3D Modelling of Combined Dredge and Disposal Plumes Dispersion

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Dredging Summit & Expo 2014

About Vale

- Brazilian global mining company;
- Leader in the production of iron ore and the second largest producer of nickel;
- Operations exist in more than 30 countries over the five continents
- Products:

➔Coal
➔Copper
➔Energy
➔Fertilizers
➔Iron Ore
➔Logistics
➔Manganese and Ferro-Alloys
➔PGM & Precious Metals
➔Steelmaking
➔Nickel

Location

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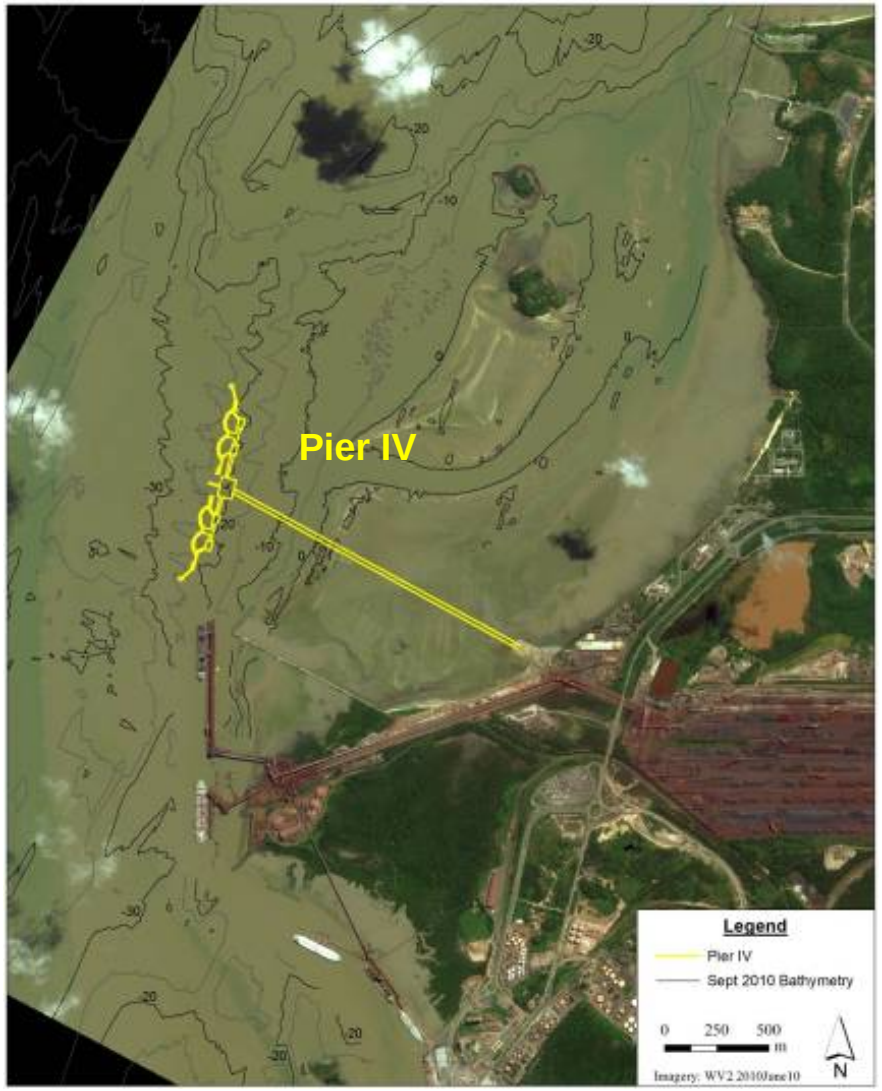
Location



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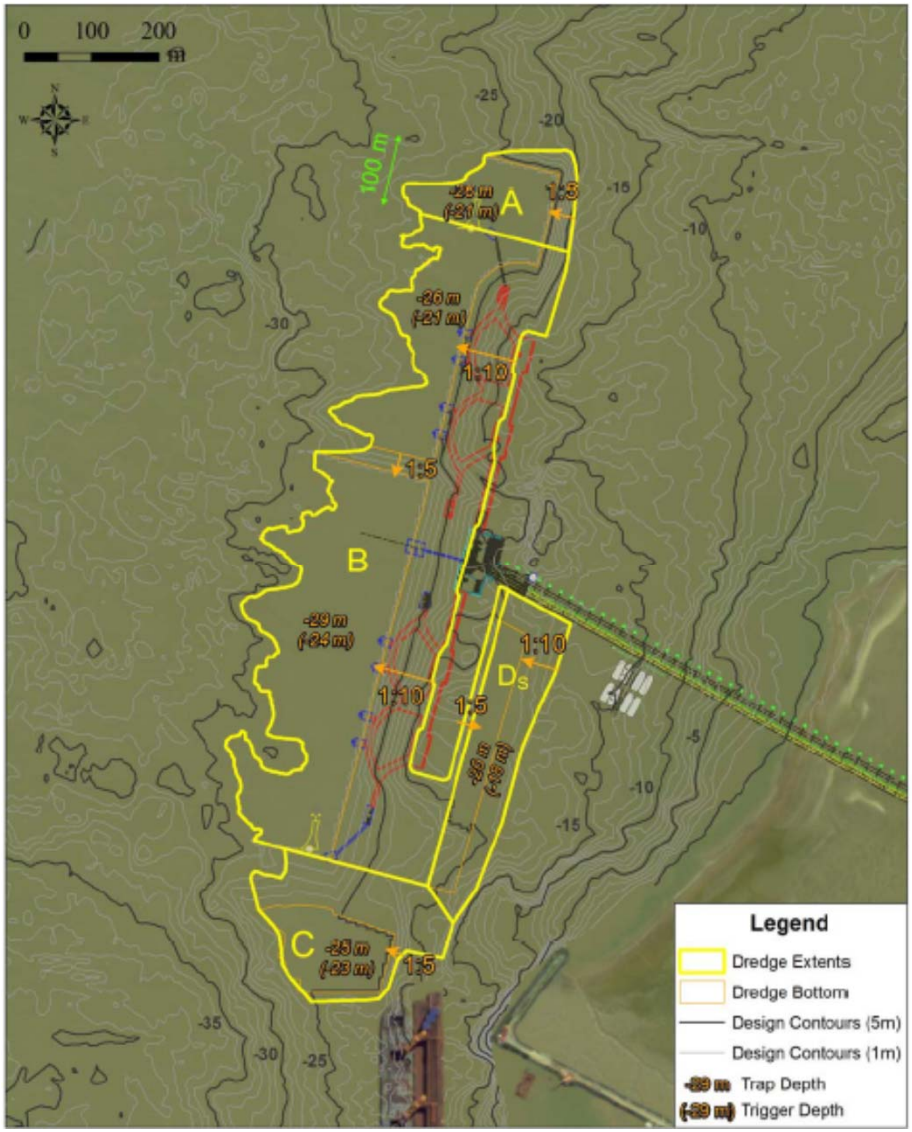
Preliminary dredge design



