



Innovative Treatment of Wood Waste Impacted  
Sediments Using Reactive Amendments and DGT  
Passive Porewater Sulfide Testing Techniques



Esquimalt Harbour, Victoria, BC

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*ESQUIMALT  
HARBOUR*

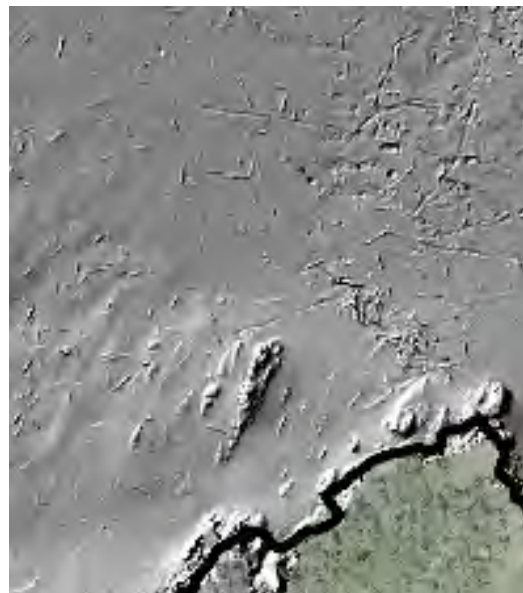
*VICTORIA  
HARBOUR*





# North Esquimalt Harbour

- Log booming
- Log storage
- Wood mill operations



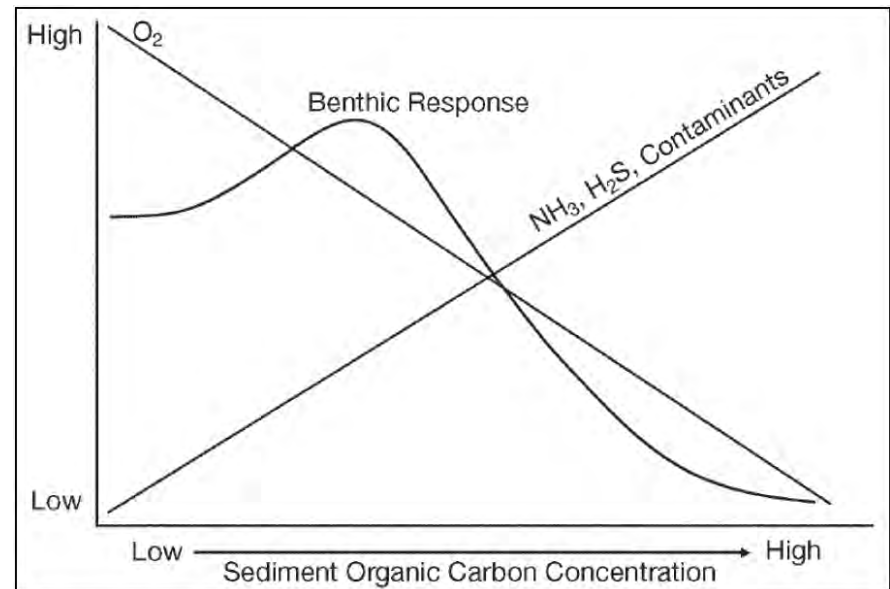
# Physical Wood Waste Effects

- Logs, bark, wood chips, processed wood (sawdust), partially decomposed wood fibers
- Slow to decay
- Can isolate benthic organisms from native sediment
- Can be highly flocculent



# Chemical Effects

- Wood waste degradation
  - Creates anoxic conditions
  - Ammonia production
  - Hydrogen sulfide production
- Degradation by-products can be toxic to benthic organisms

