

Occurrence of Heavy Metals in a Freshwater Beach, Lake Erie

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Background

Is groundwater contamination a risk for water supply?

Is it safe to swim?

Industrial Site

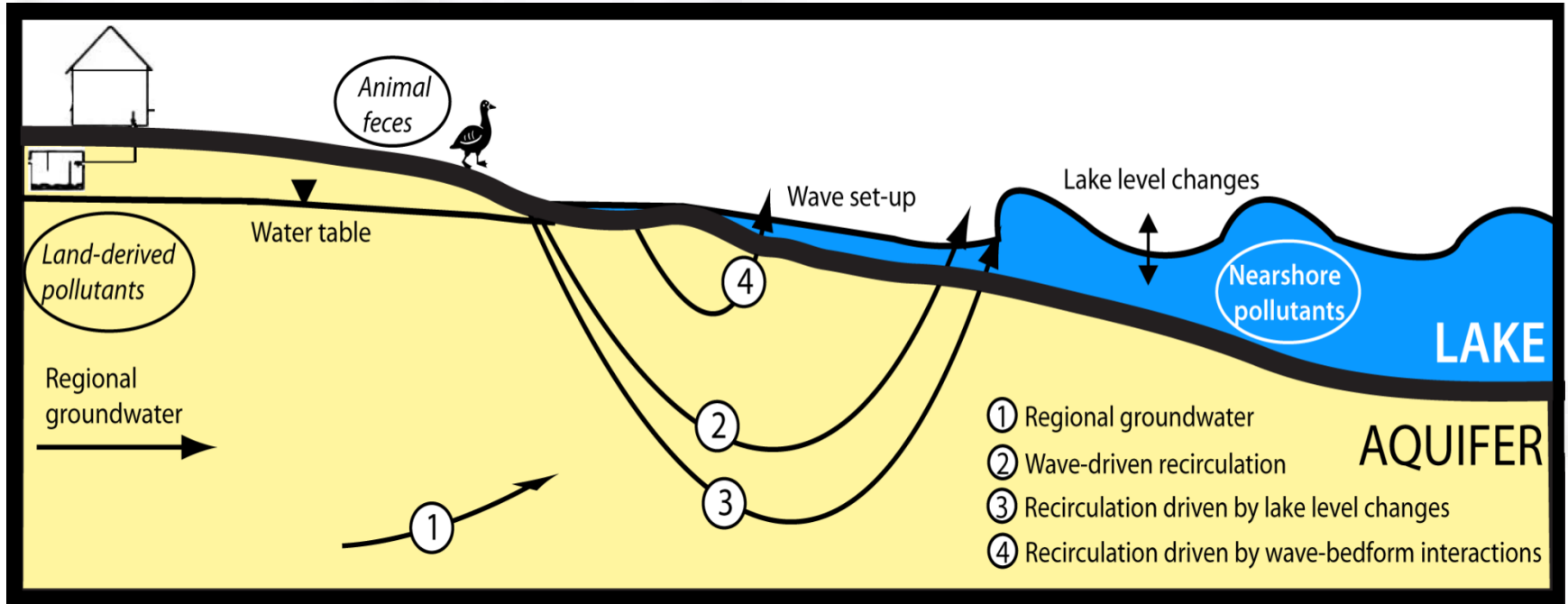
Water Treatment
Plant Intake



Where will groundwater discharge occur?

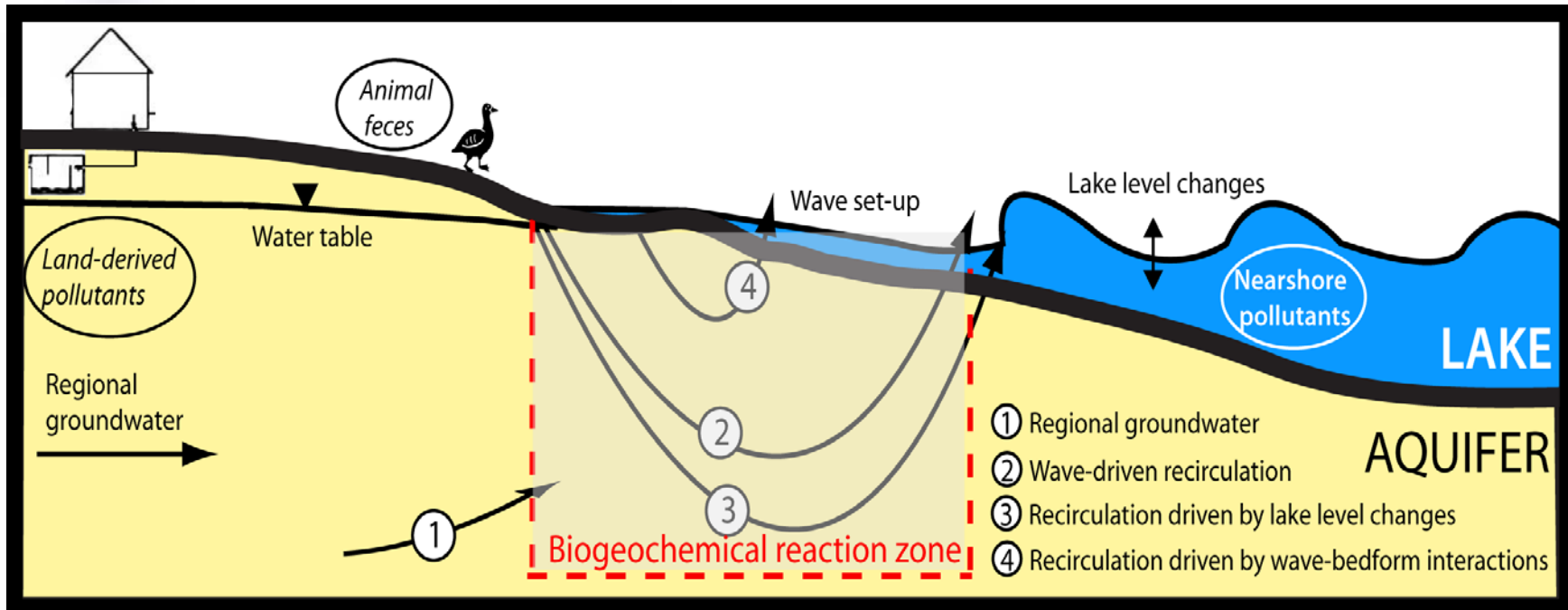


Groundwater discharge “101”