Capex: 740,000 m^3

Opex: 177,000 m^3/month

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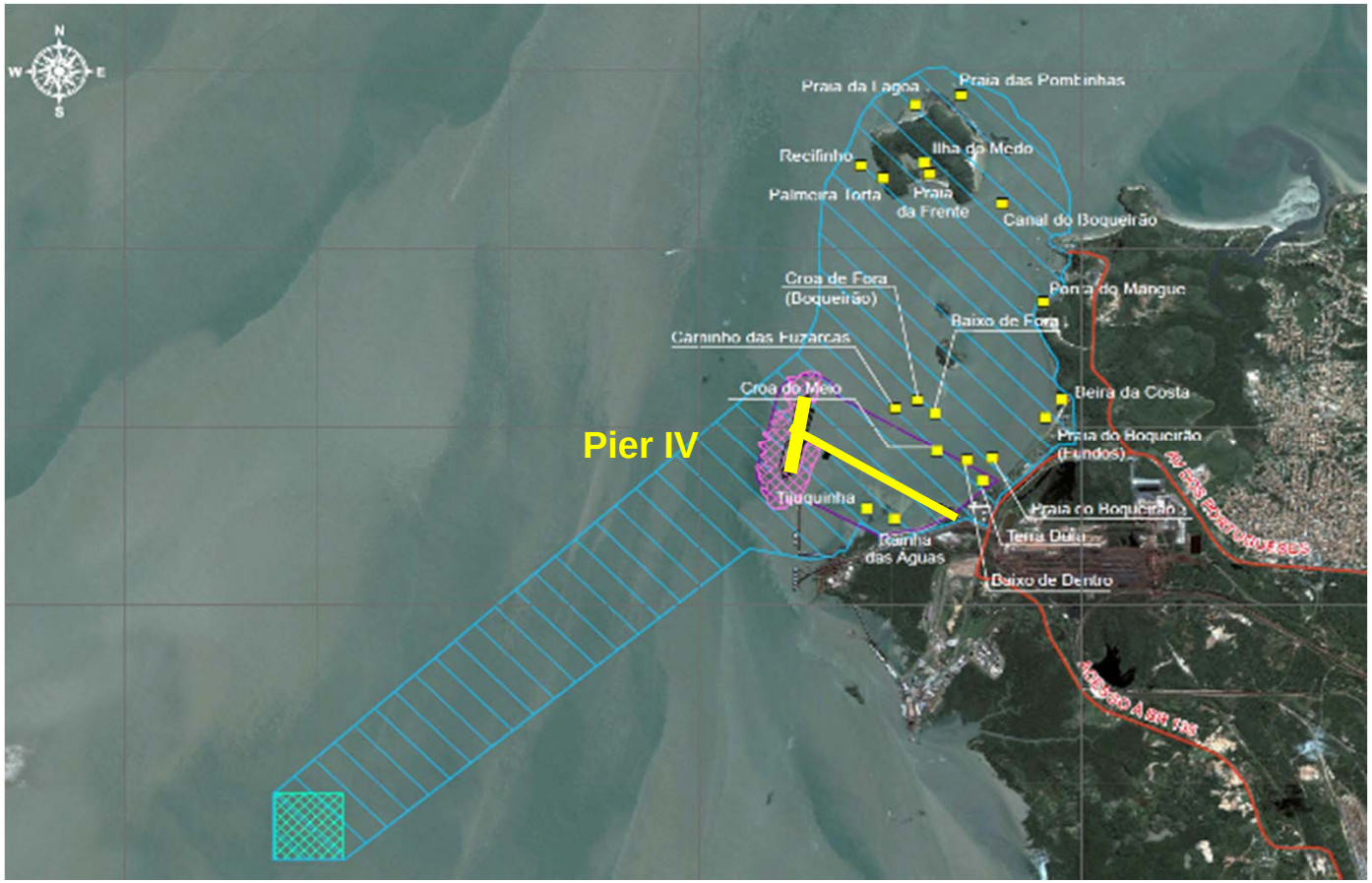
Environmental Requests



Fishing Zones

What is the range of the plumes created at dredging and disposal sites?

What is the impact of those plumes?

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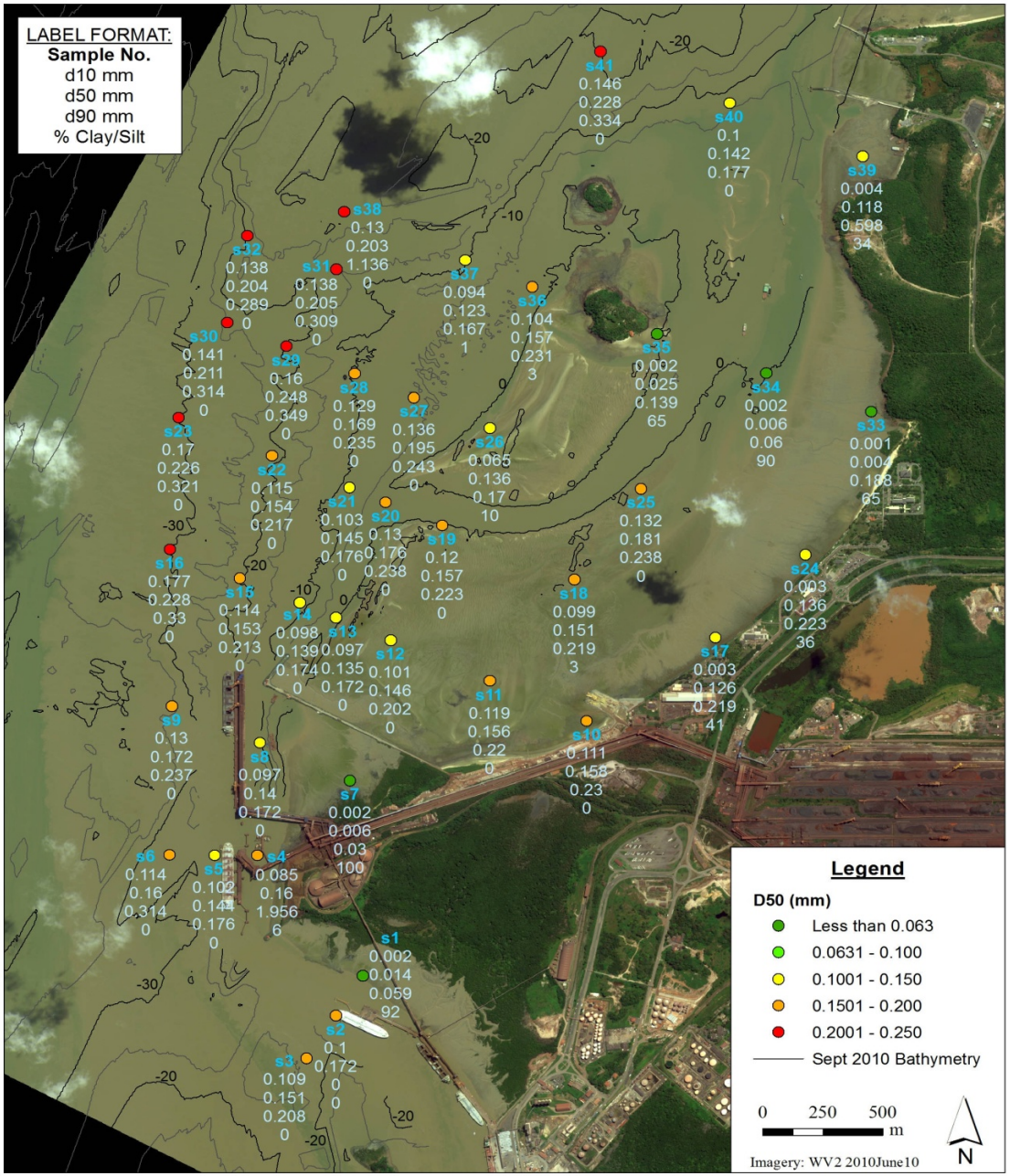
Sediment Properties