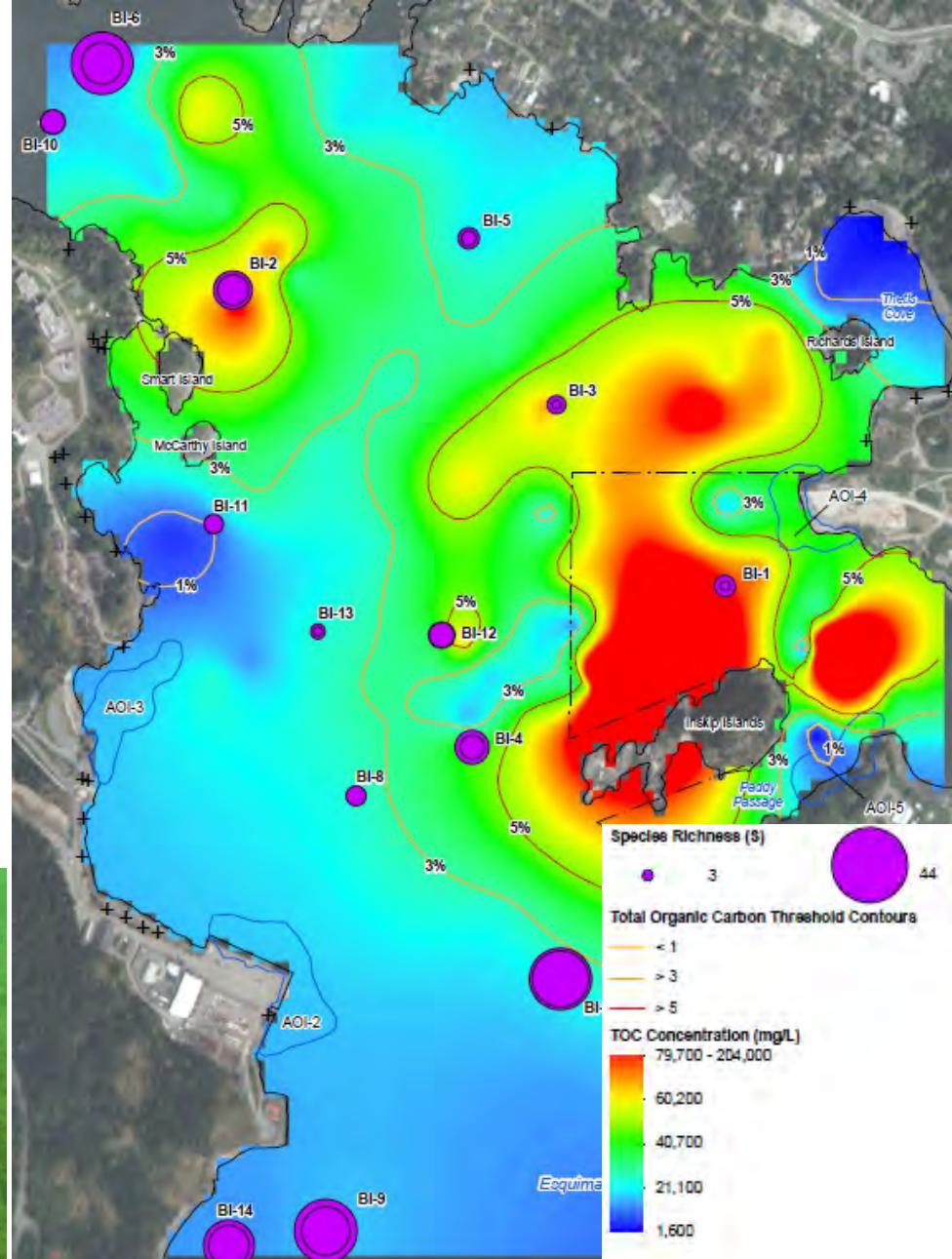


Source: Hyland et al. 2005

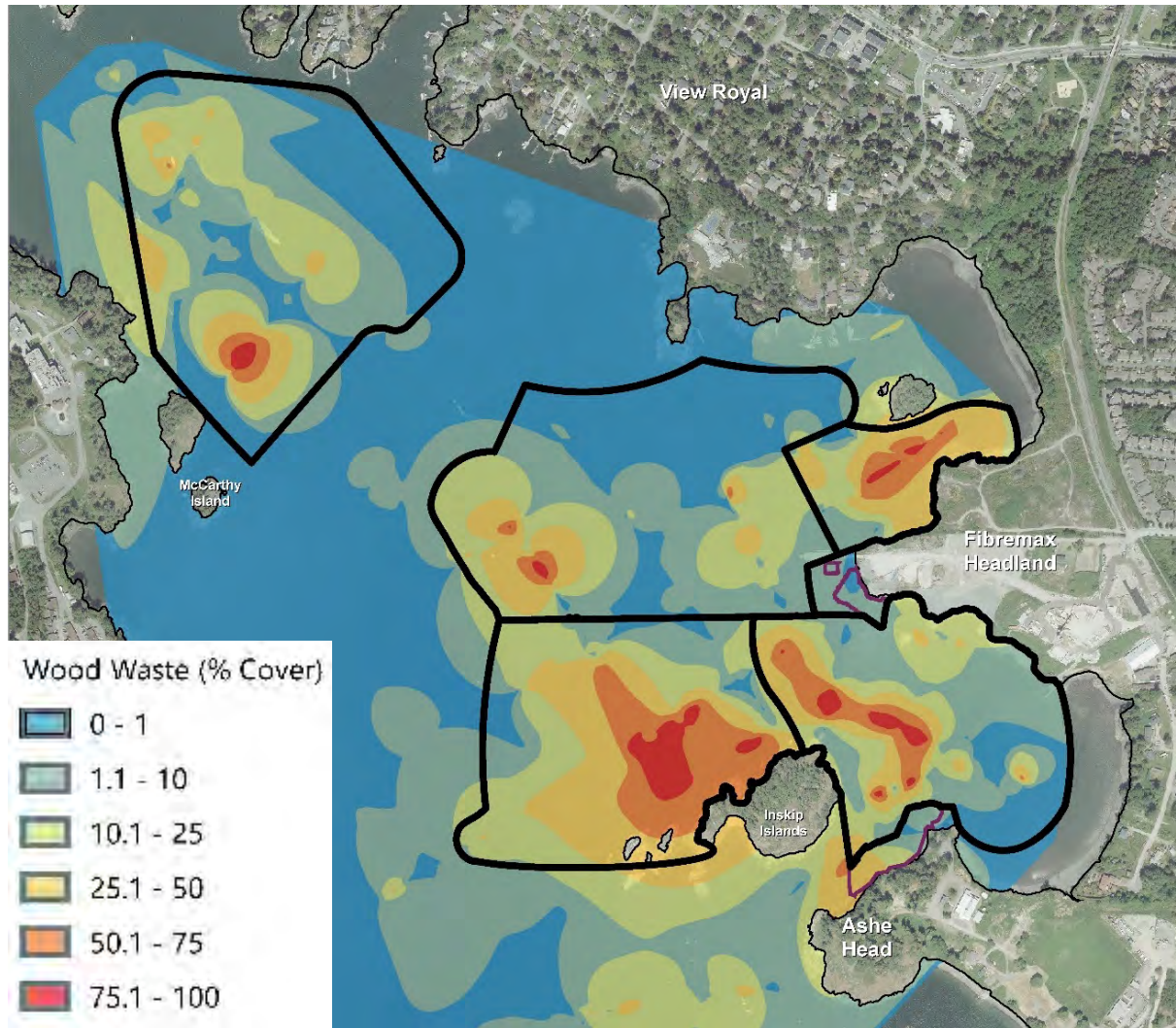


# Biological Effects

- Reduced benthic community abundance and diversity
- Reduced survival of bivalves
- *Beggiatoa* spp. bacterial mats

