# Initial Dilution of a Deep Sea Outfall

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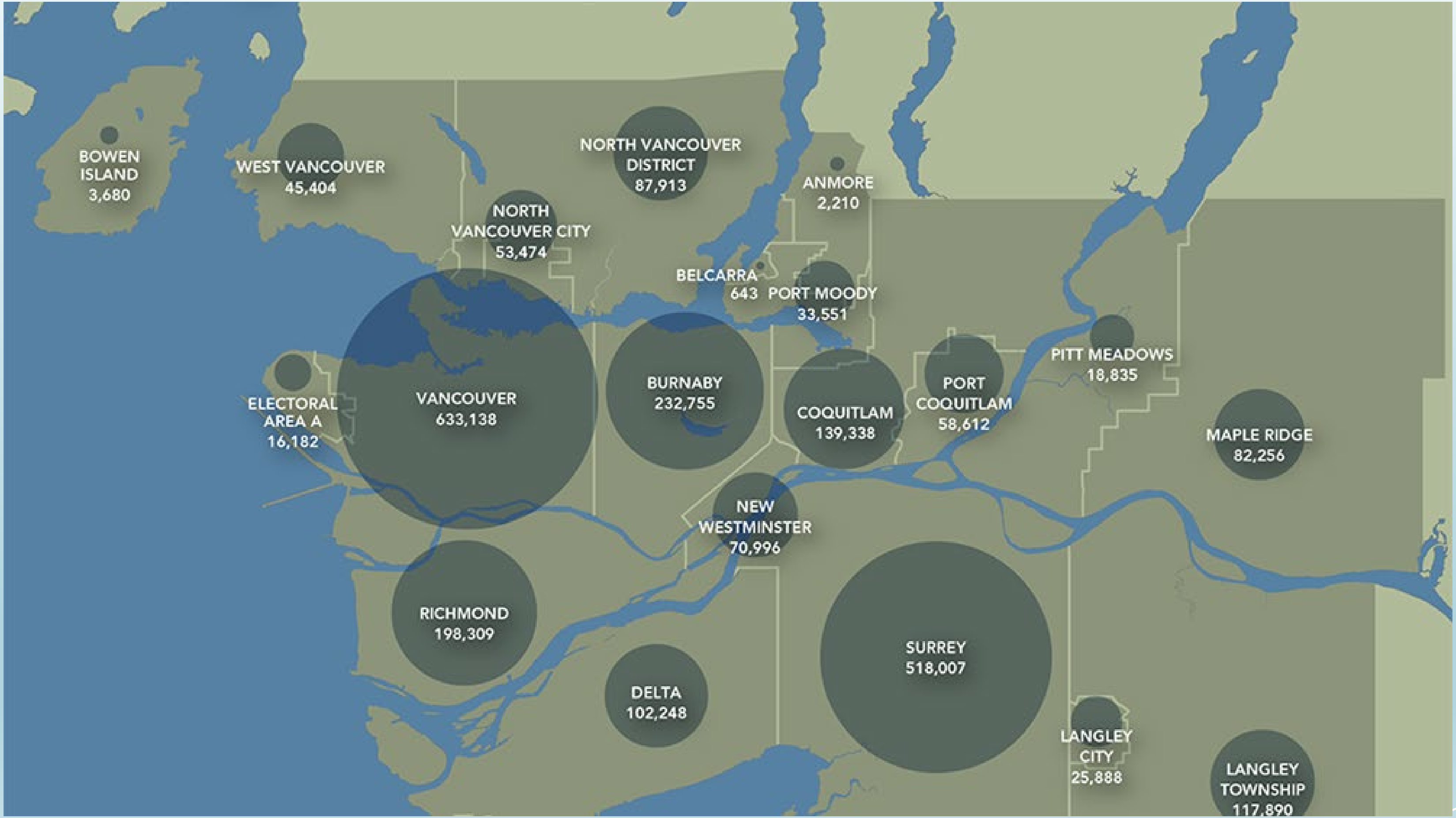
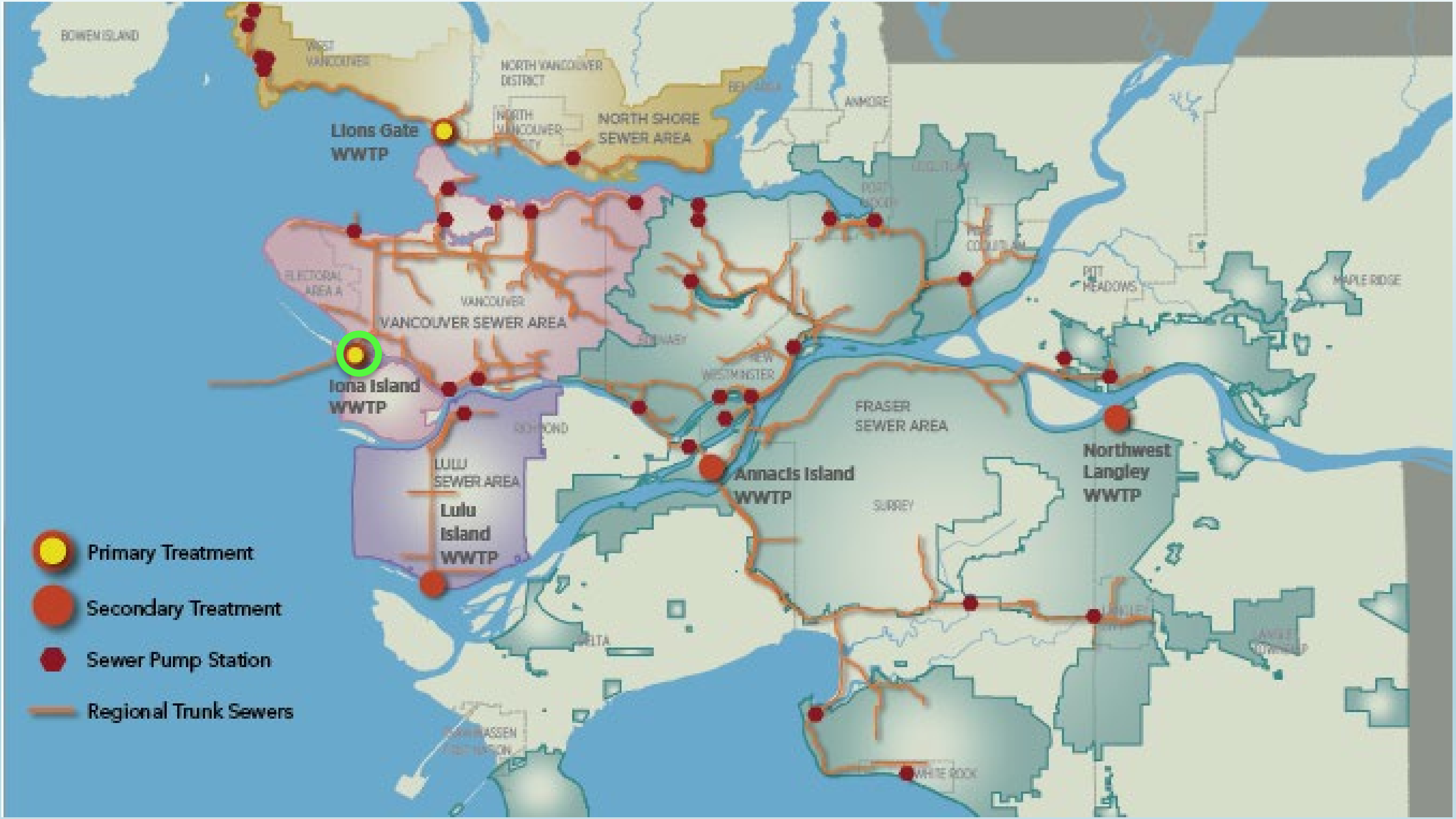
# Metro Vancouver