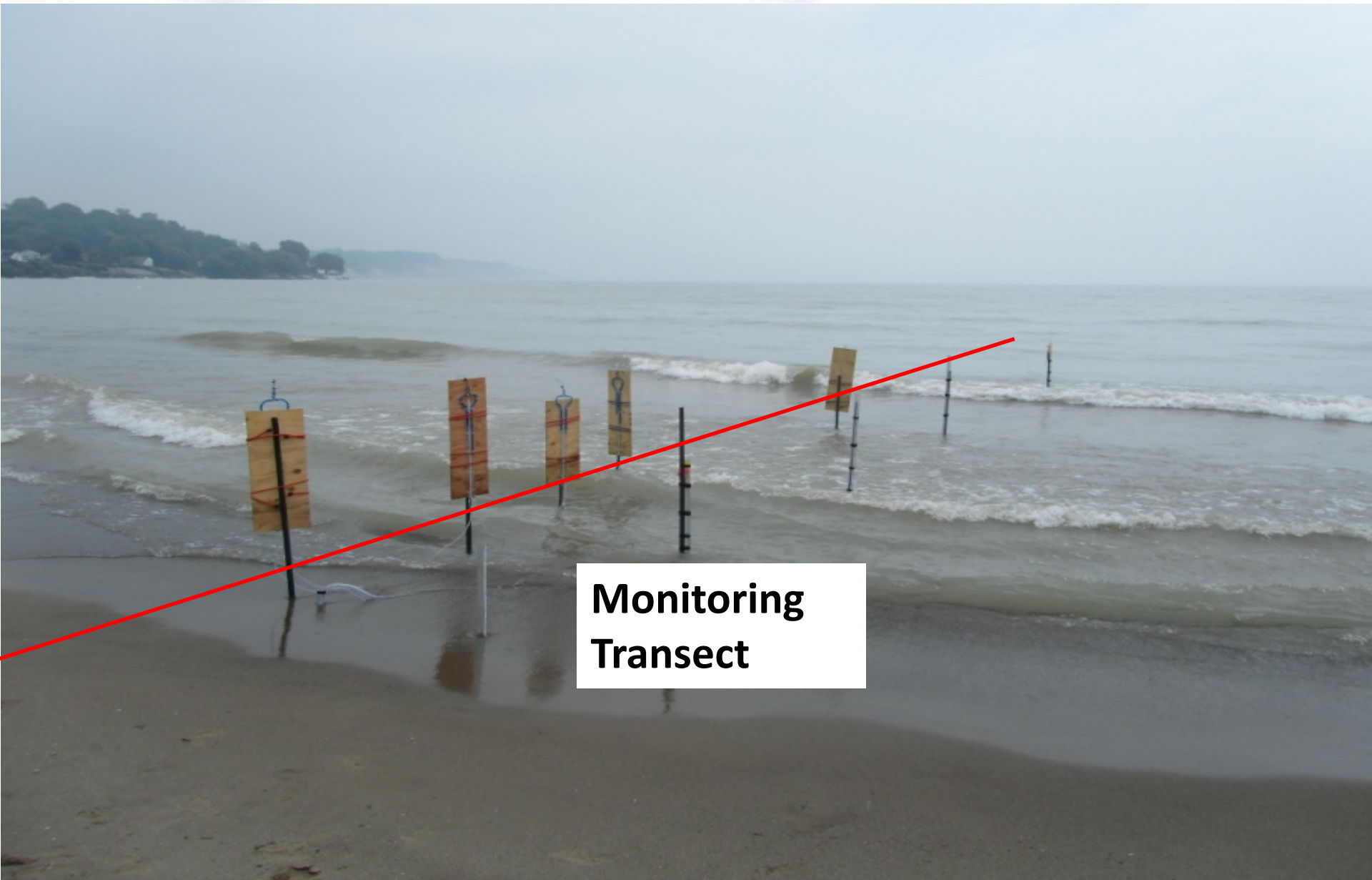
Why do we care about recirculating water?

Groundwater discharge “101”



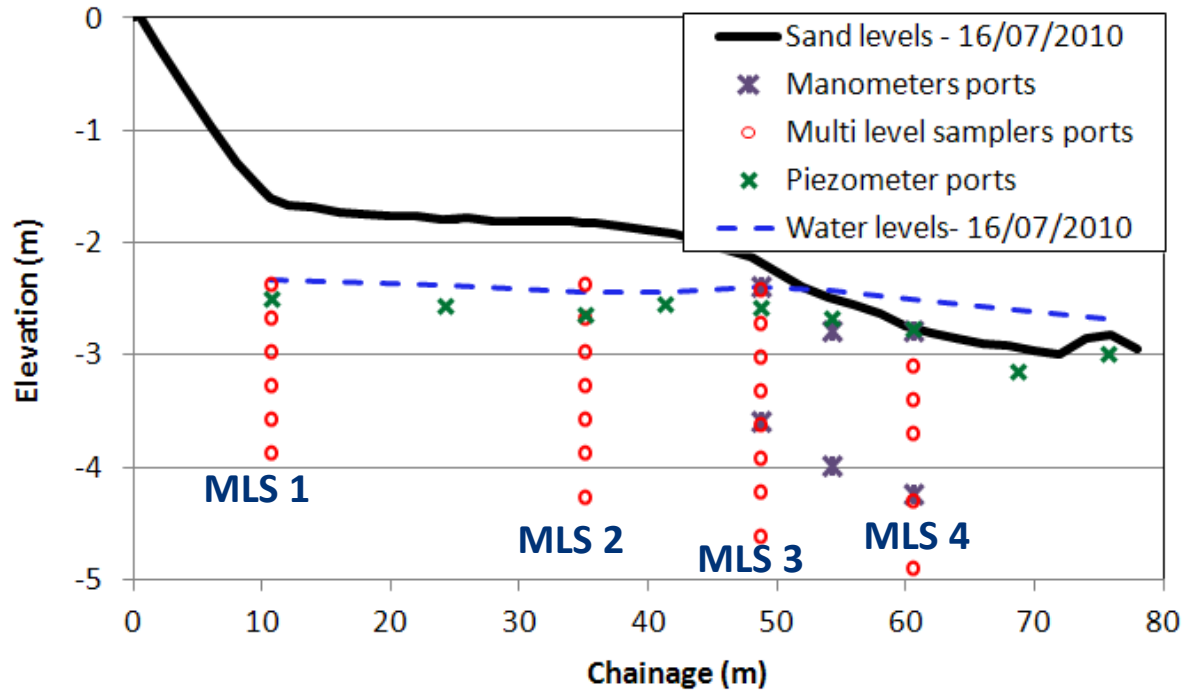
Recirculating water sets up a reaction zone that controls fate of chemicals (**heavy metals**, **nutrients**, **bacteria**) discharging

