics

- Surface-piercing hulls, producing less wake
- Wider (beam) and more stable, reducing rolling and pitching (which can contribute to wakes)
- Can plane at high speed, reducing submerged volume, resulting in less drag and wake