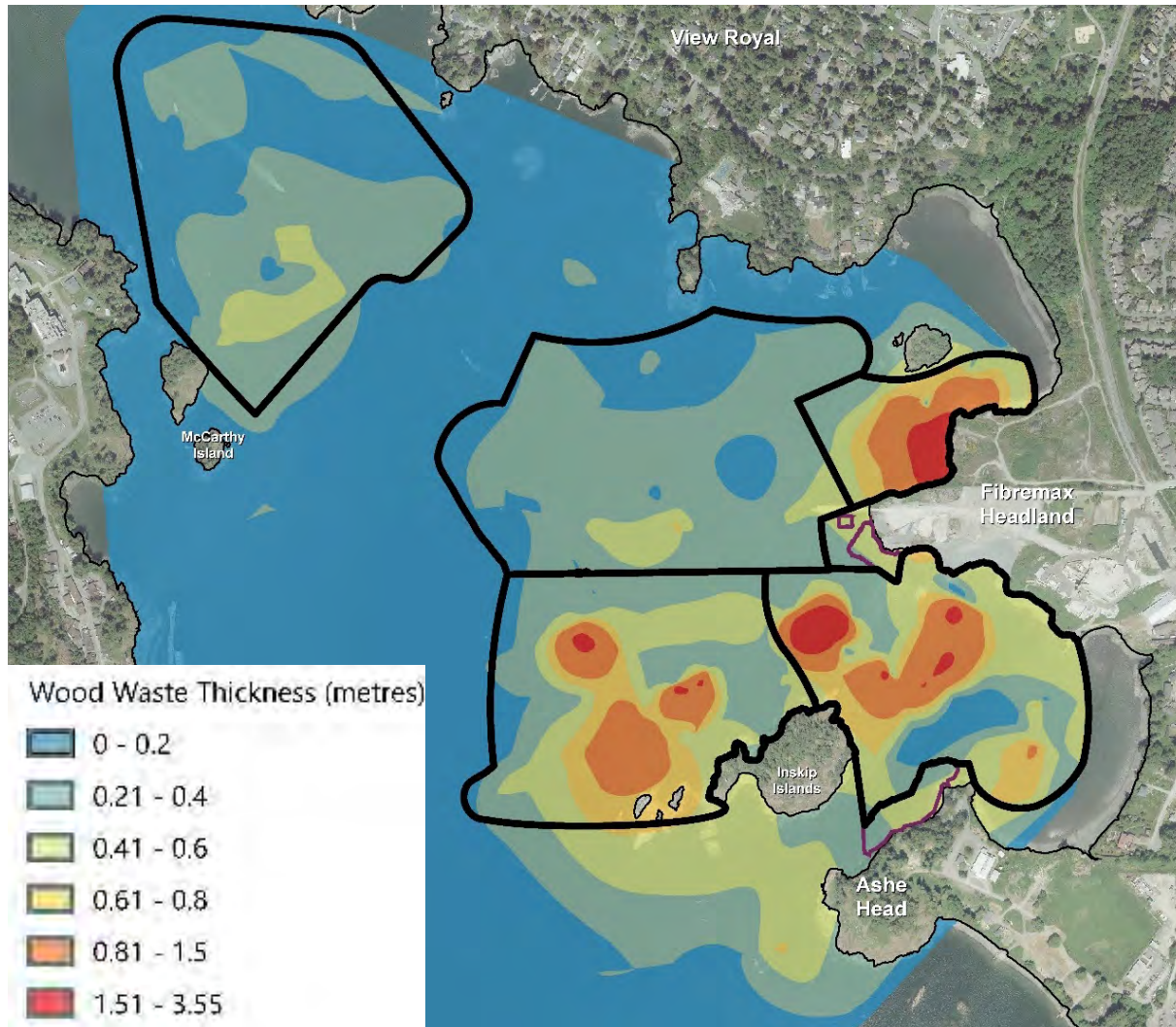


# Wood Waste Cover



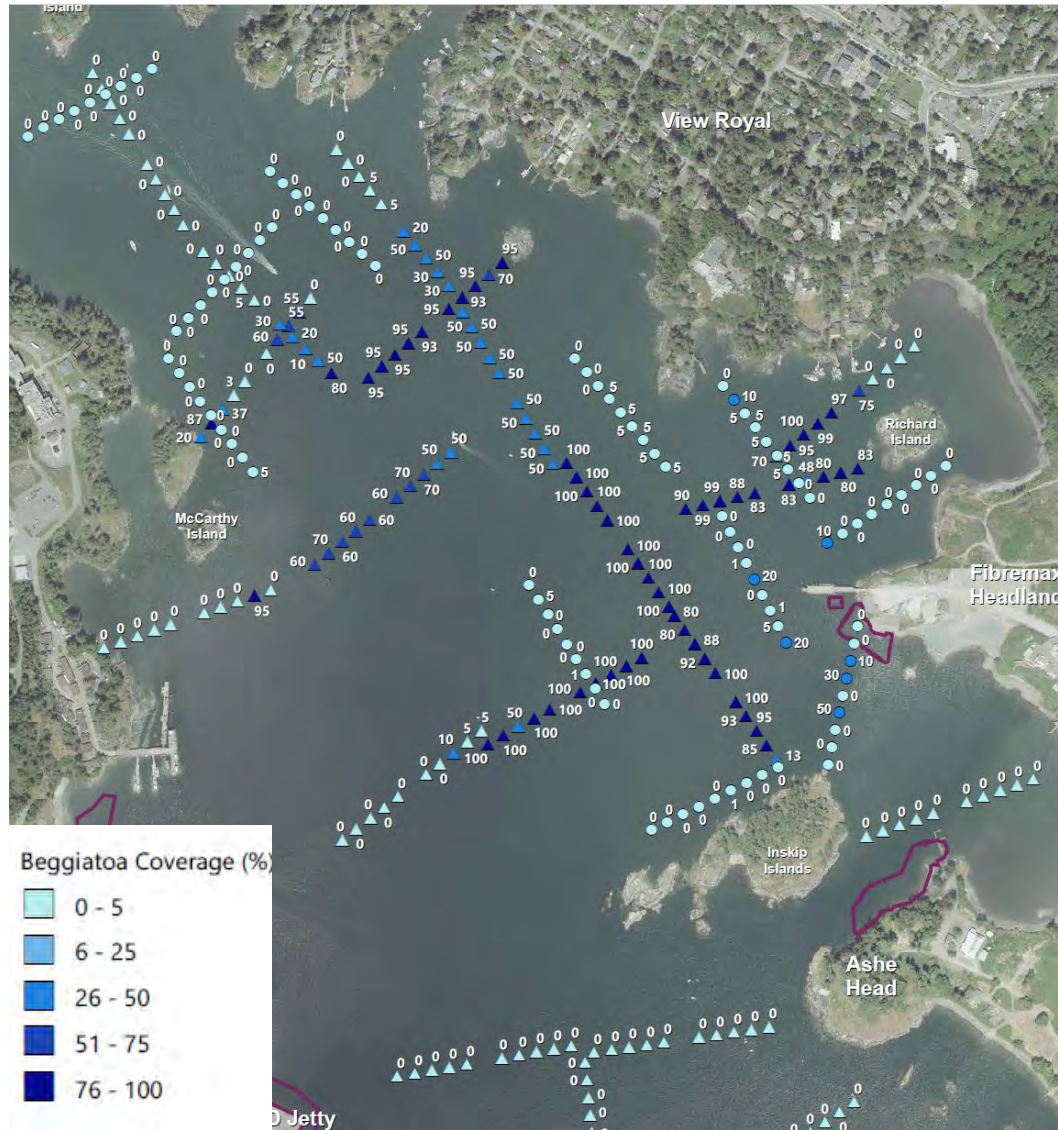


# Wood Waste Thickness



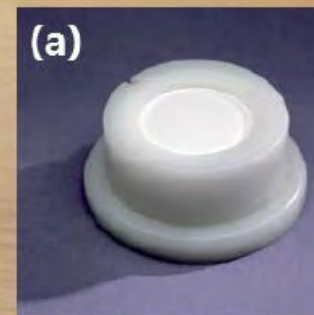


# Beggiatoa Cover



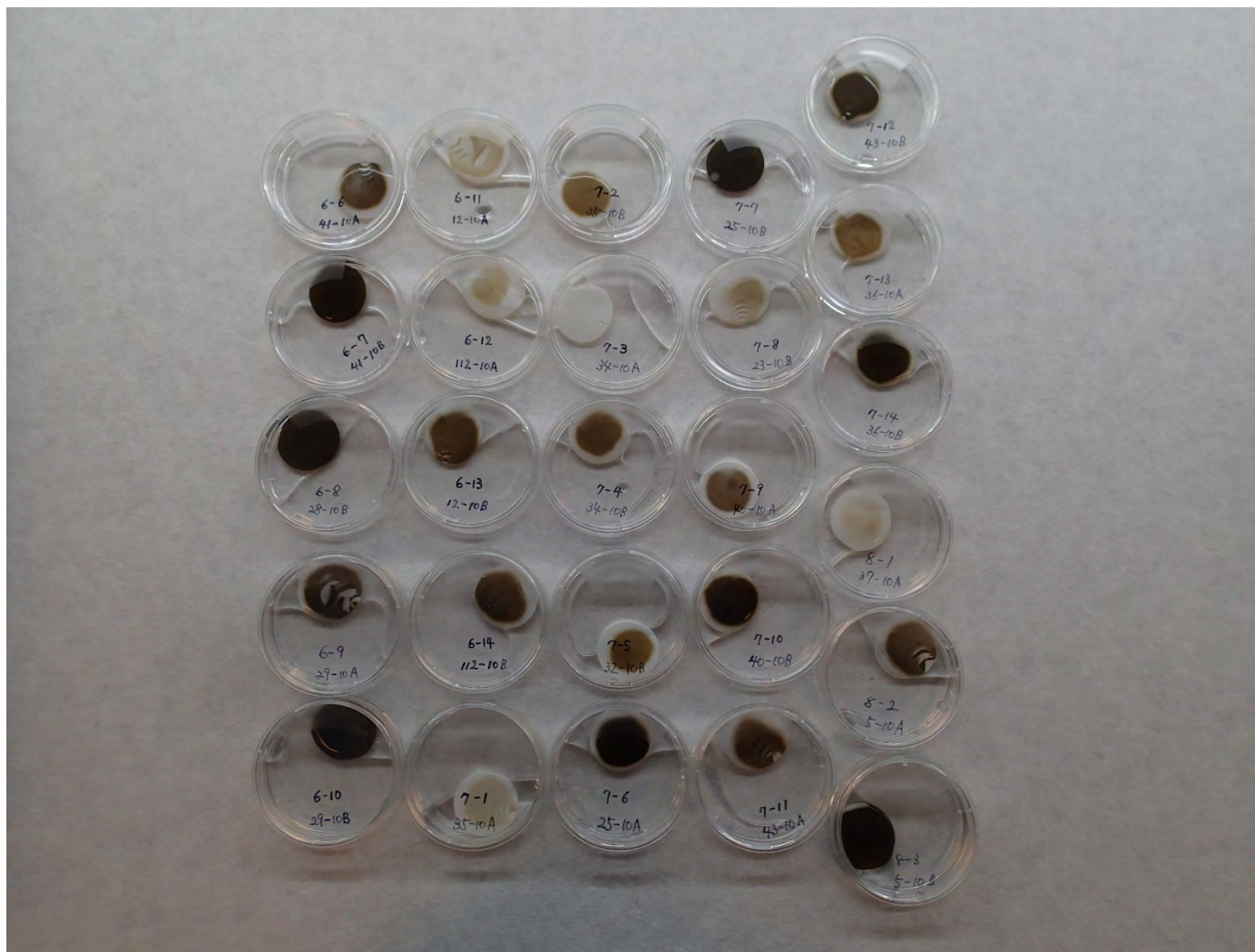
# Porewater Sulfides Using DGT

- DGT – Diffusive Gradients in thin films
  - Increasingly common as reliable in situ measure of porewater sulfide
  - Reaction of sulfide with silver iodide gel (white) to produce silver sulfide (black)
  - Intensity of color is proportional to sulfide on the gel
  - Proportional to exposure duration