Fine Sand (0.13 ~ 0.25 mm)	20%
Very Fine Sand (0.063 ~ 0.13 mm)	78%
Silt and Mud (<0.063 mm)	2%



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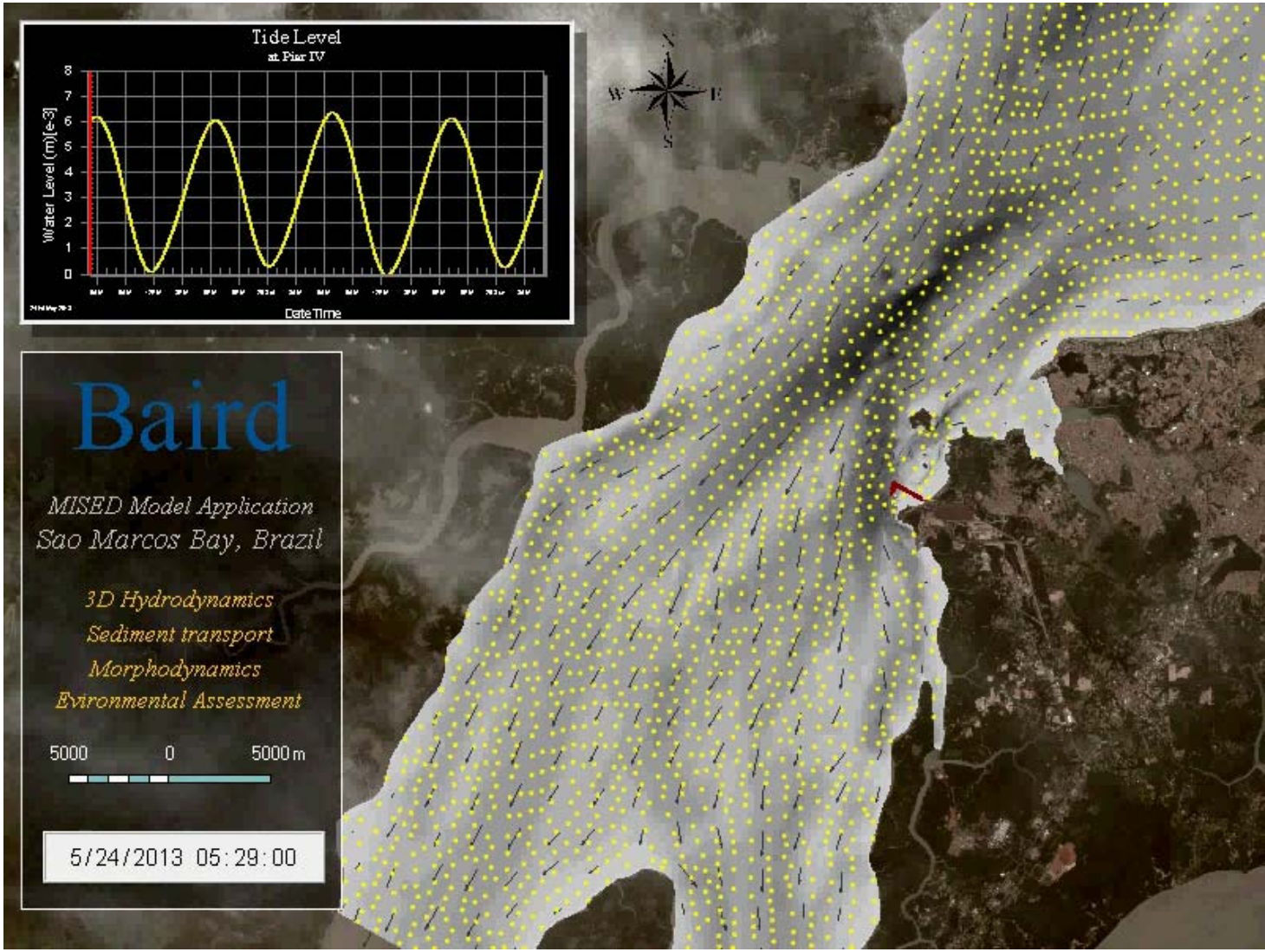
Field work

Ambient SSC Levels

- Average SSC level of 150 mg/l (dry season);
- Variation with tides and seasons in the range from 100 to 250 mg/l
- Based on UFMA and DTA measurements;



Ambient SSC

Month-Year	DEPTH	INSTITUTION	TIDE	Average Concentration (g/L)	Depth-average Concentration (g/L)
Feb-11	Near surface	DTA		0.121	0.151
Feb-11	Mid-depth	DTA		0.179	
Feb-11	Near bottom	DTA		0.153	
Jan-13	Near surface	UFMA	Spring Low	0.137	**0.149**
Jan-13	Mid-depth	UFMA	Spring Low	0.143	
Jan-13	Near bottom	UFMA	Spring Low	0.166	
Jan-13	Near surface	UFMA	Spring High	0.144	**0.146**
Jan-13	Mid-depth	UFMA	Spring High	0.142	
Jan-13	Near bottom	UFMA	Spring High	0.152	
Apr-13	Near surface	UFMA	Spring Low	0.214	0.226
Apr-13	Mid-depth	UFMA	Spring Low	0.230	
Apr-13	Near bottom	UFMA	Spring Low	0.235	
Apr-13	Near surface	UFMA	Spring High	0.264	0.243
Apr-13	Mid-depth	UFMA	Spring High	0.254	
Apr-13	Near bottom	UFMA	Spring High	0.212	
Jul-13	Near surface	UFMA	Spring Low	0.106	0.110
Jul-13	Mid-depth	UFMA	Spring Low	0.131	
Jul-13	Near bottom	UFMA	Spring Low	0.092	
Jul-13	Near surface	UFMA	Spring High	0.210	0.228
Jul-13	Mid-depth	UFMA	Spring High	0.255	
Jul-13	Near bottom	UFMA	Spring High	0.219	