Beach groundwater monitoring



**Monitoring
Transect**

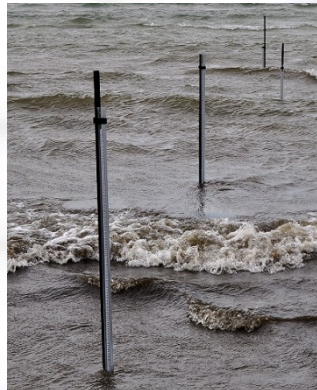
Monitoring equipment



Groundwater samples



Groundwater levels

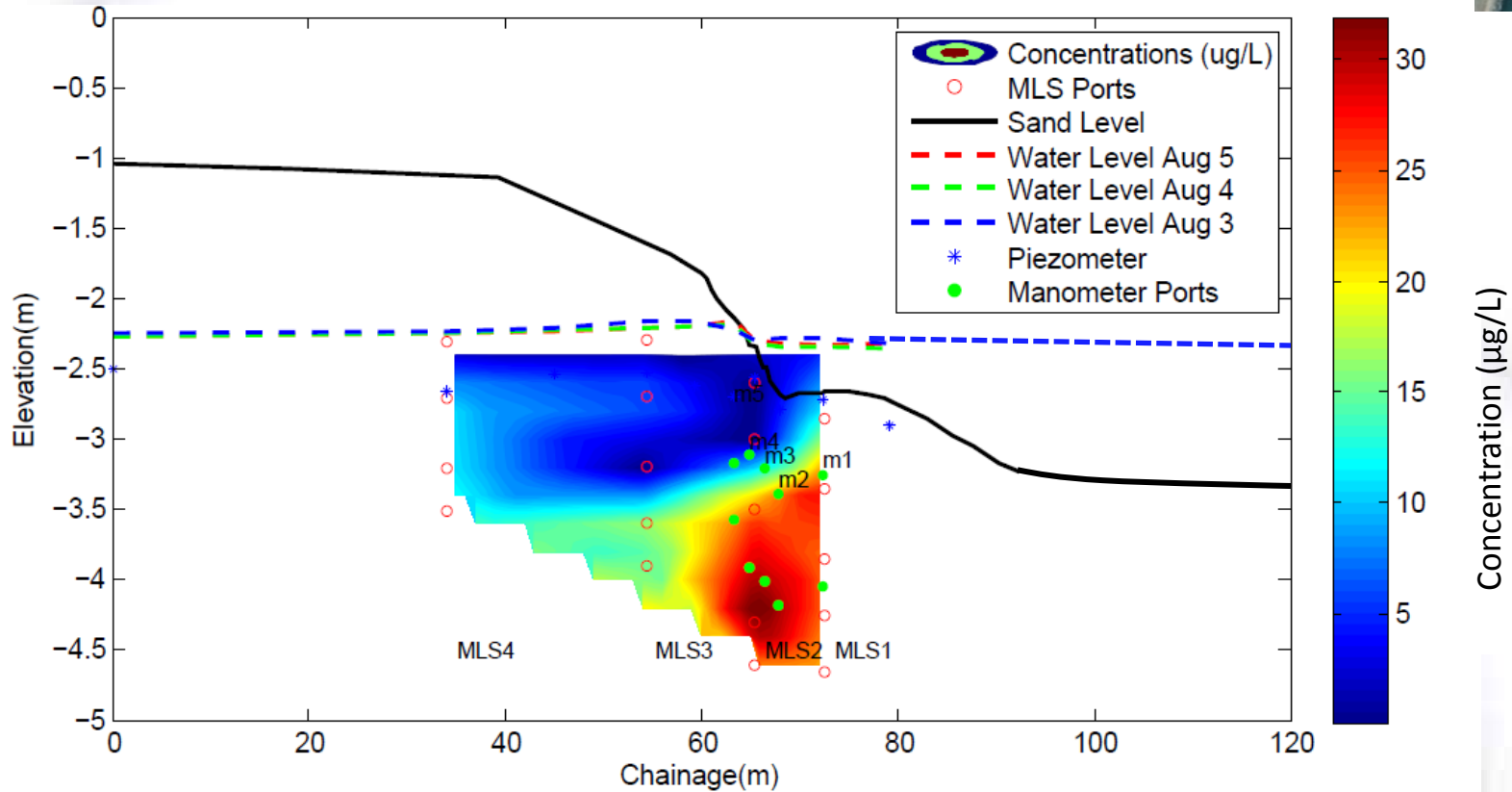
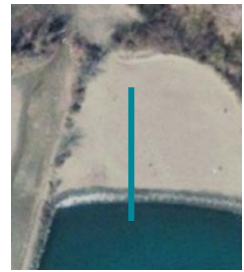