# Metro Vancouver's Liquid Waste Services



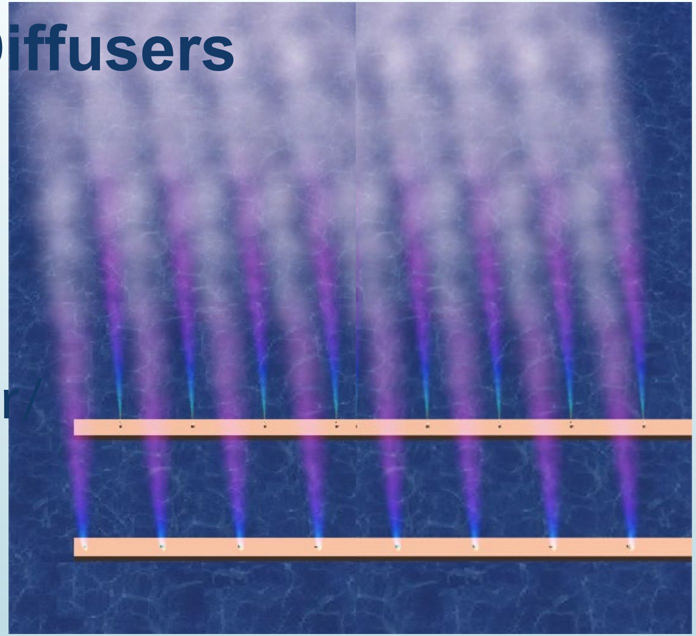
# Iona Island Wastewater Treatment Plant

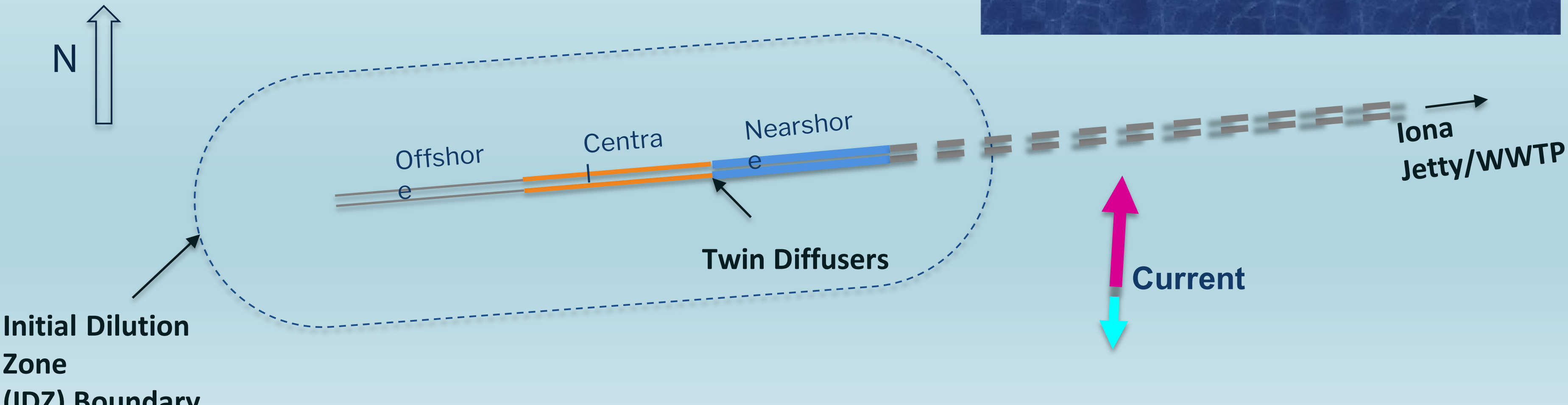
- Primary treatment
- Combined sewer system
- Average 2021 flow of 530 MLD (6.2 $m^3/s$)
- Discharge via a deep-sea outfall to the Strait of Georgia


Google, 2018

# Iona Deep Sea Outfall – Twin Diffusers

- Roughly parallel to each other
- 71 to 106 m deep
- 505 m long with 100 ports each
- 3 pipe segments of decreasing diameter/ increasing port size