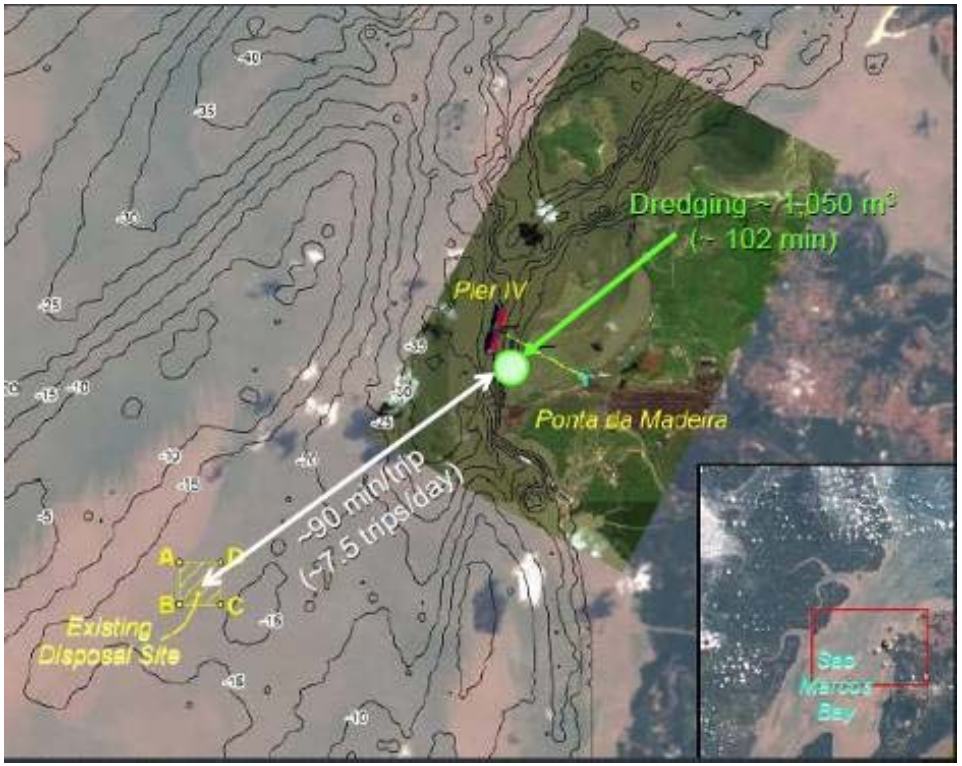
Acceptable SSC Levels

- British Colombia – SSC to protect fish

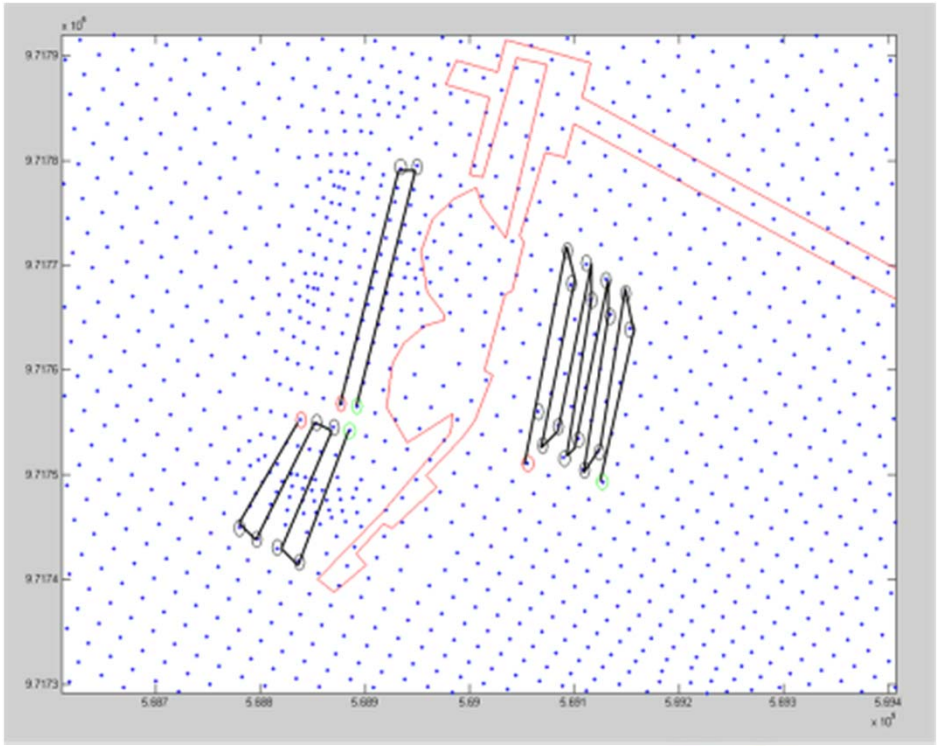
  - When ambient SSC is between 25 and 250 mg/l
    - Maximum increase = 25 mg/l
  - When ambient SSC > 250 mg/l
    - Maximum increase is 10% of ambient

  - Baird assumed
    - Increases < 30 mg/l are considered insignificant
    - Ambient SSC = 150 mg / l

Dredging Cycle



- Each dredge cycle
  - 102 min for dredging
  - 90 min for dump
- ~ 7.5 trips per day on average
- Average dredge volume per trip: 1,050 m^3
- Average daily dredge capacity:~ 7,500 m^3/day



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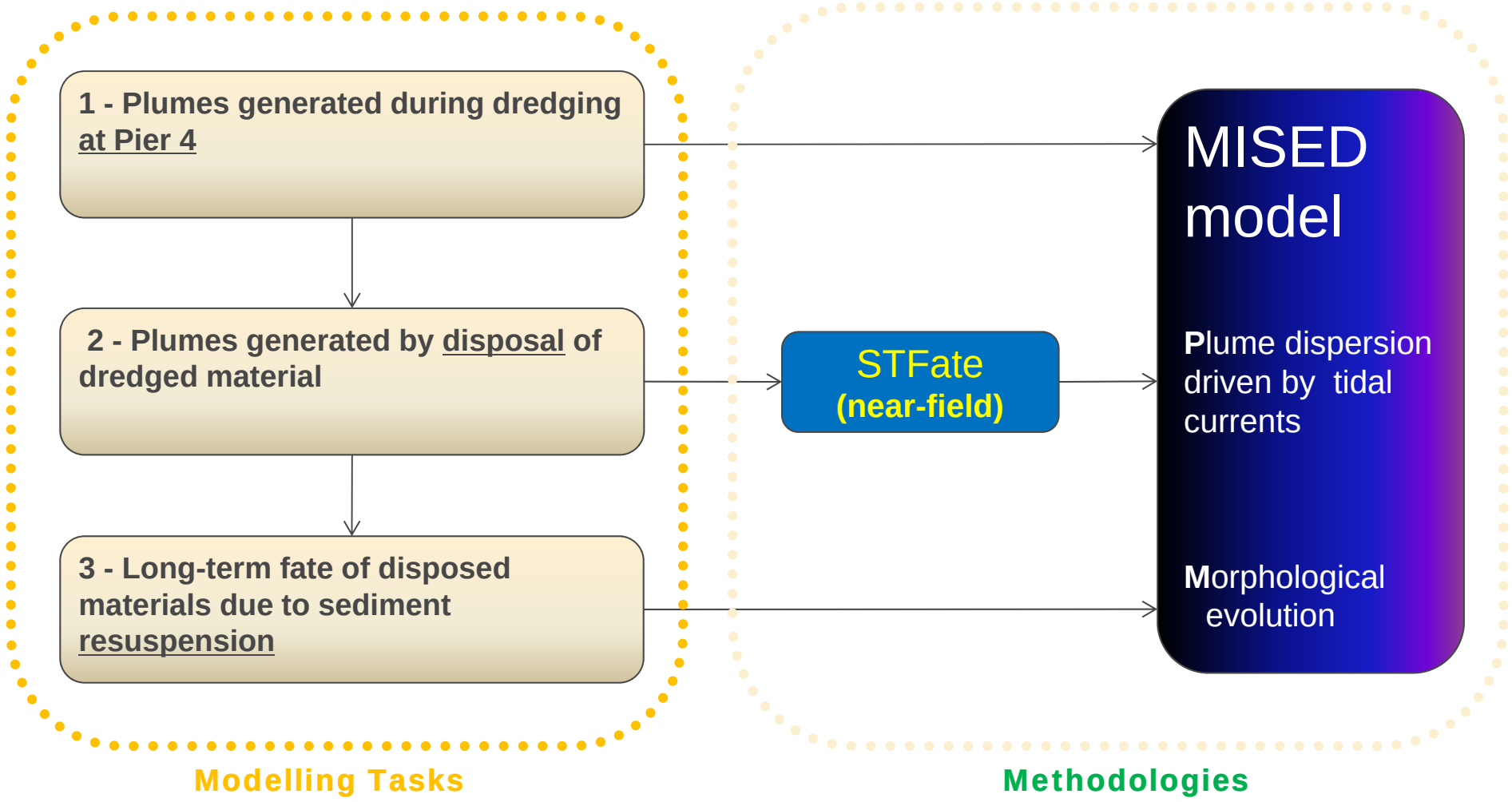
Hybrid Modelling



