Evaluating Contaminated Groundwater Discharges to Surface Water

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CALIFORNIA Water Boards

Edmund G. Brown Jr.
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Secretary for Environmental Protection

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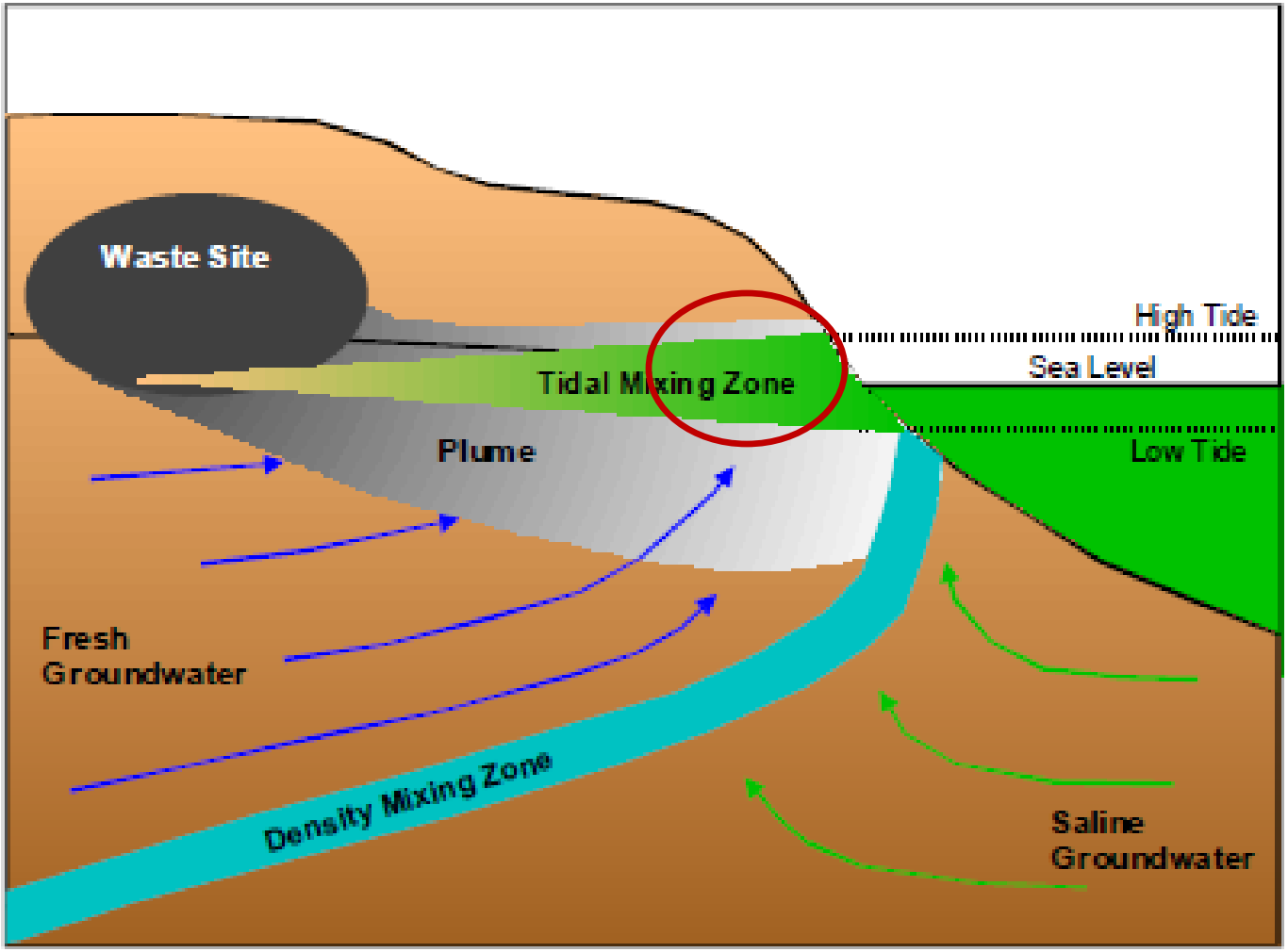
Outline

1) **Background**
    a. Regulatory Context
    b. Groundwater-Surface Water Interaction
2) **Previous Approach**
3) **Updating the Approach**