Surface water levels



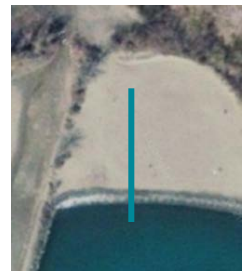
Vertical flows

Arsenic concentration in groundwater

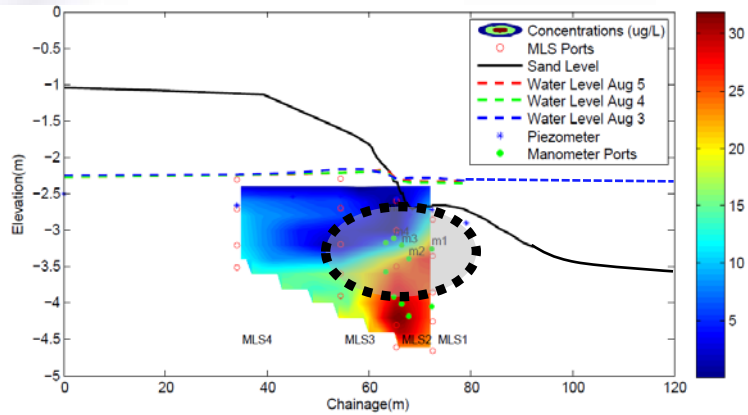


- Arsenic is higher in groundwater below the shoreline ($33\mu\text{g/L}$) than at adjacent industrial site ($20\mu\text{g/L}$).