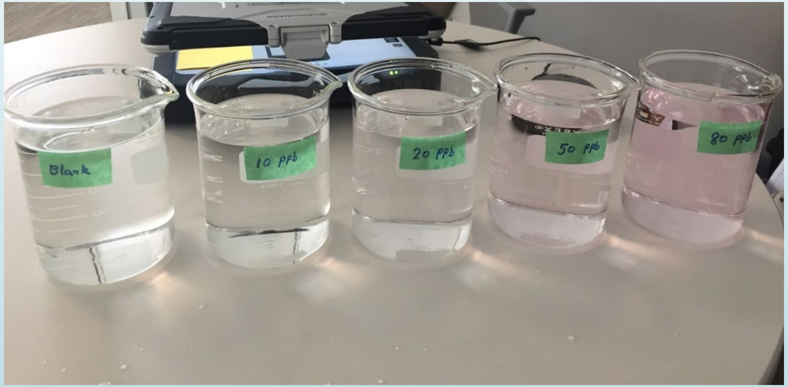


# Rhodamine Dye Tracer Study

- To characterize effluent plume initial mixing through field observations
- To update Iona Island WWTP near-field mixing model
- To facilitate improvement of initial dilution zone (IDZ) monitoring program

# Dye Tracing and Near-field Mixing

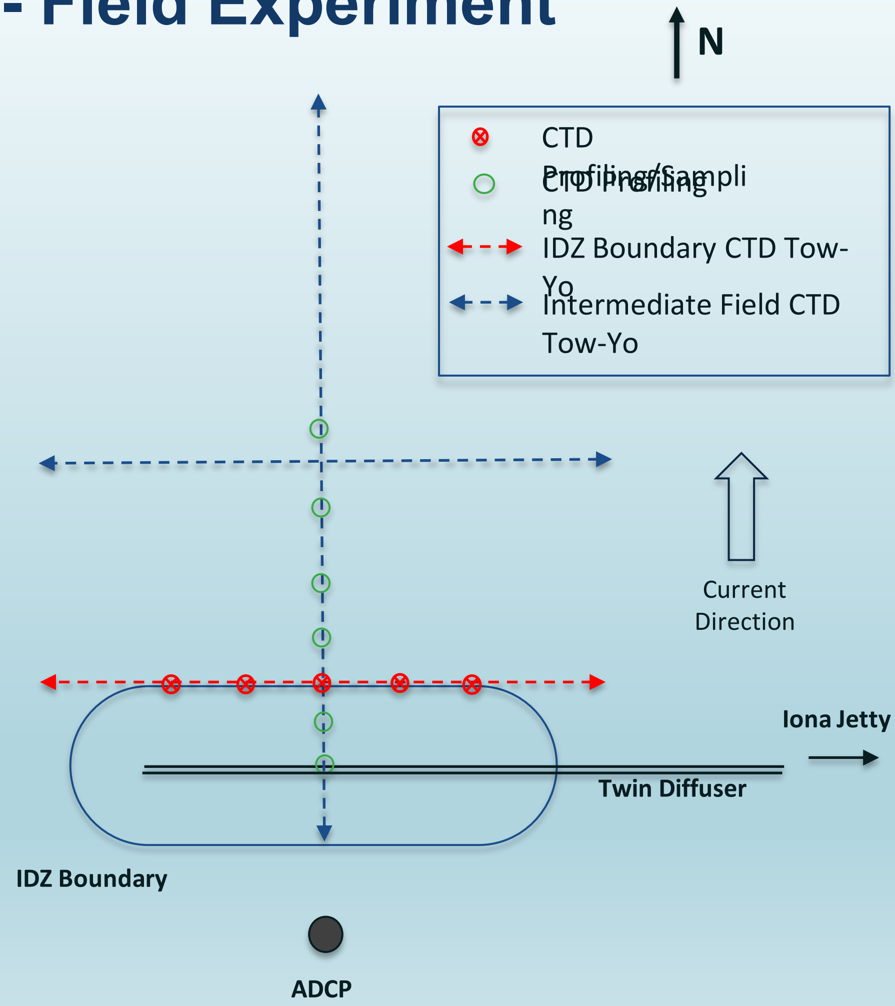
- Rhodamine WT dye was used for its conservative nature and low background level.
- Represent the effluent plume mixing and transport processes in receiving water