Regulatory Context

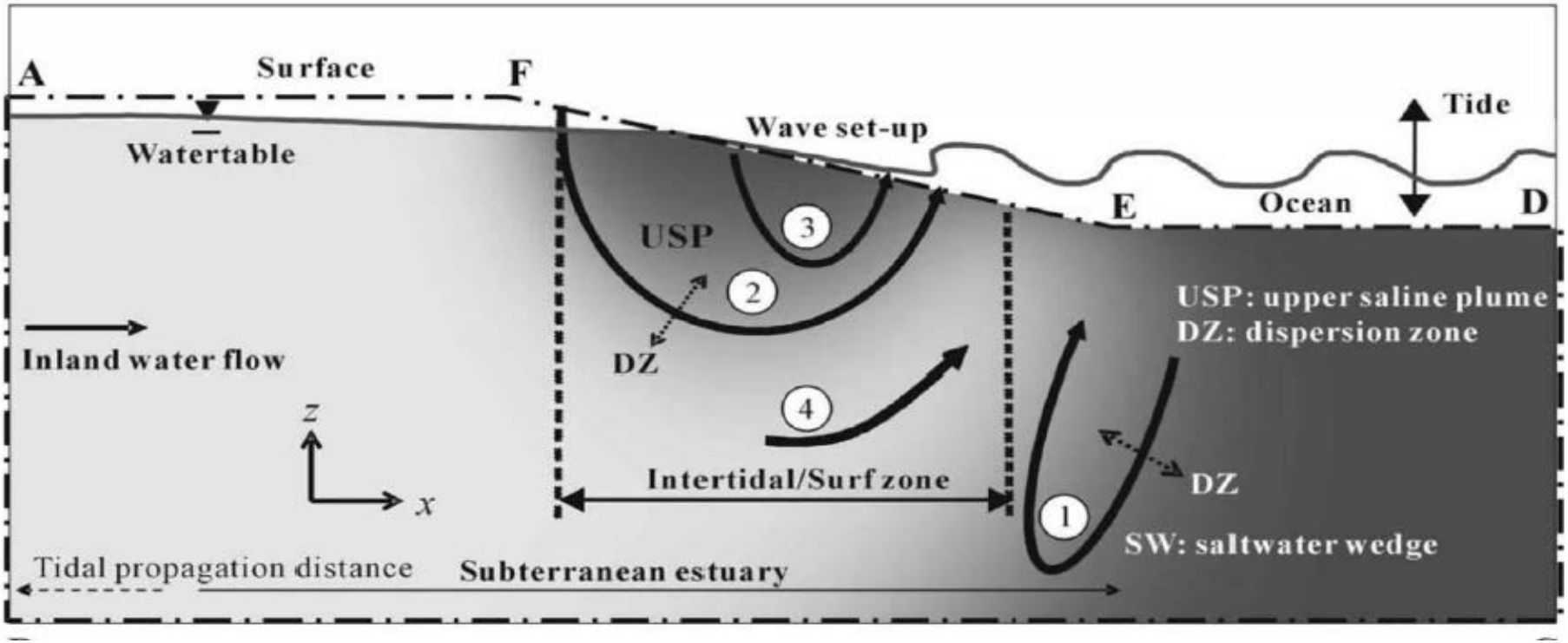
- **Clean Water Act** – No discharge of toxics in toxic amounts.
- **CA Water Code** – No right to discharge without a permit
- **State Board Anti-degradation Policy** – Migrating plume is a discharge (moving molecule theory)

GW Plume Discharging to Coastal Water Body



(from Chadwick and Hawkins 2008)

Wave and Tide Induced Circulation



1. Density-driven circulation
2. Tide-induced circulation
3. Circulation caused by wave run-up
4. Groundwater discharge

Xin et al. (2010)