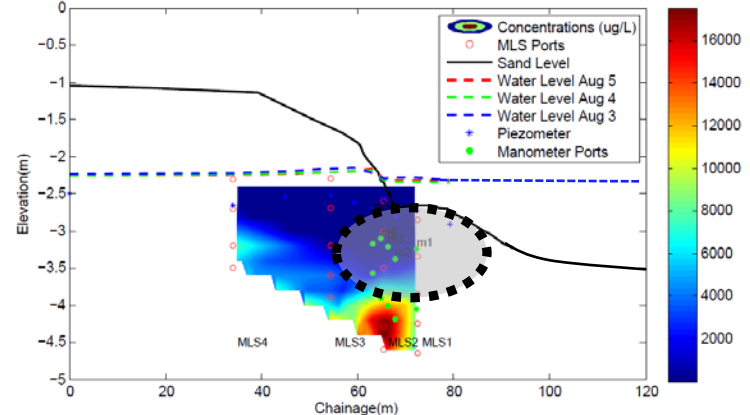
Concentrations in beach groundwater



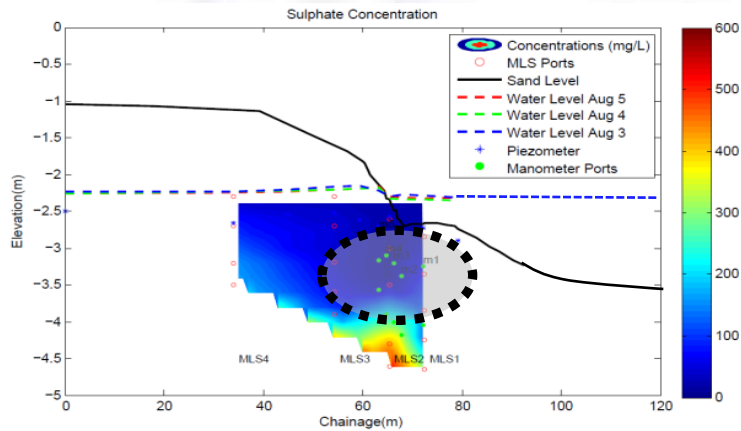
Arsenic



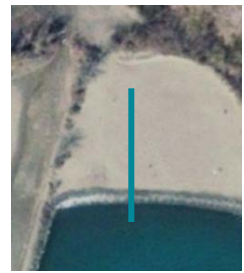
Iron



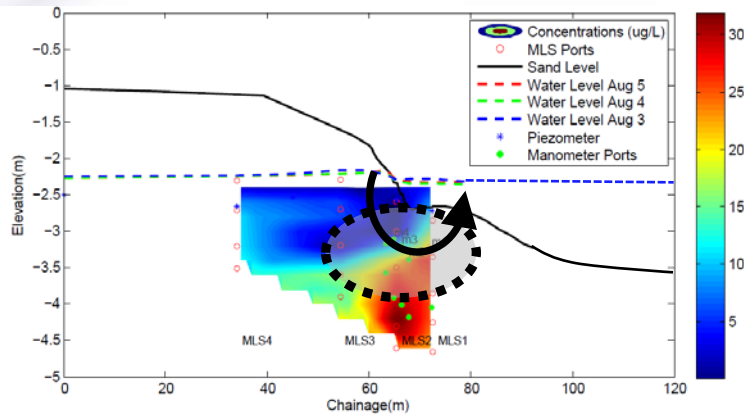
Sulphate



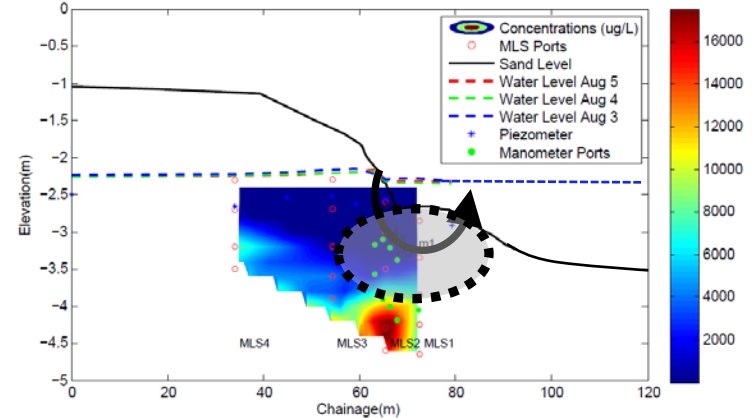
Concentrations in beach groundwater



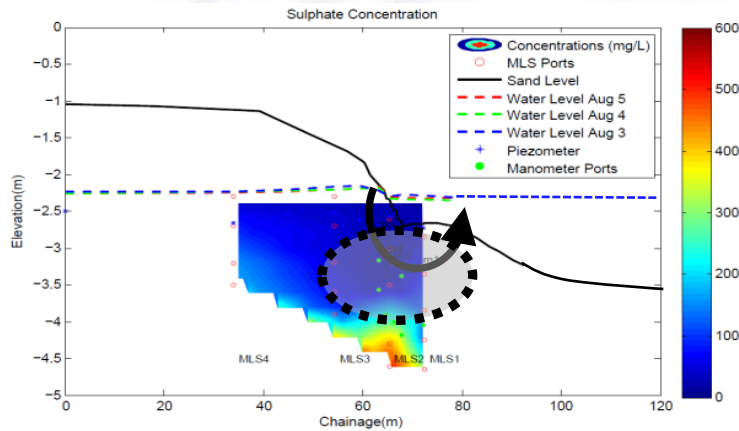
Arsenic



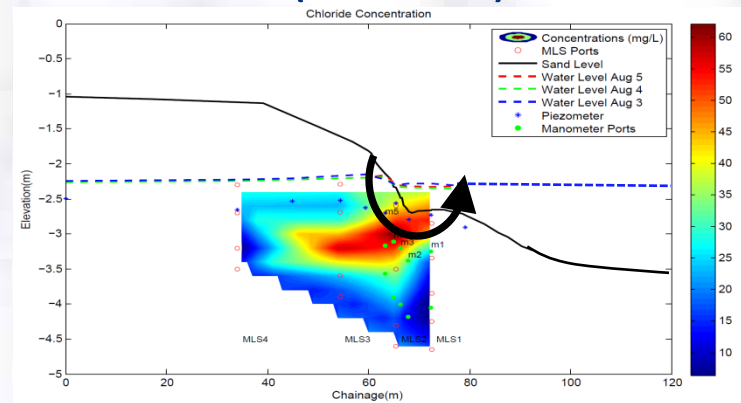
Iron



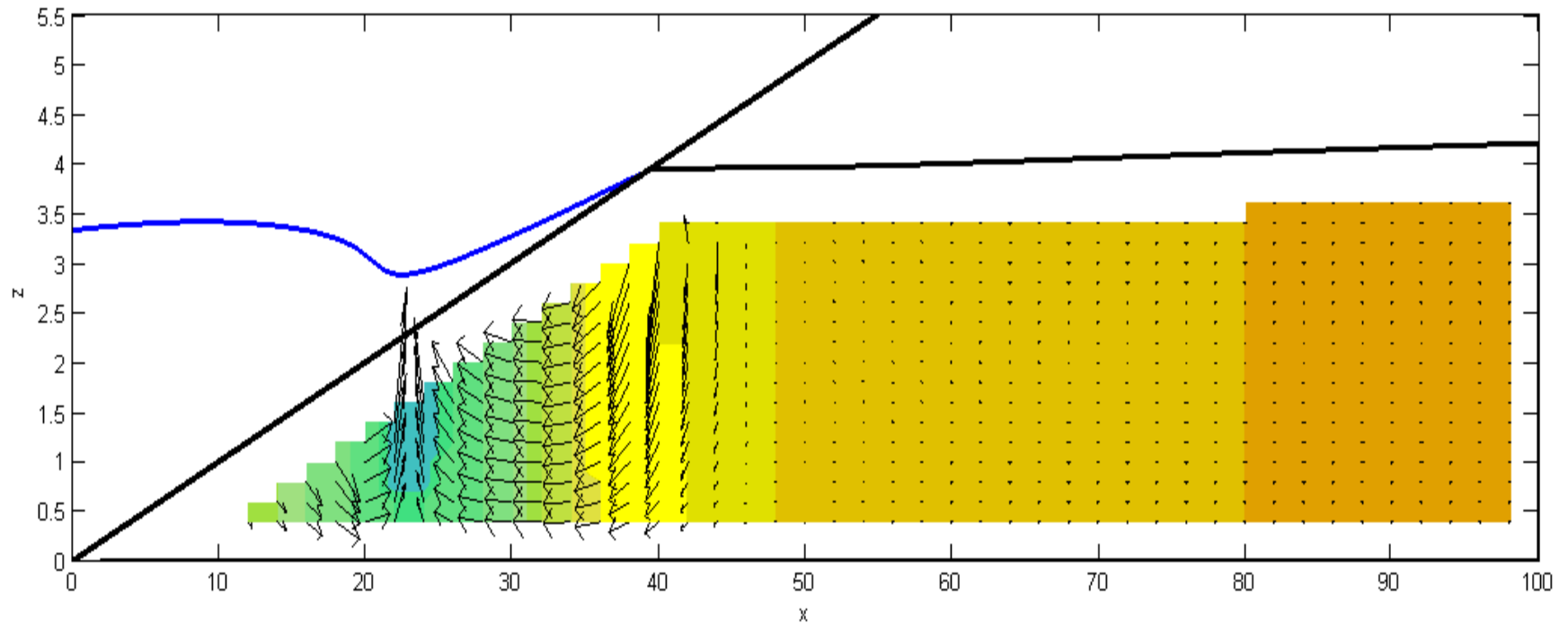
Sulphate



Chloride (tracer?)