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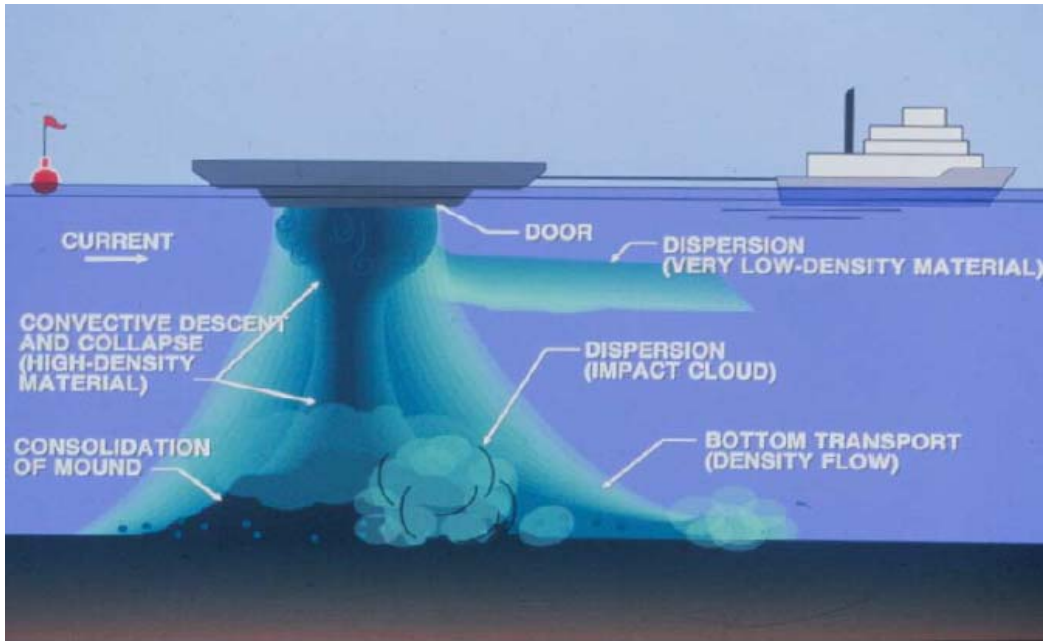
STFATE

Short-Term Fate of Dredged Material

STFATE is the universal tool to:

- Provide deposition pattern and resuspension from placement,
- Manage placement sites,
- Regulatory Compliance (water column concentration),
- Evaluate environmental resource issues



STFATE includes descent, dynamic collapse, bottom transport, and stripping phases

STFATE Model Setup

1-Duration of the disposal

2-10 min

2-Total number of bins

Split dumping

3- Length of bin

50m (~160 ft)

4- Width of bin

13m (~42 ft)

5-Draft of loaded hopper dredge

4.5 m(~14.8 ft)

6-Draft of unloaded hopper dredge

1.8 m(~6 ft)

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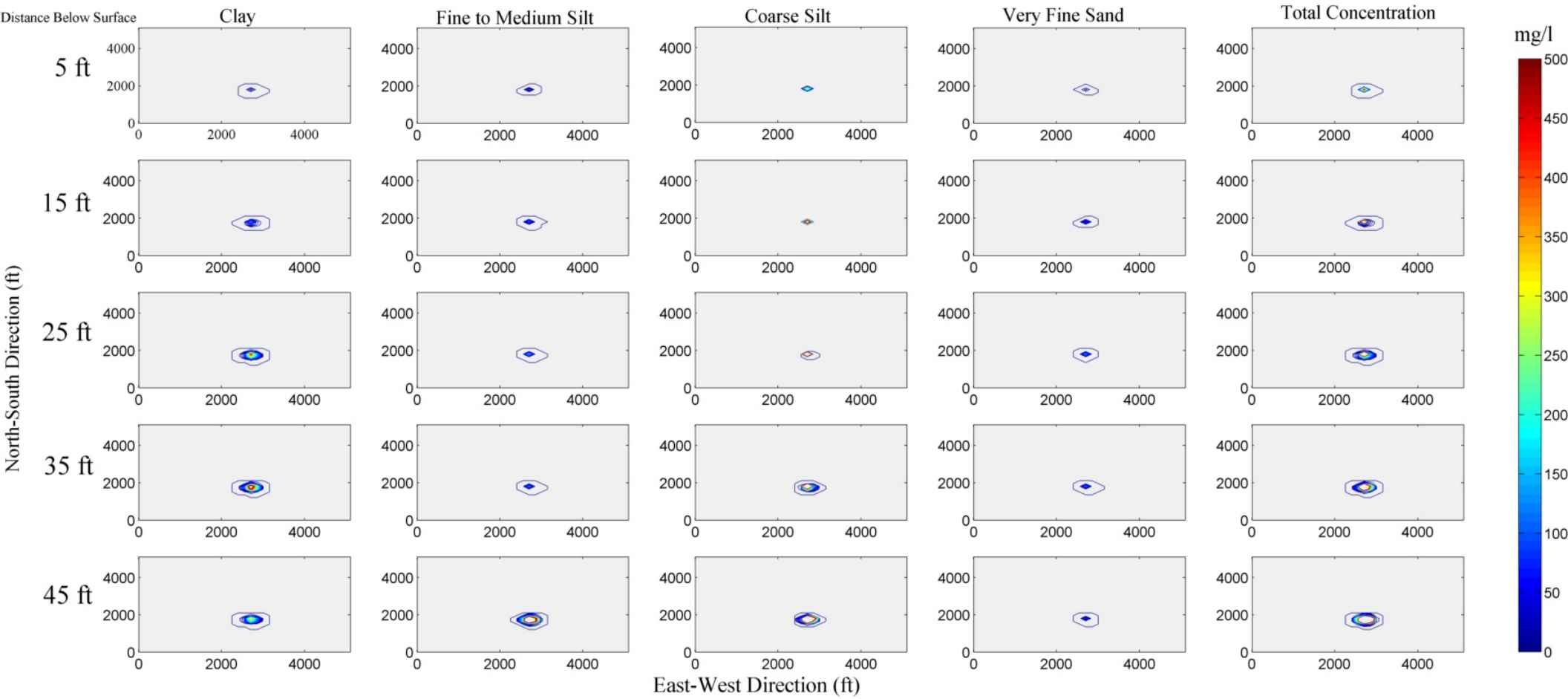
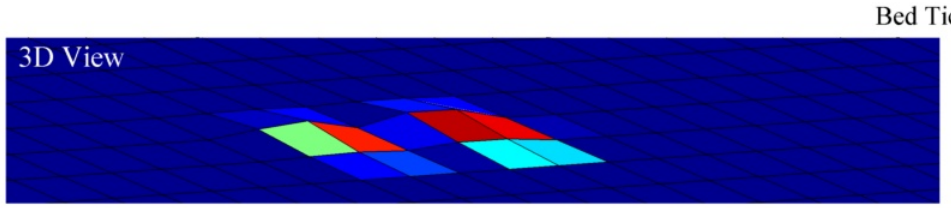
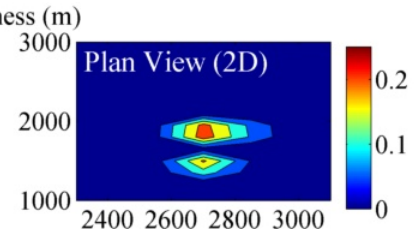
STFATE Sample Results