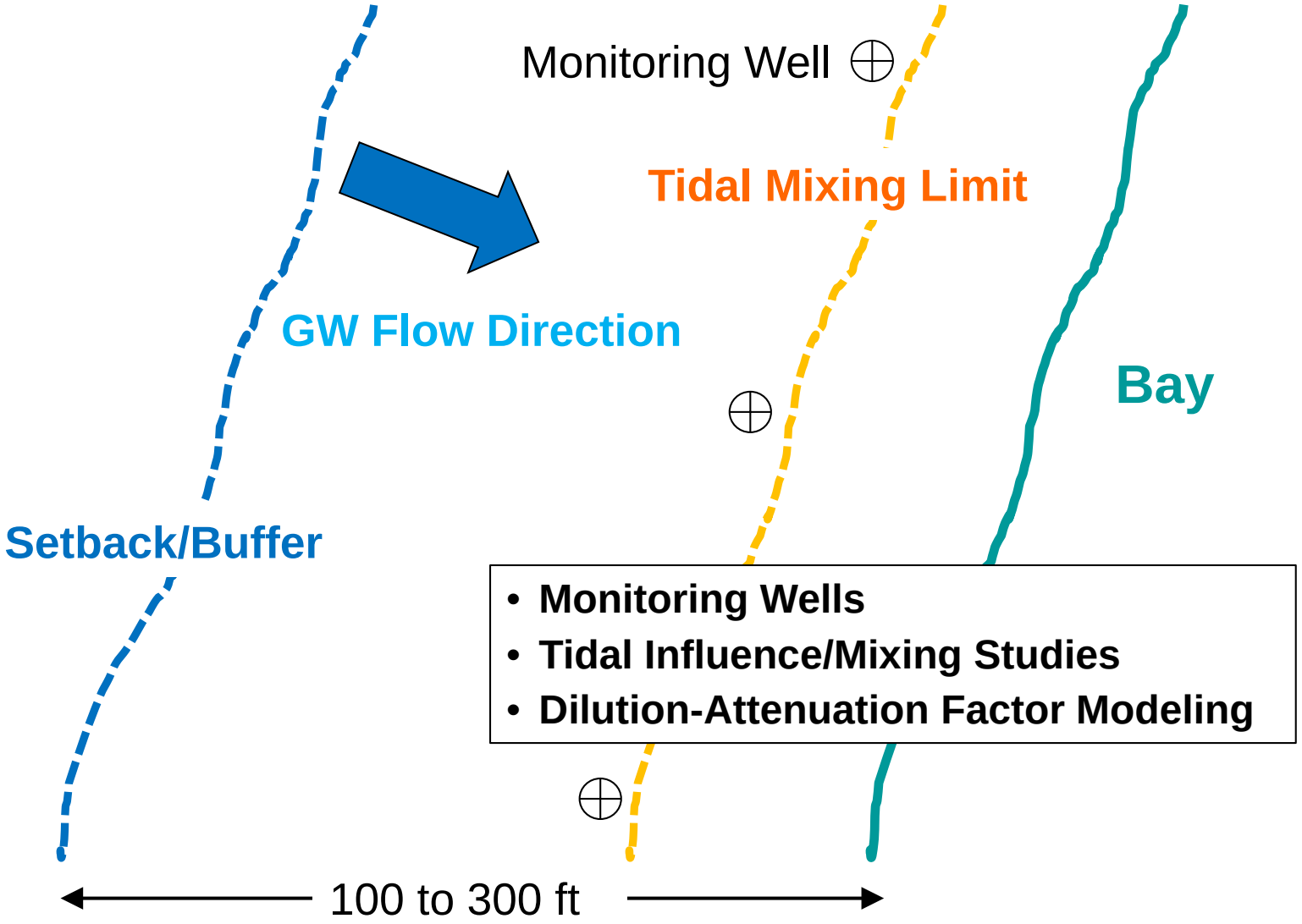
Previous Approach – Background

Large Petroleum Release Sites

- Presidio of SF – Fuel Petroleum Action Level Report (1996)
- San Francisco International Airport – Cleanup Order (1999)
- Naval Station Treasure Island – Preliminary Remediation Criteria (2001)
- Naval Fuel Depot Point Molate – Fuel Petroleum Action Level Report (2001)
- Alameda Naval Air Station – Preliminary Remediation Criteria and Closure Strategy (2001)
- Hunters Point Naval Shipyard – Preliminary Screening Criteria and Petroleum Program Strategy (2007)
- Mare Island Naval Shipyard – Tier 2 Risk Assessment Approach (2009)