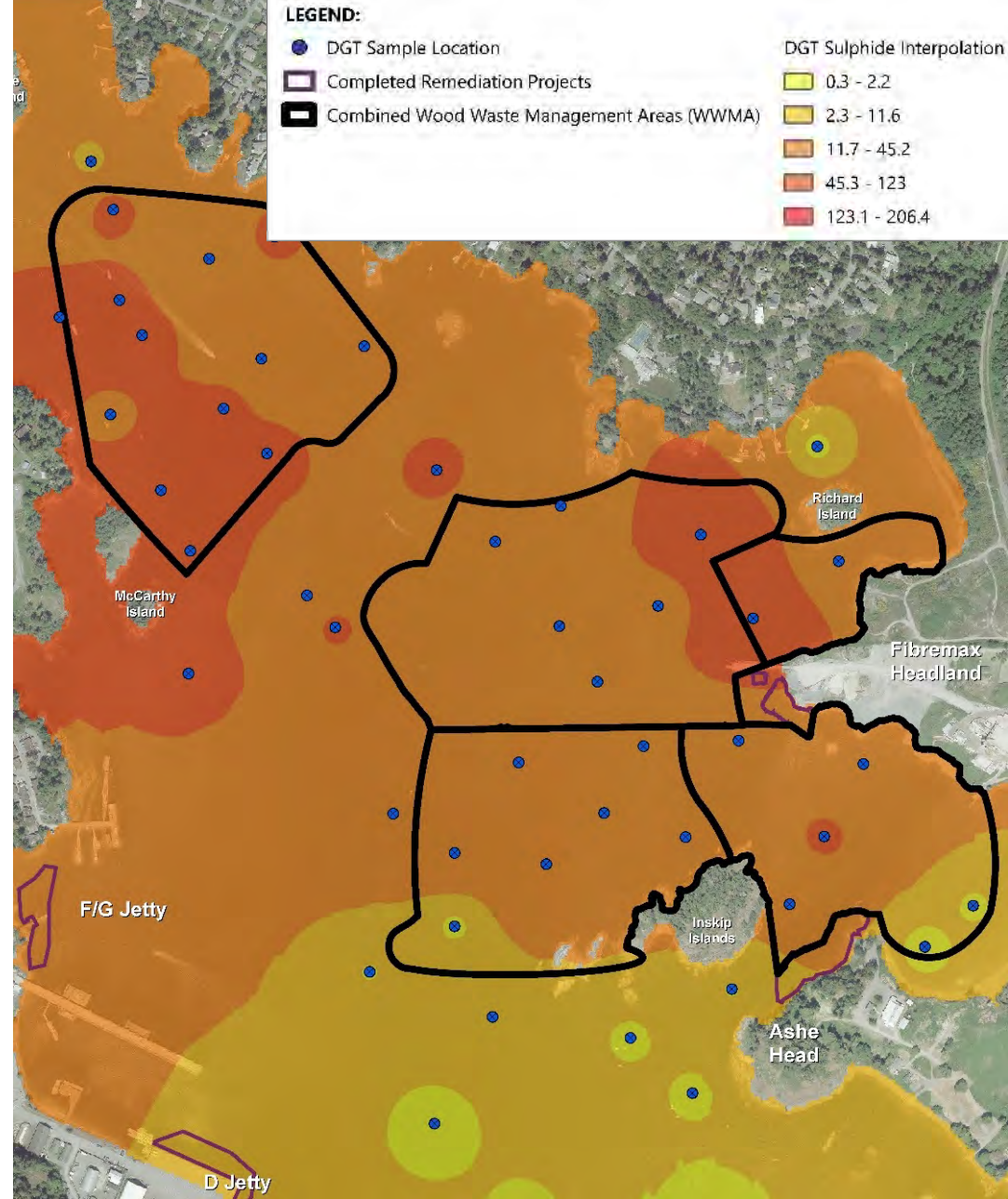


# DGT results



# Porewater Sulfide Concentrations

- 65 samples
  - Up to 206 mg/L
  - Median 25 mg/L
- 2 mg/L can cause toxicity to sensitive species
- Usually less than 1 mg/L at most sites





# Bench Scale Treatability Testing

- Test effectiveness of sand cover mixed with treatment amendments to reduce bioavailable porewater sulfide
- Siderite binds sulfide (precipitates iron sulfides)
- Manganese and mixed metal oxide oxidize sulfide into sulfate and manipulate sediment redox conditions