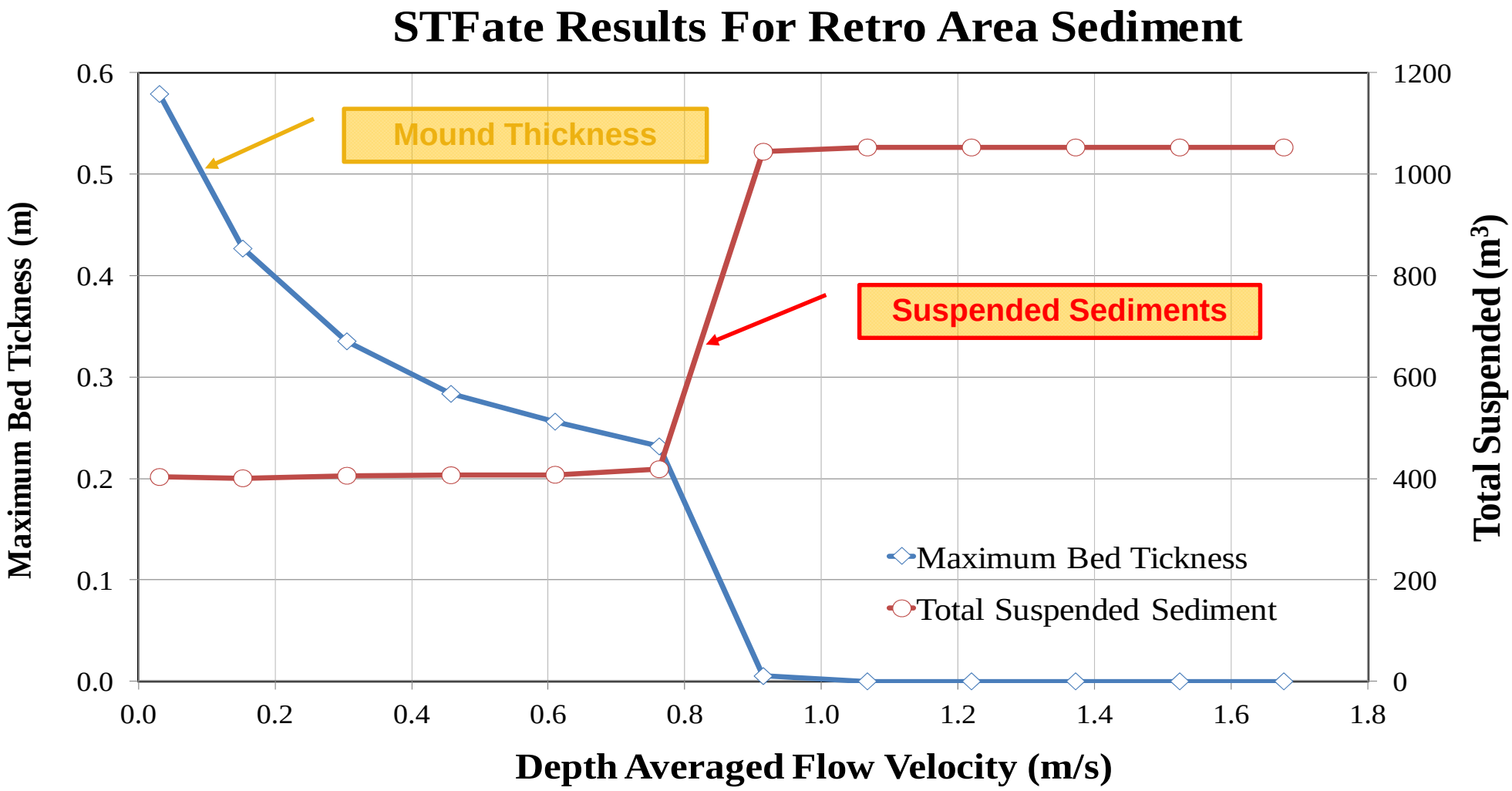




STFate Results for Depth Averaged Velocity of 2.5 ft/s

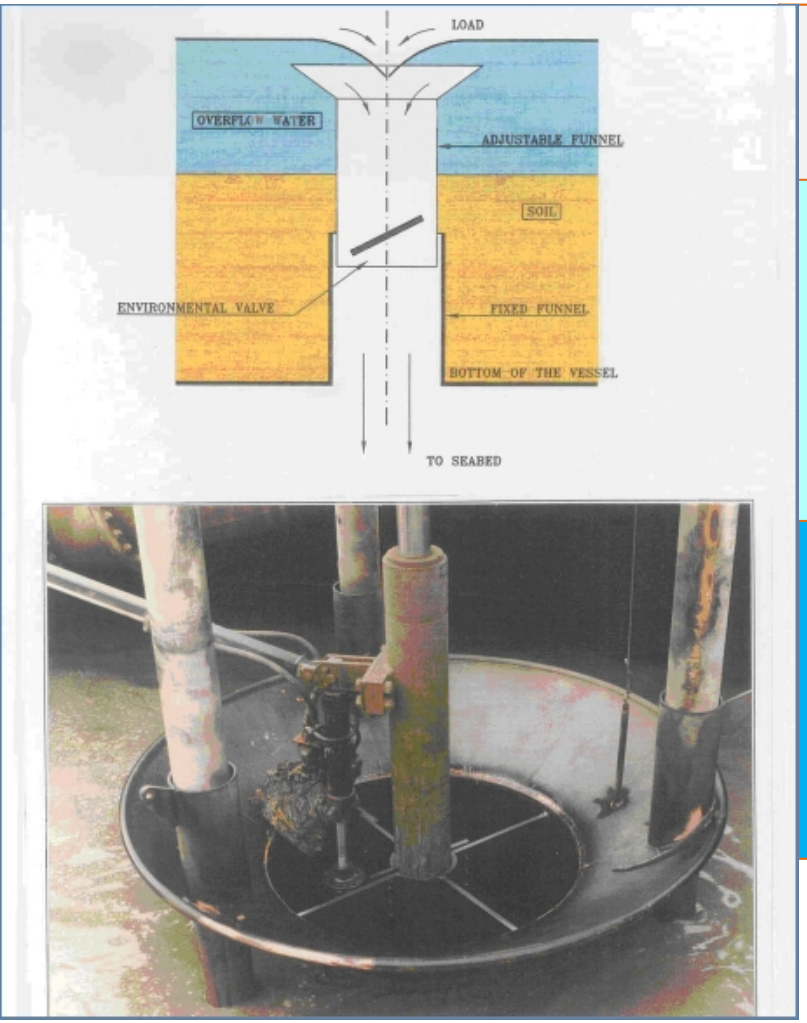
Disposal of Material From Retro Area

STFate Results – Retro Area Sediment Mound thickness ~ flow velocity



Overflow Sediment Properties (Choked Overflow)