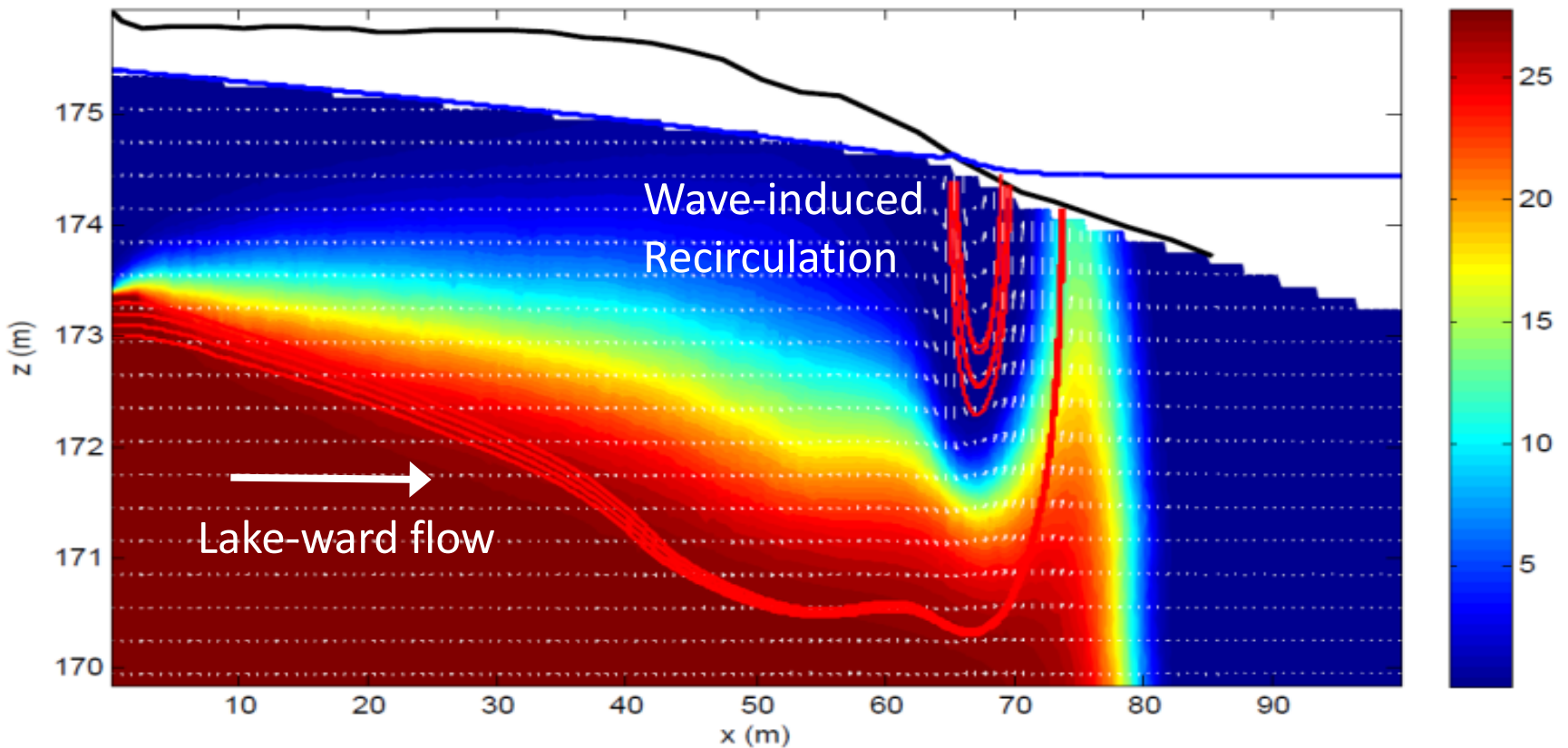


Wave recirculation – numerical model

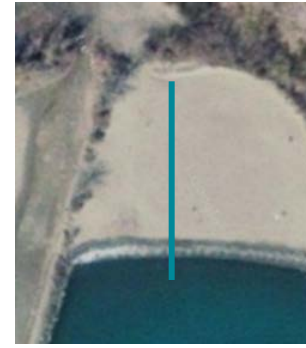


Wave-induced flows – Model simulations

August 2011

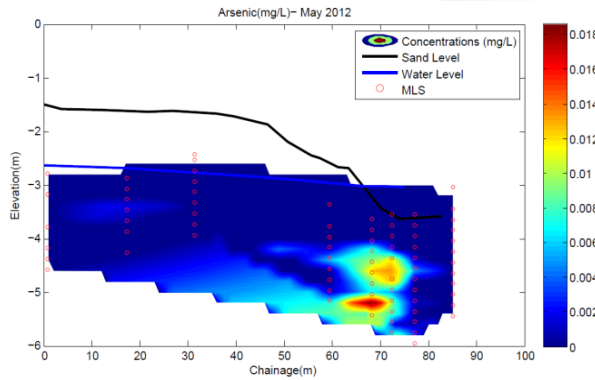


Temporal concentration variability

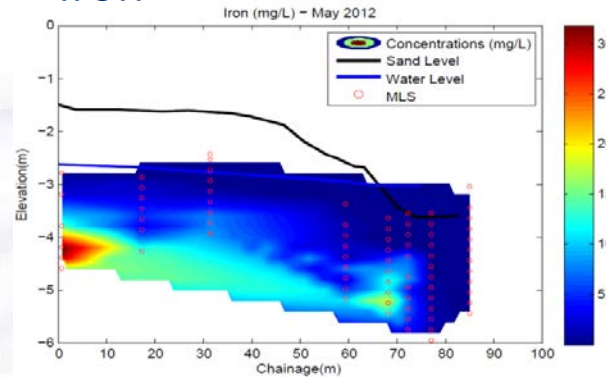


May 2012