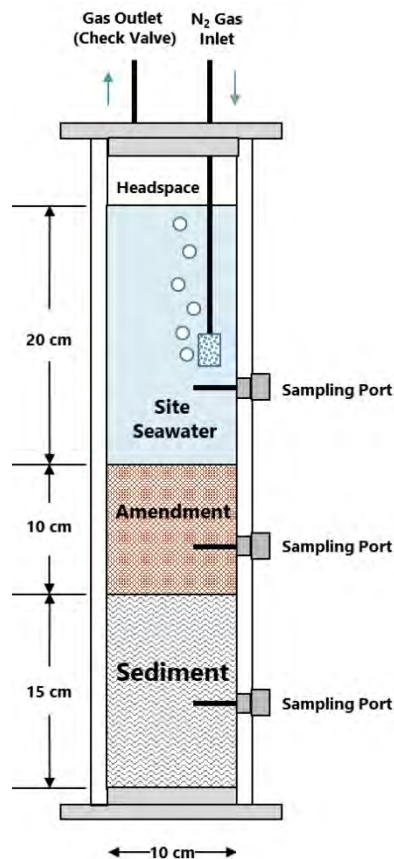
**Siderite**  
**FeCO<sub>3</sub>**

**Manganese Oxide**  
**MnO<sub>2</sub>**

**Mixed Metal  
Oxide (MMO)**

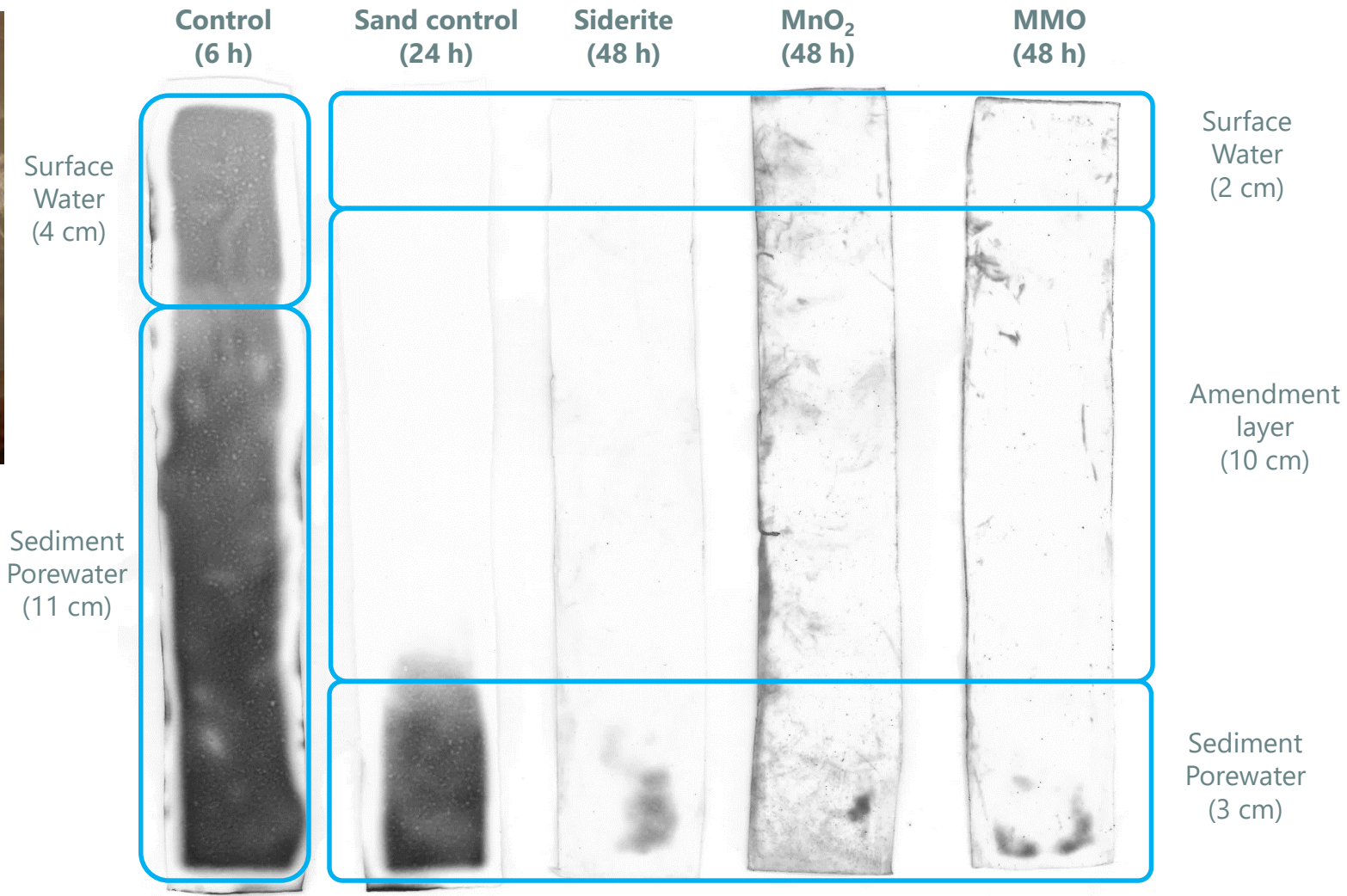
# Treatability Setup

- Sediment Control
- Sand Cover Control
- Siderite Treatment
- $\text{MnO}_2$  Treatment
- MMO Treatment