Criteria for Evaluating Whether Low Risk

Components of the Approach



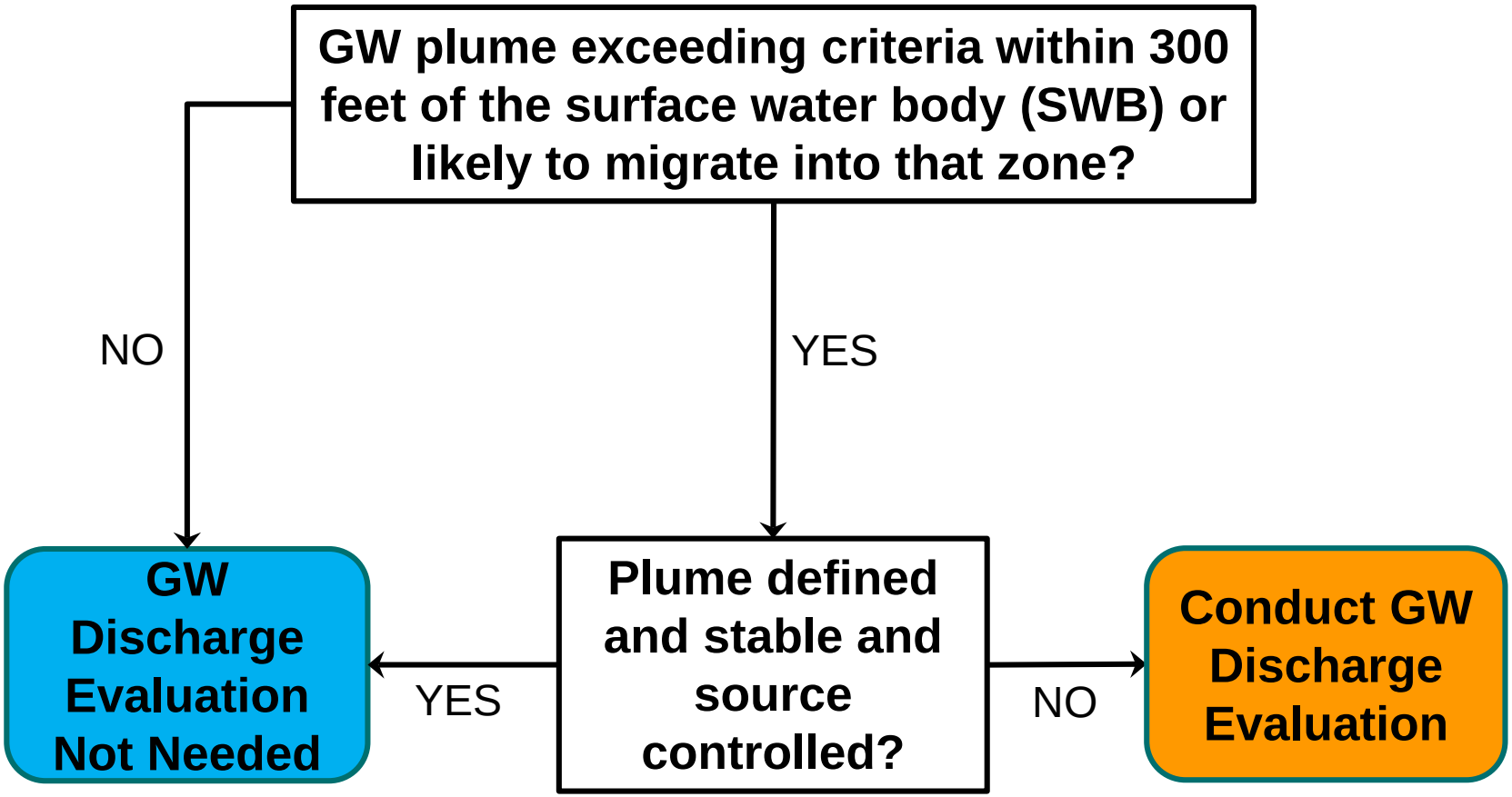
Surface Water Quality Standards

- **Single Chemicals** – Available standards
- **Petroleum Mixtures (TPH)** – Bioassays
  - Employed NPDES-style whole effluent tests to assess toxicity and develop criteria
  - Multiple species from diverse taxa for acute testing and chronic exposures
  - Samples tested from wells, soil leachate, or fresh product
  - Key sites: SF Airport, Presidio, Treasure Island

Motivation for Updating Our Approach

- **Improved understanding**
- **Better tools**
- **Models rarely verified**
- **Need for evaluation comes up often enough**