# Methods and Material - Field Experiment

- Carried out over 2 days on July 26 & August 14, 2018

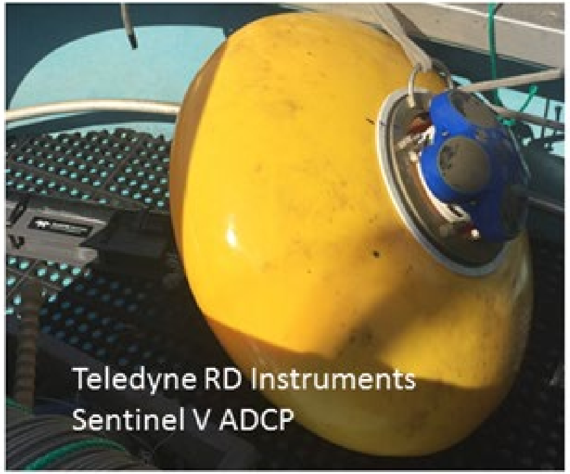
- For both study days, field crews were
  - ➢ at the IIWWTP, injecting dye, collecting effluent samples and measuring effluent dye concentration.
  - ➢ on the water, in 2 boats completing oceanographic monitoring and sample collection



# Methods and Material - Instrumentation

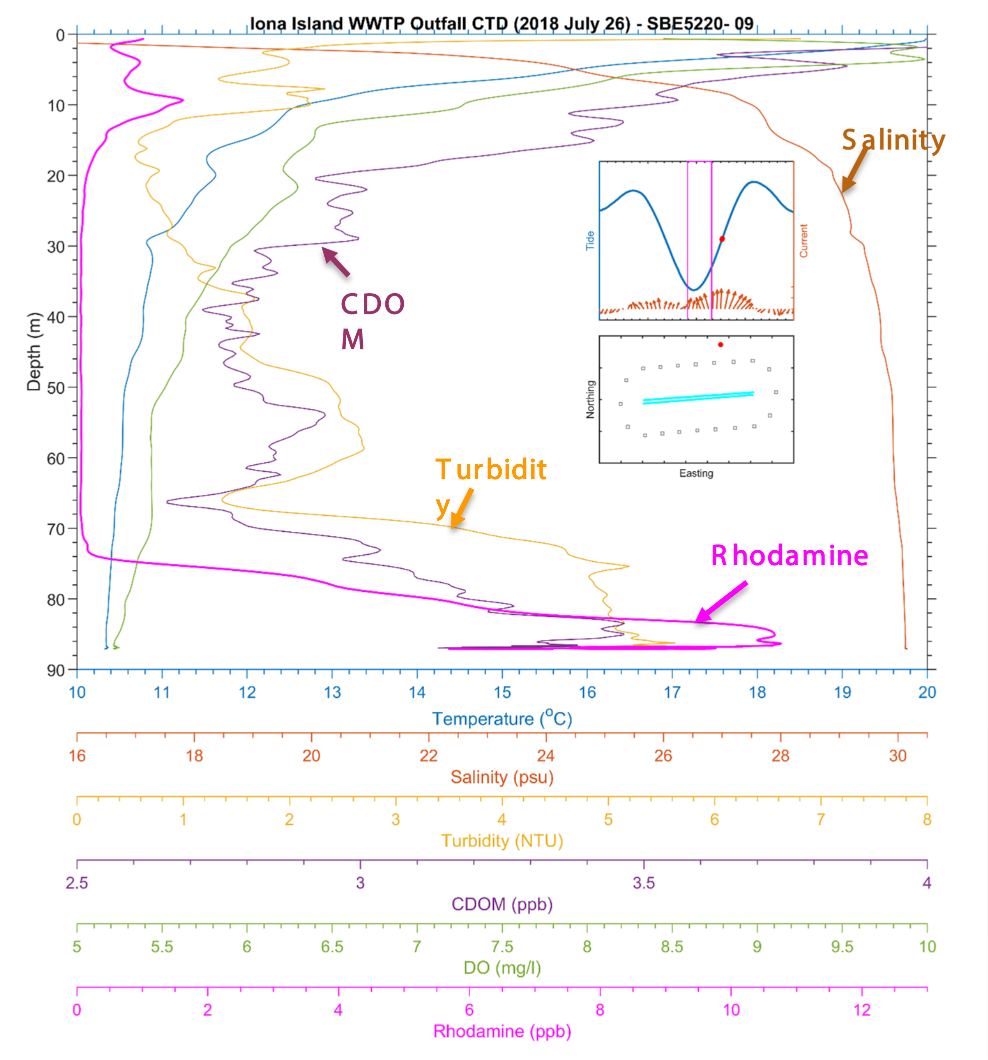




# Field Observations- CTD Profile

- Coinciding with Rhodamine, CDOM and turbidity peaks at bottom
- High CDOM and turbidity and low Salinity at surface – Fraser River plume
- Minor secondary peak of CDOM and turbidity at ~55 m (no Rhodamine)