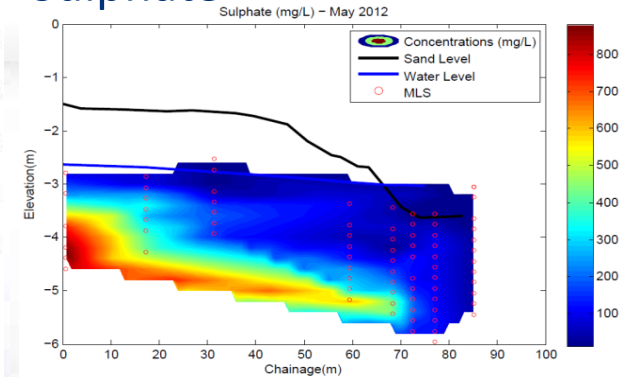
Arsenic



Iron

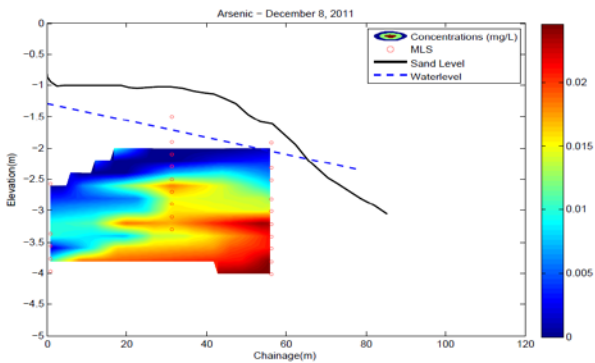


Sulphate

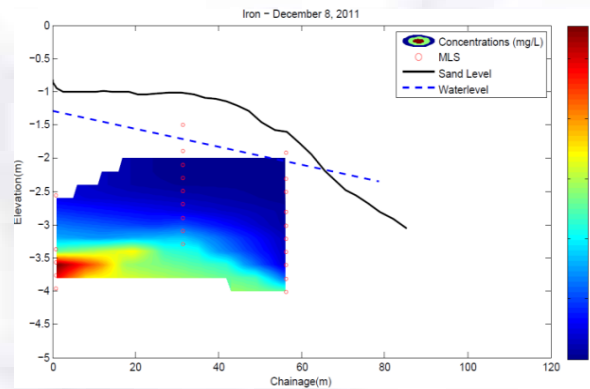


Dec 2011

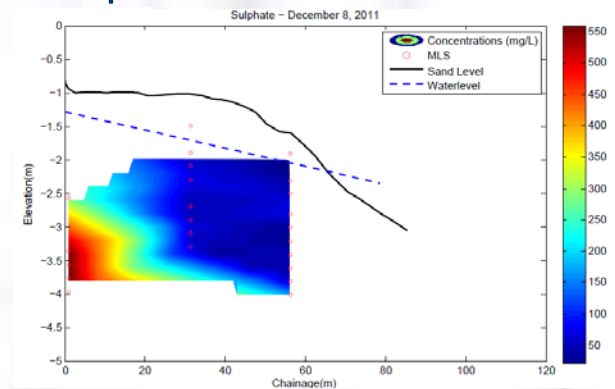
Arsenic



Iron



Sulphate



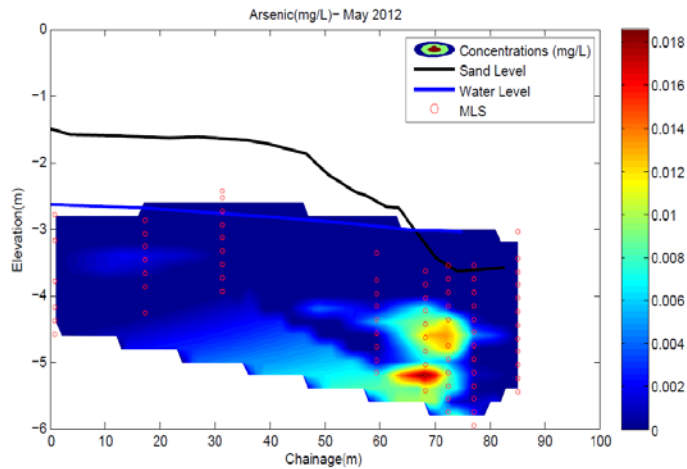
What is happening below the shoreline?