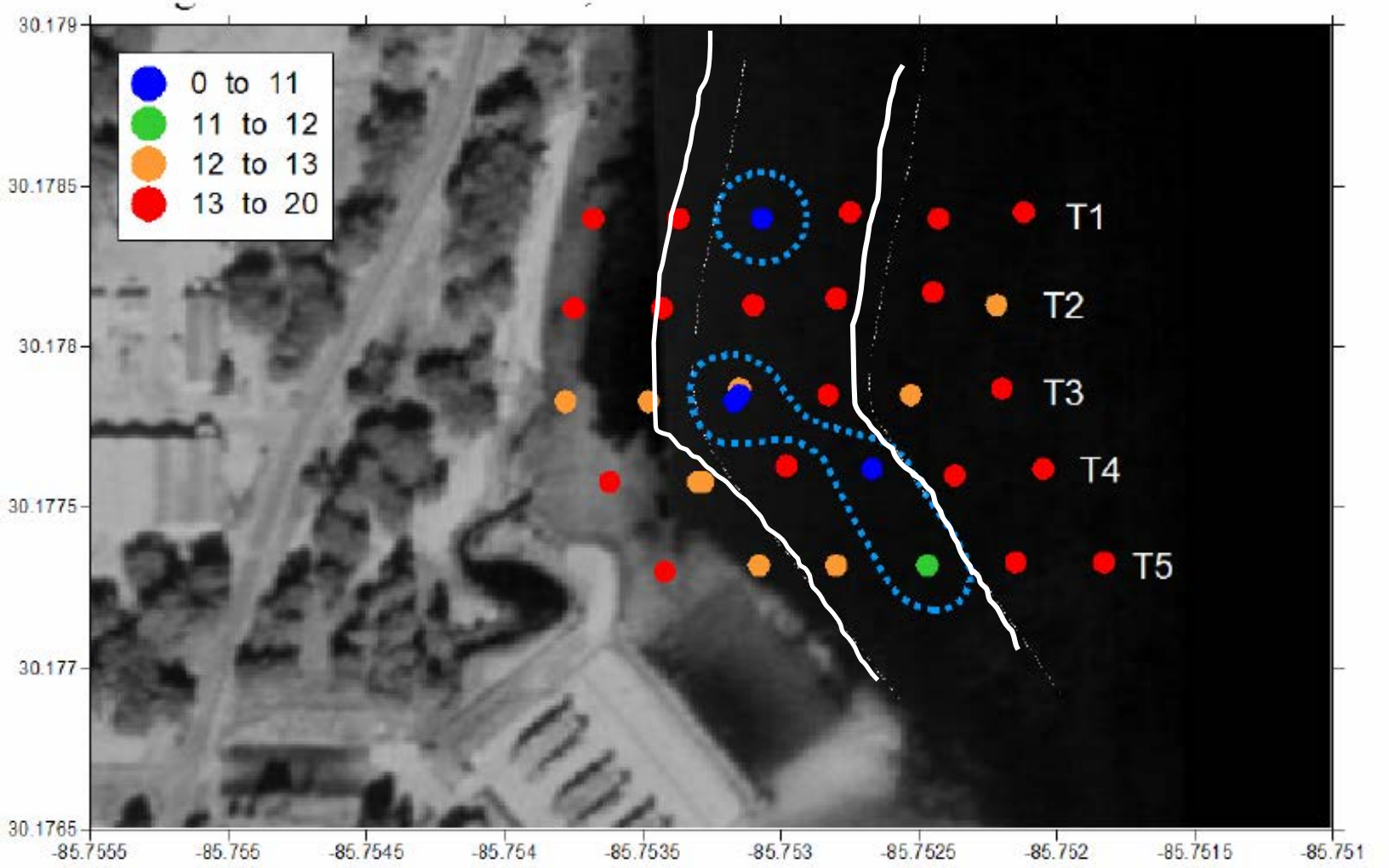
GW Discharge Evaluation Needed?