(Measurements in August 2013 - Concentration)



Location	Sample	Concentration (g/L)
Retro Area	Overflow D1	3.9
	Overflow D2	4.4
	Overflow D3	3.4
	Overflow D4	4.4
	Overflow D5	3.4
Berth Pocket	Piér 4 P1	0.4
	Piér 4 P2	0.4
	Piér 4 P3	0.5
	Piér 4 P4	0.4
	Piér 4 P5	0.5

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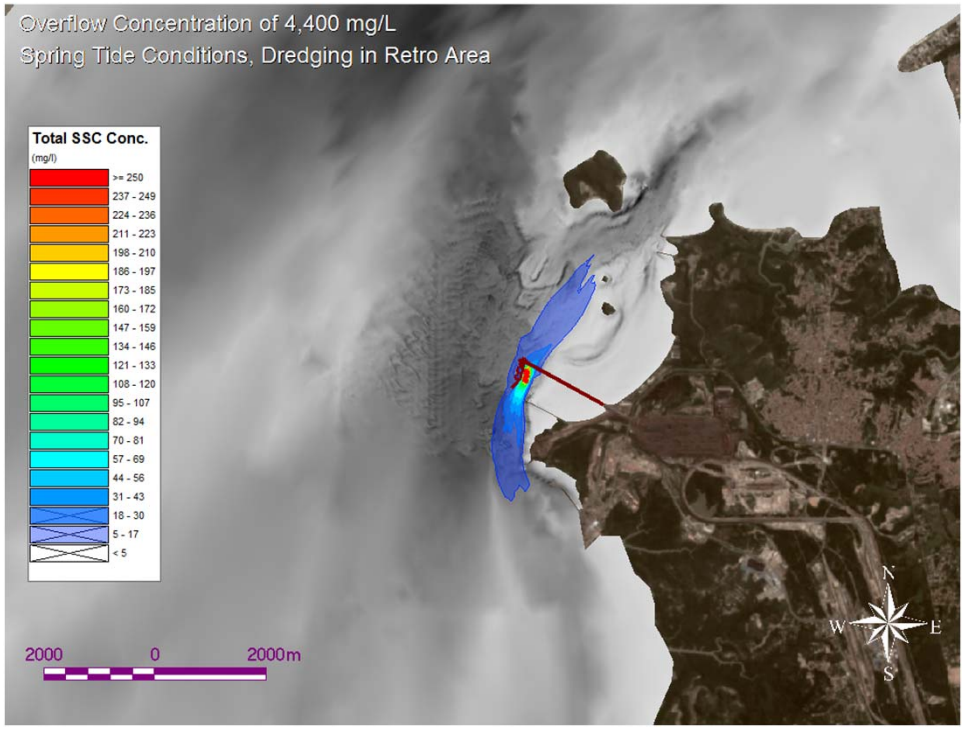
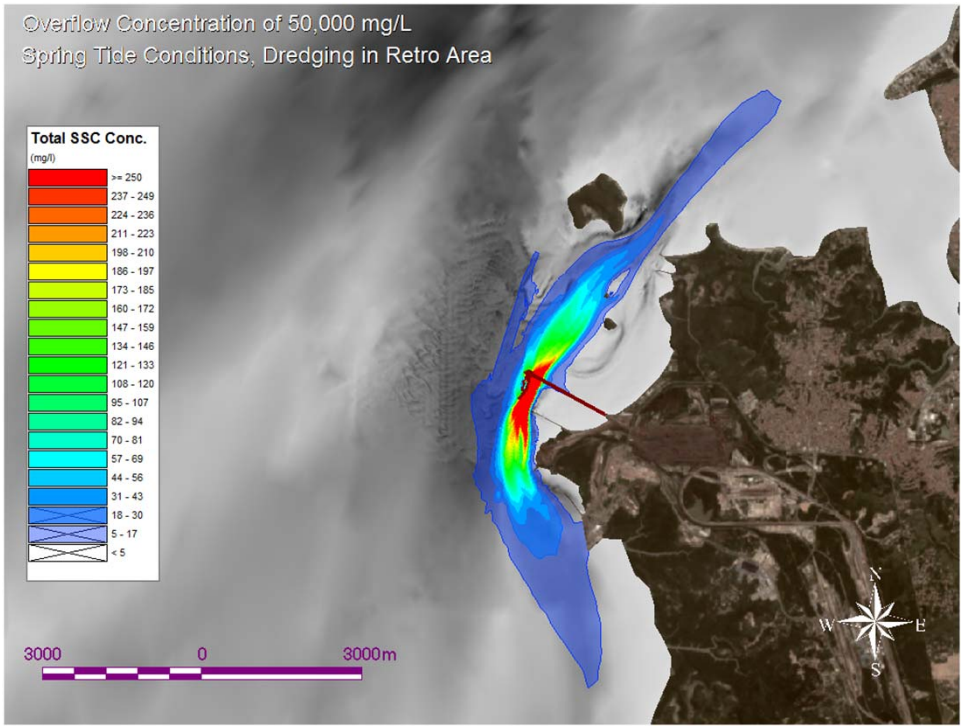
Model Results - Sediment Plume Generated by Dredging Activities