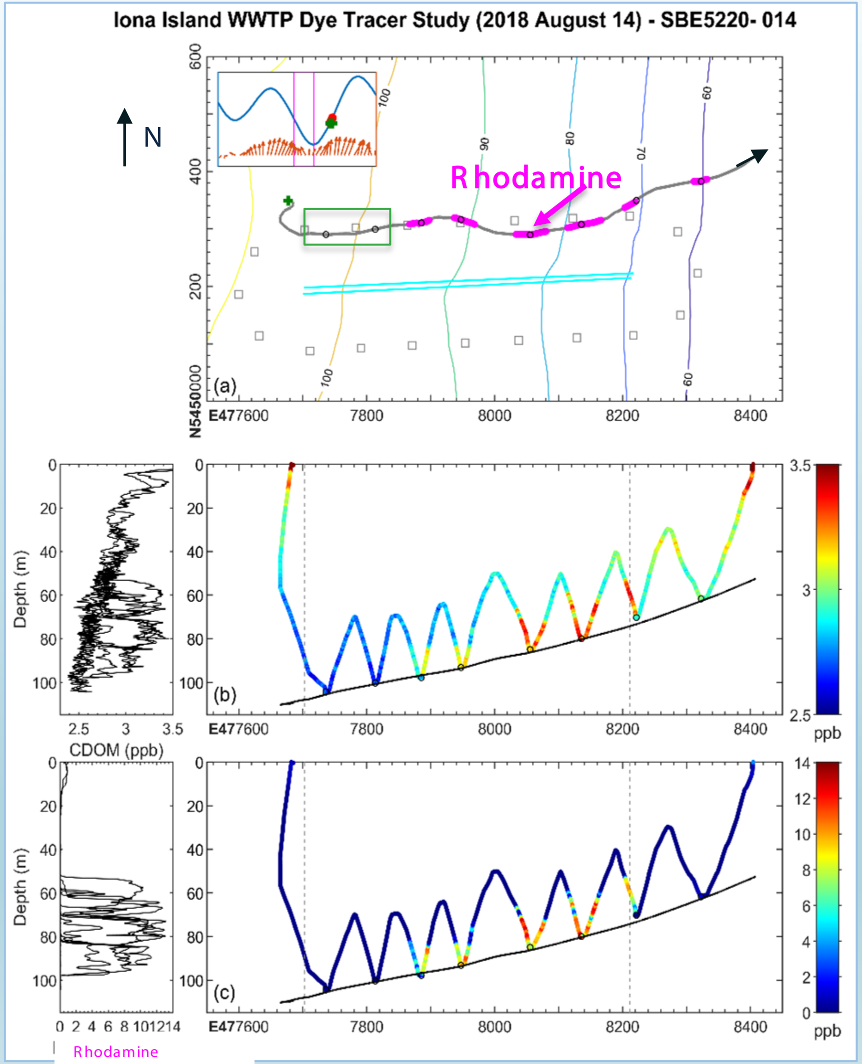


# Field Observations –Two-yo Profile

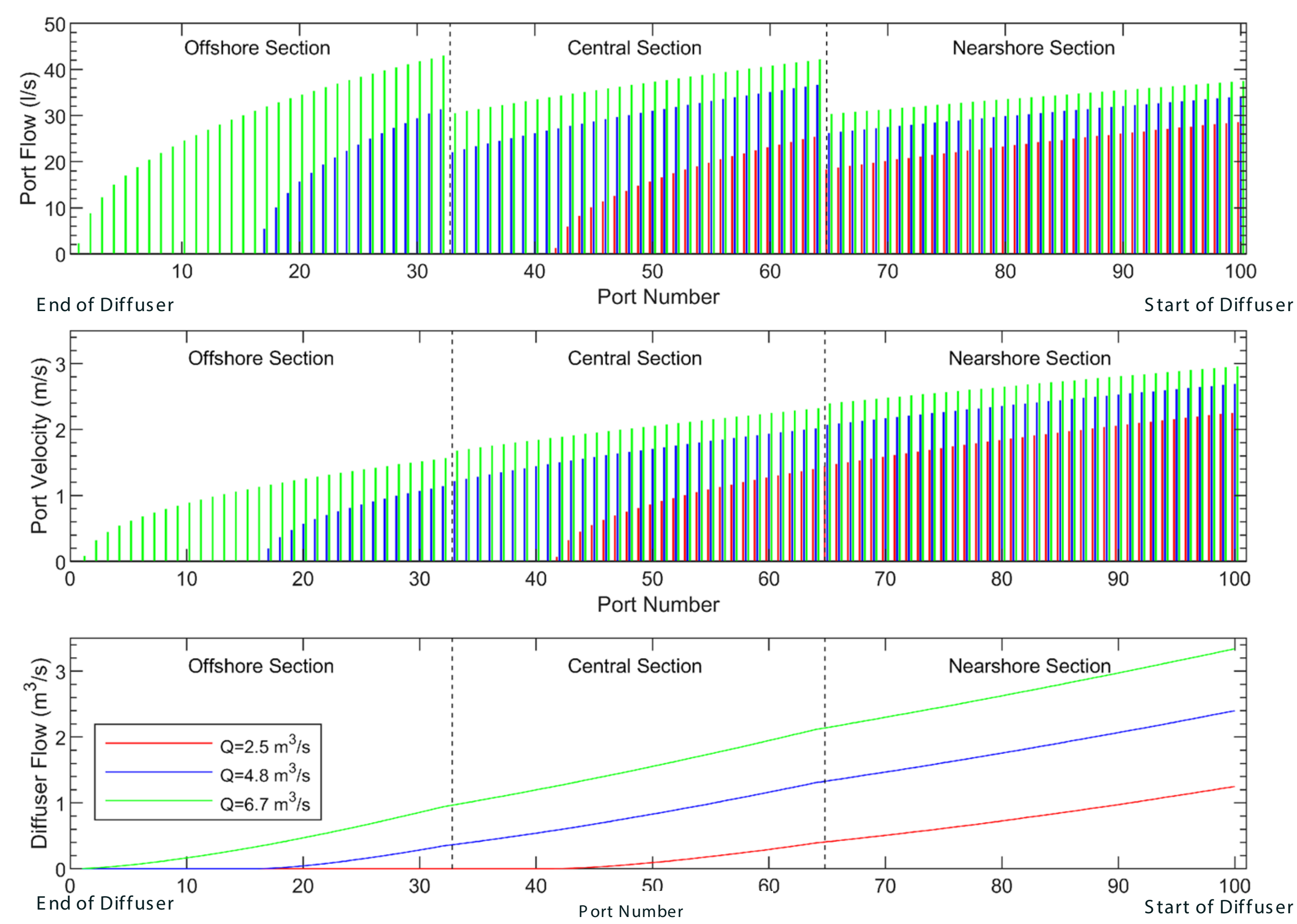
- No dye detected at the end of the diffuser - possibly due to saltwater intrusion