GW Discharge Evaluation

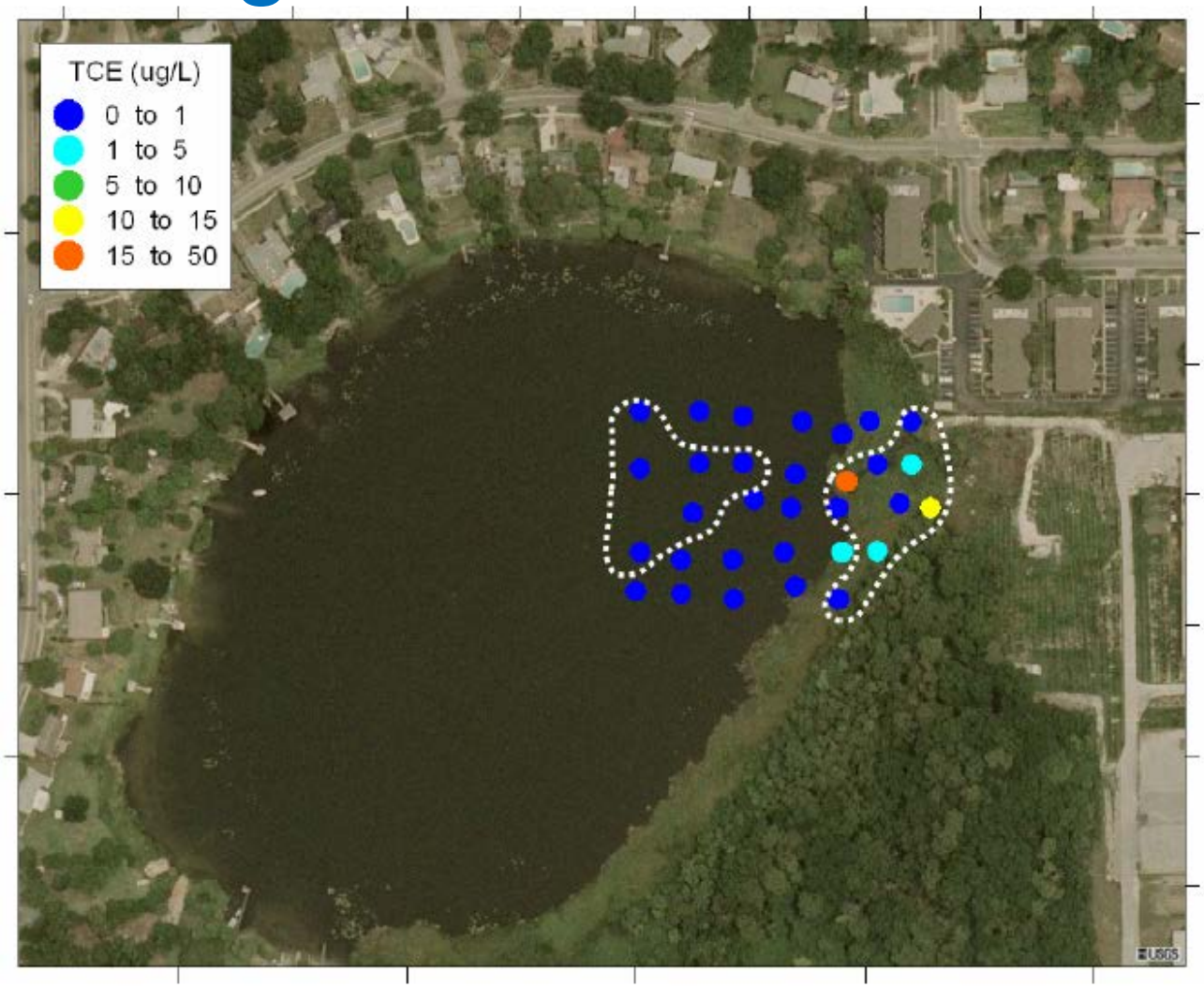
- **Characterize the groundwater plume**
- **Locate the discharge zone(s)**
  - Geology and substrate
  - Surface water processes
  - Representative samples of groundwater
  - Pollutant concentrations and geochemical parameters
  - Flow
  - Spatial and temporal considerations
- **Toxicity testing** (if multiple pollutants or mixtures)
- **Biological survey/assessment**