Distribution of maximum predicted concentration with choked overflow



Distribution of maximum predicted concentration for conventional overflow

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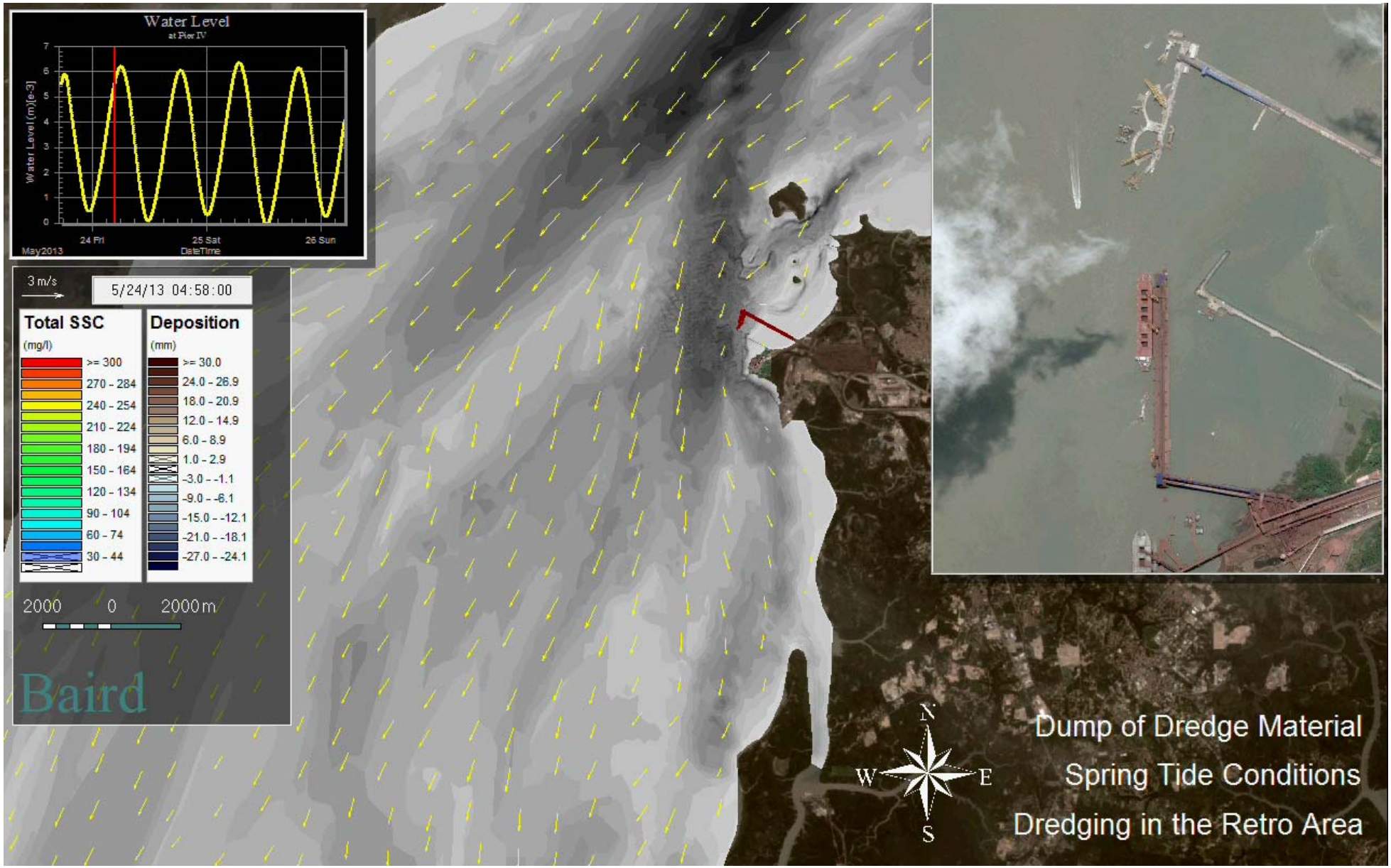
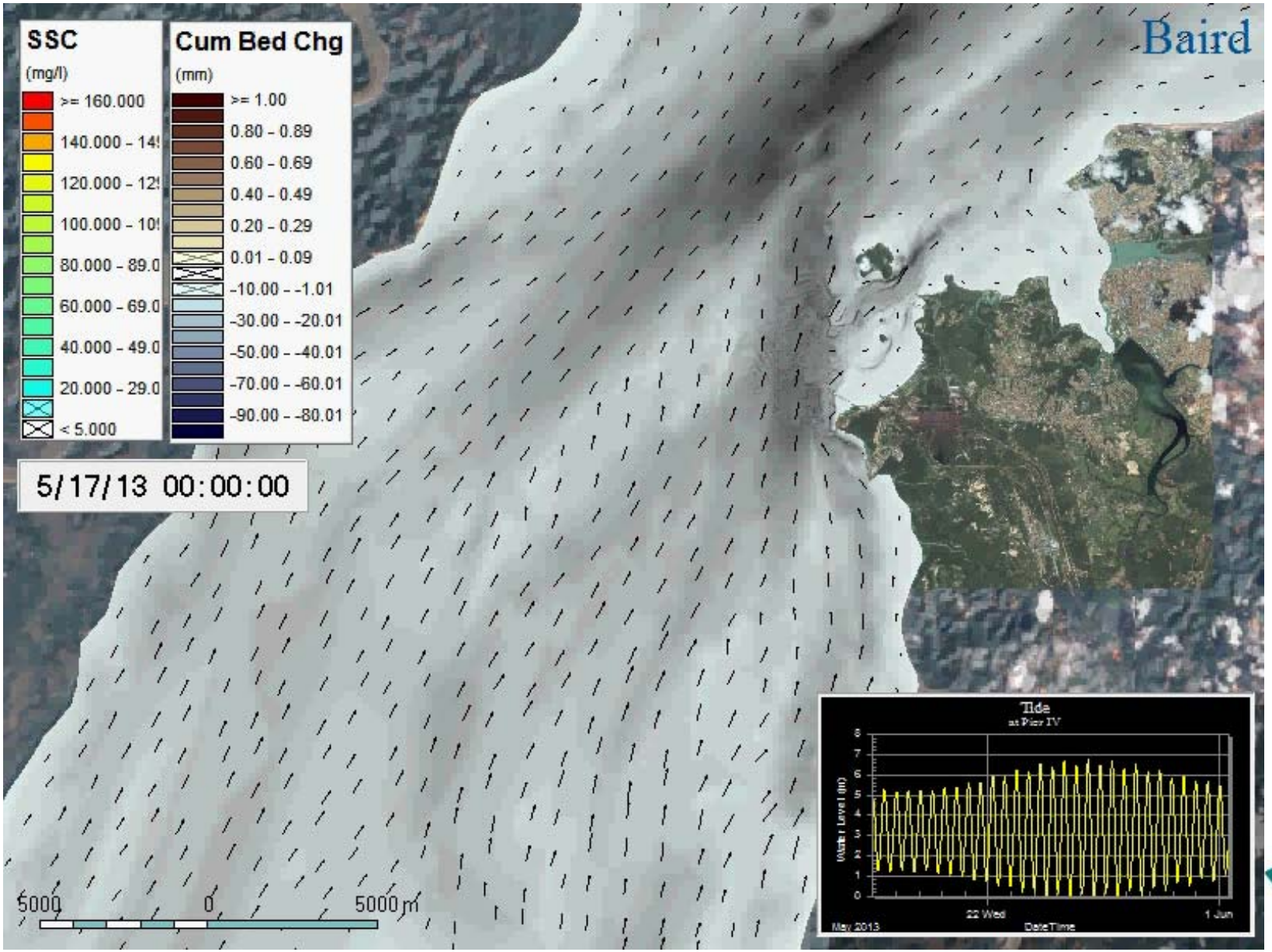
Model Results:

Combined Dredge and Disposal Plumes Dispersion



Model Results:

Sedimentation at the Disposal Site



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Conclusions

- Under current dredging practice the increase in ambient suspended sediment concentration is limited to the area around the dredge. Any increase in areas beyond Pier IV structure is insignificant;

- The influence of dredged material disposal activities is limited to 5 km to the north and 1 km to the south of disposal site,

- It was concluded that any impact of the dredge plume dispersion on sedimentation in the neighbouring areas would be insignificant and not measurable.

Obrigado, Thank you, Merci beaucoup!