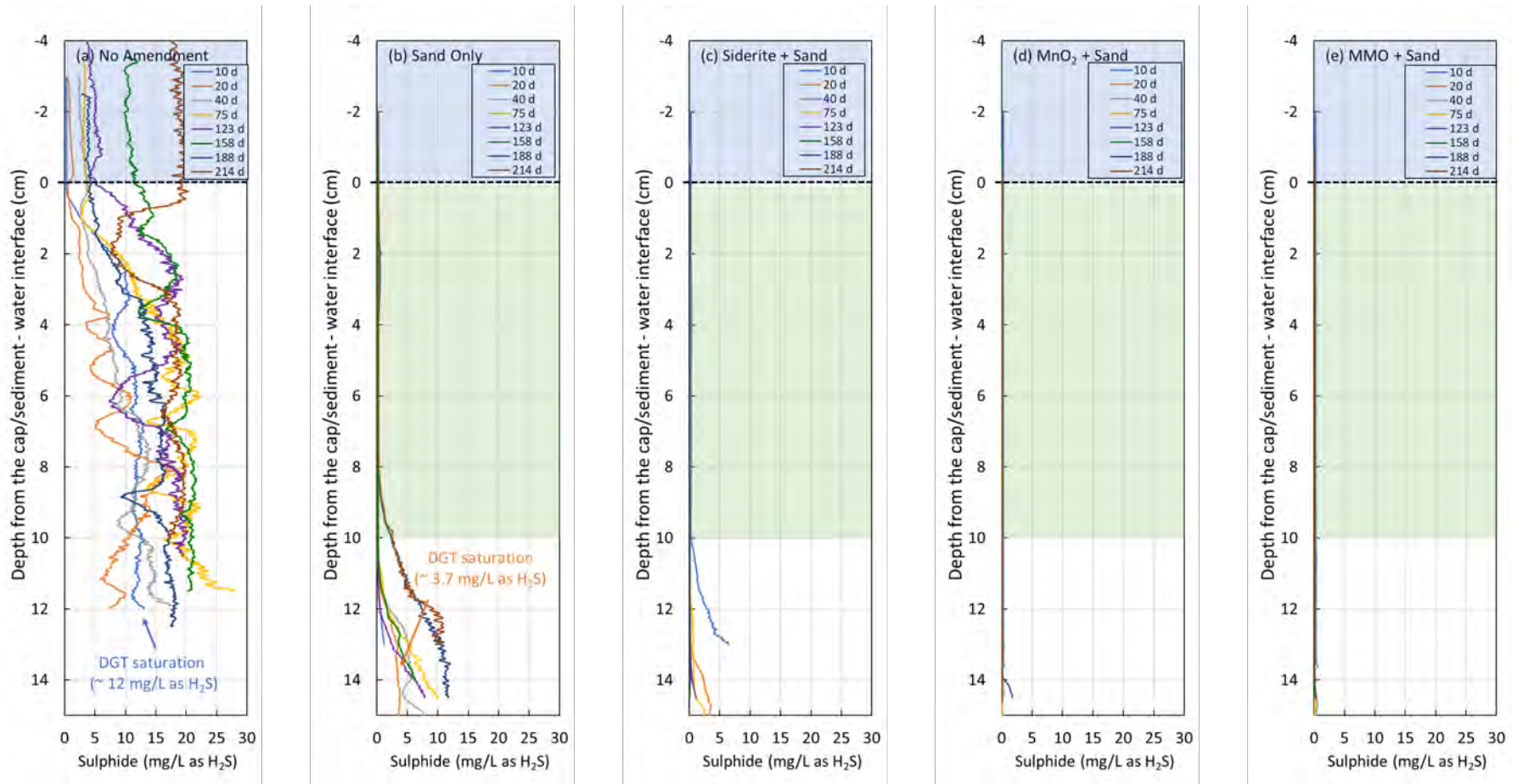




# Flat-probe DGT Results – 1 Month



# Dissolved sulfide Concentration Profiles in the Mesocosms





# Images of the Mesocosms after 214 Days



Sand  
Control



Siderite



Manganese  
Oxide



MMO

# Treatability Results

- Sulfide concentration in the sand-only layer is slowly increasing over time
- Siderite,  $\text{MnO}_2$  and MMO-amended sand layers suppressed dissolved sulfide concentrations not only in overlying water and amended sand porewater but also in underlying sediment porewater over the 214-day test duration.



# Questions/Discussion