Discharge Zone Located Using Conductivity



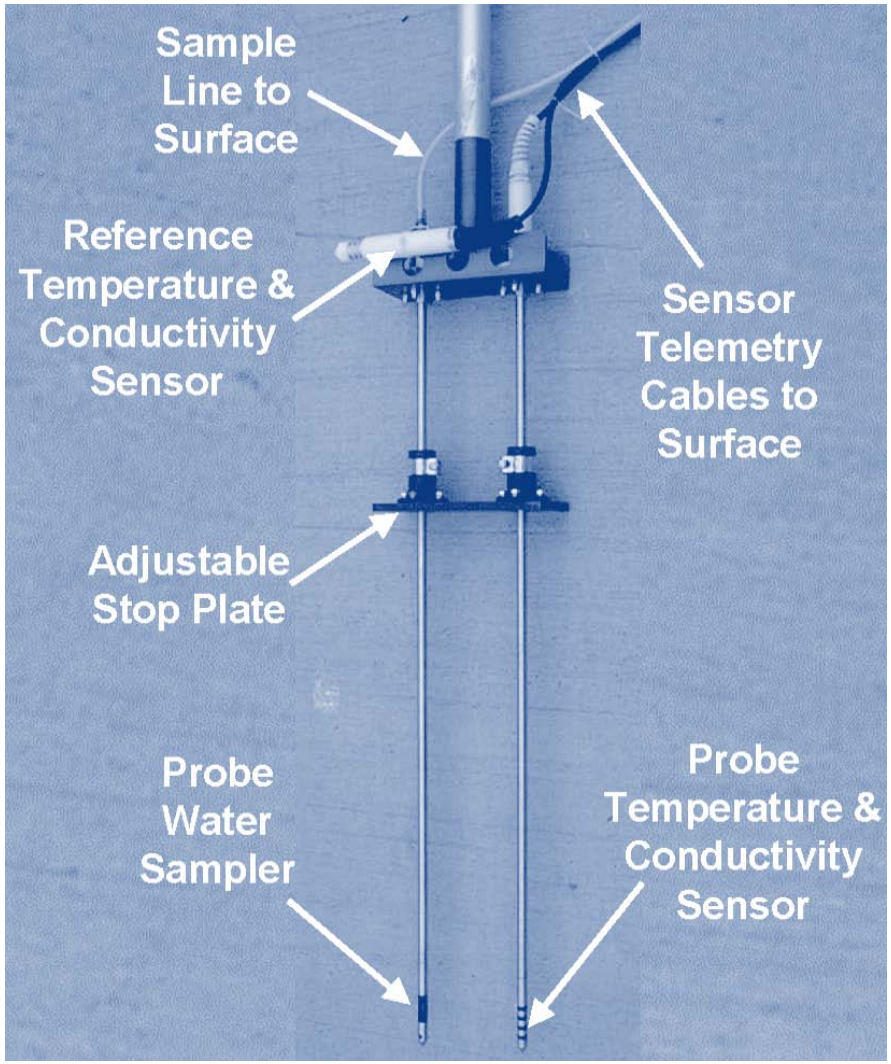
Conductivity (mS/cm). Blue lines indicates interpreted discharge zones. White lines delineate offshore band of potential discharge.

Discharge Zones in Freshwater Lake



TCE (µg/L). White lines delineate GW discharge areas based on sub-surface temperature.

Navy SPAWAR Trident Probe



Refinements to Toxicity Testing Approach

- **Background toxicity**
  Test a background sample as well

- **Persistence test**
  Test for pollutant loss (aeration, oxygenation) through each step of the bioassay protocol before running the test with test organisms

Keeping Up with the Literature

- **Cardiotoxicity to Fish Embryos**
  (Incardona et al. 2015)
  ∑PAHs (3-ring PAHs from crude oil) at 0.15 µg/L

- **Finfish Swimming Performance**
  (Mager et al. 2014)
  ∑PAH50 at 1.2 µg/L

Basin Plan WQO for Total PAHs 15 µg/L

Comments/Questions?

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Backup Slides

The Hyporheic Zone

1. Highly variable zone beneath surface water bodies and lakes.
2. Location of biological abundance and diversity.
3. Important for biogeochemical cycling of nutrients.
4. Primary processes are dilution and dispersion with small amount of biodegradation (Landmeyer et al. 2010).

Site-specific evidence is needed to demonstrate that the hyporheic zone is sufficiently degrading contaminants.

Aquatic Toxicity of Diesel-Range Hydrocarbons and Metabolites

- **Literature**
  - marine oil spills
  - weathered mixture bioassays: 1,000 – 2,000 µg/L
- **Regional Water Board experience**
  - groundwater and soil leachate bioassays: 600 – 170,000 µg/L
  - TPH-diesel ESL for aquatic habitats: 640 µg/L
  - recent testing of metabolite-only mixtures in near-shoreline groundwater: 1,000 µg/L

Schematic of GW Criteria Concepts