Sediment
analysis

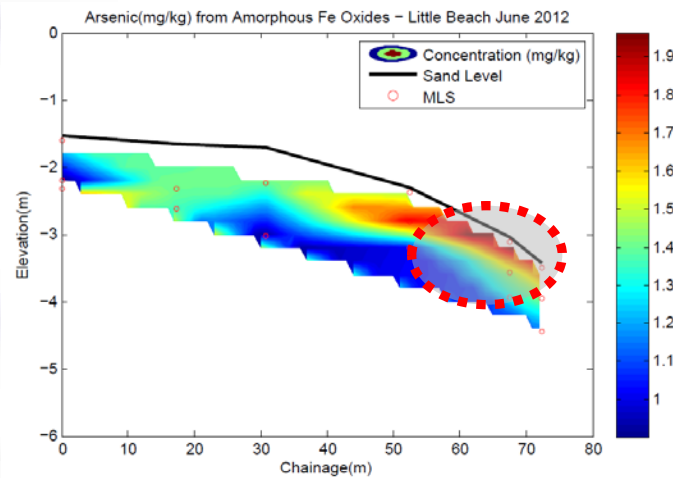


Sediment analysis – selective extraction

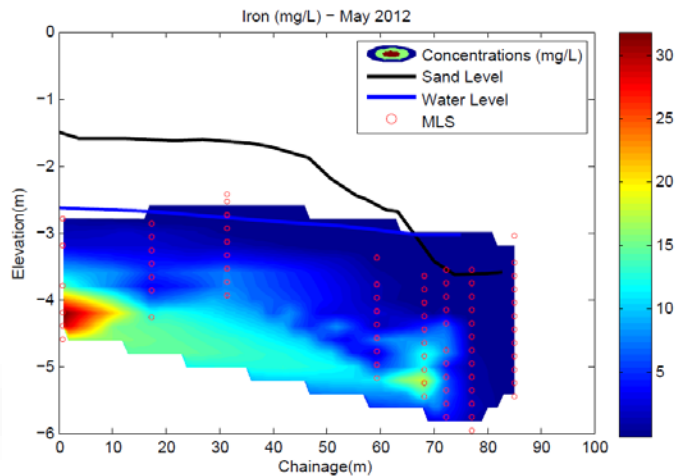
Dissolved Arsenic



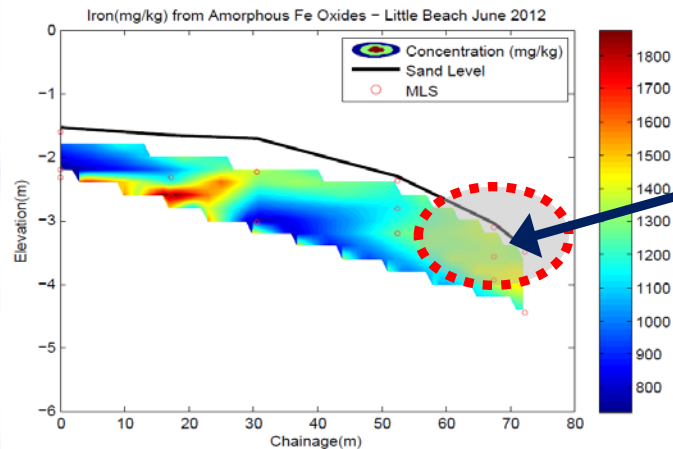
Sediment - Arsenic



Dissolved Iron



Sediment - Iron



Iron curtain

**Traps
chemicals**

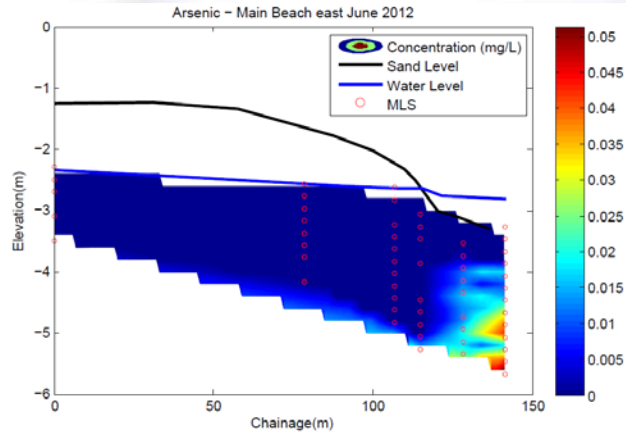
Is arsenic coming from industrial site?



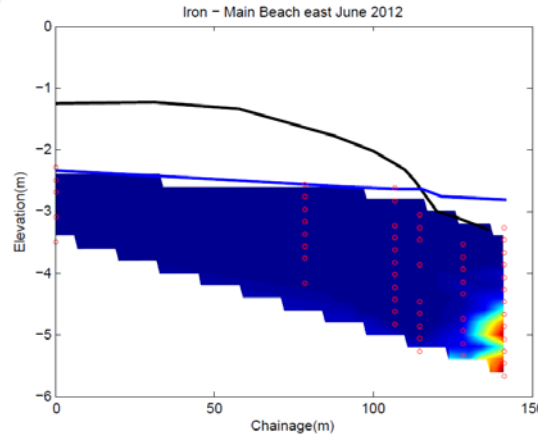
Concentrations at other beaches

Beach 2

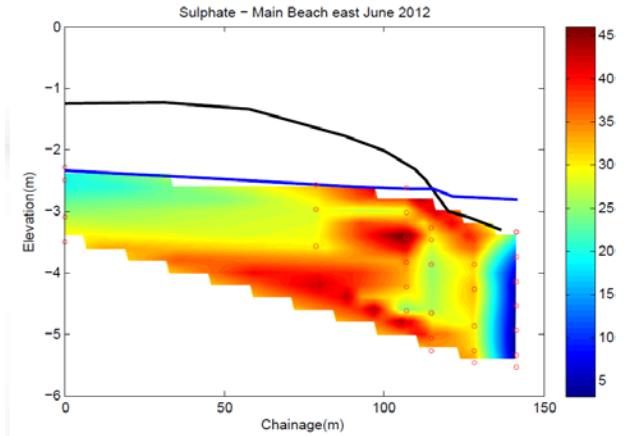
Arsenic



Iron

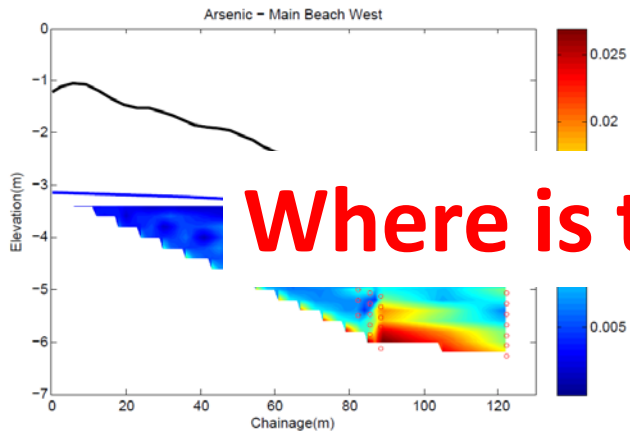


Sulphate

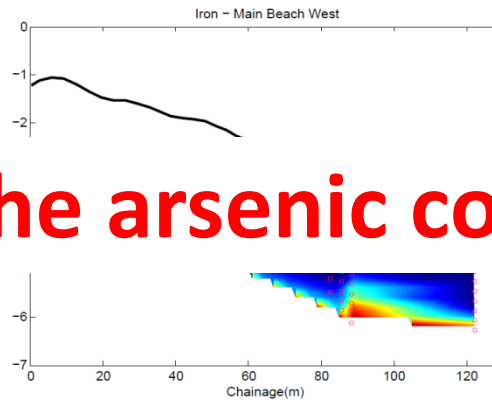


Beach 3

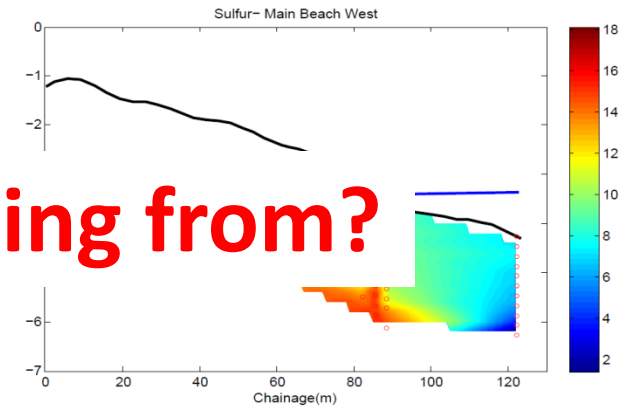
Arsenic



Iron



Sulphate



Where is the arsenic coming from?

Concluding remarks

- Direct implications for remediation of industrial site
- May influence heavy metal budgets for the lakes
- Groundwater-lake interactions strongly control discharge of **heavy metals**, **nutrients** and **bacteria**



Questions?