- Plume is found close to the bottom along the slope

- CDOM peaks were found highly correlated with the observed Rhodamine dye peaks



# Outfall Internal Hydraulics Model – CorHyd

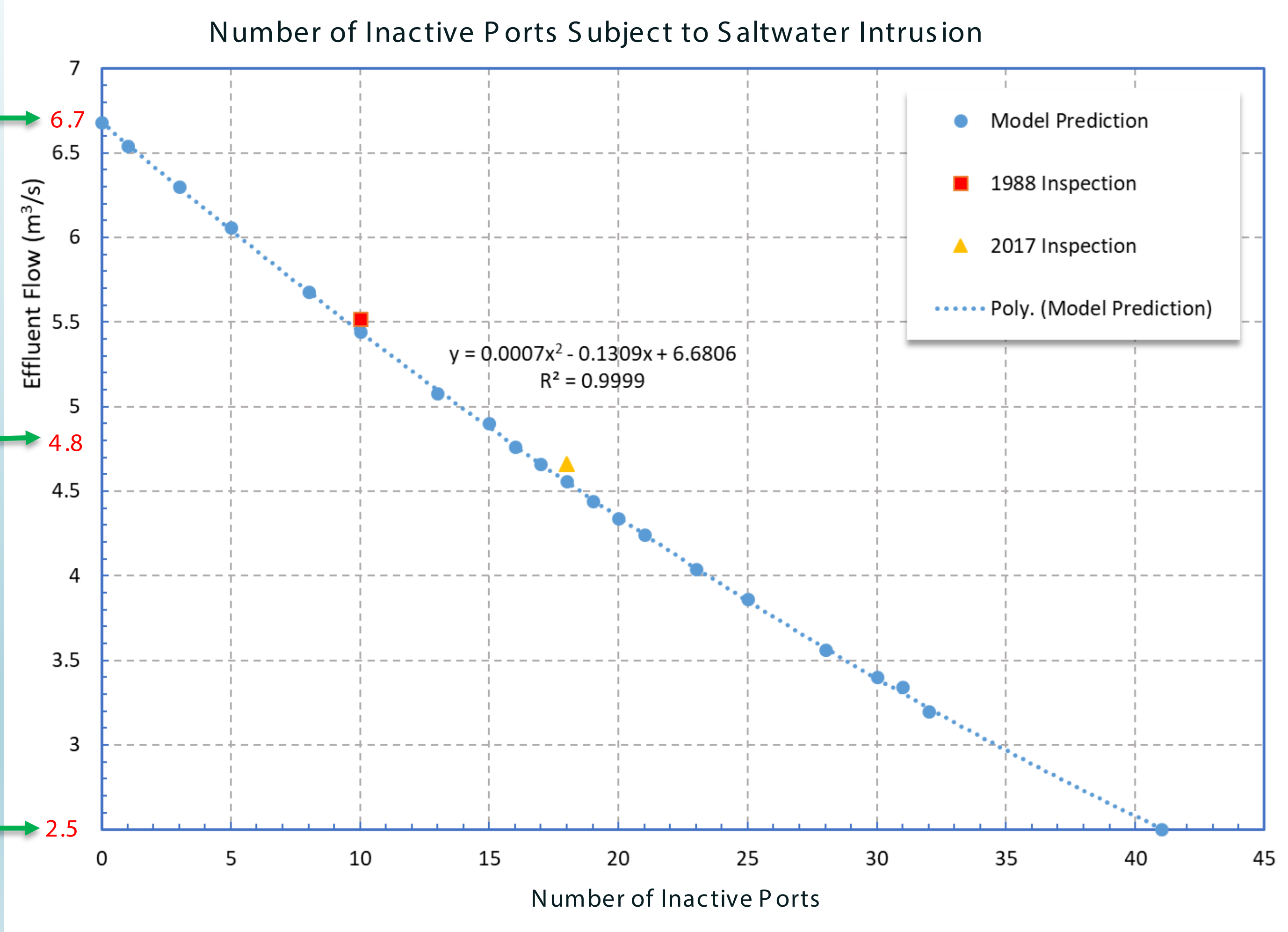


# Outfall Internal Hydraulics – Saltwater Intrusion

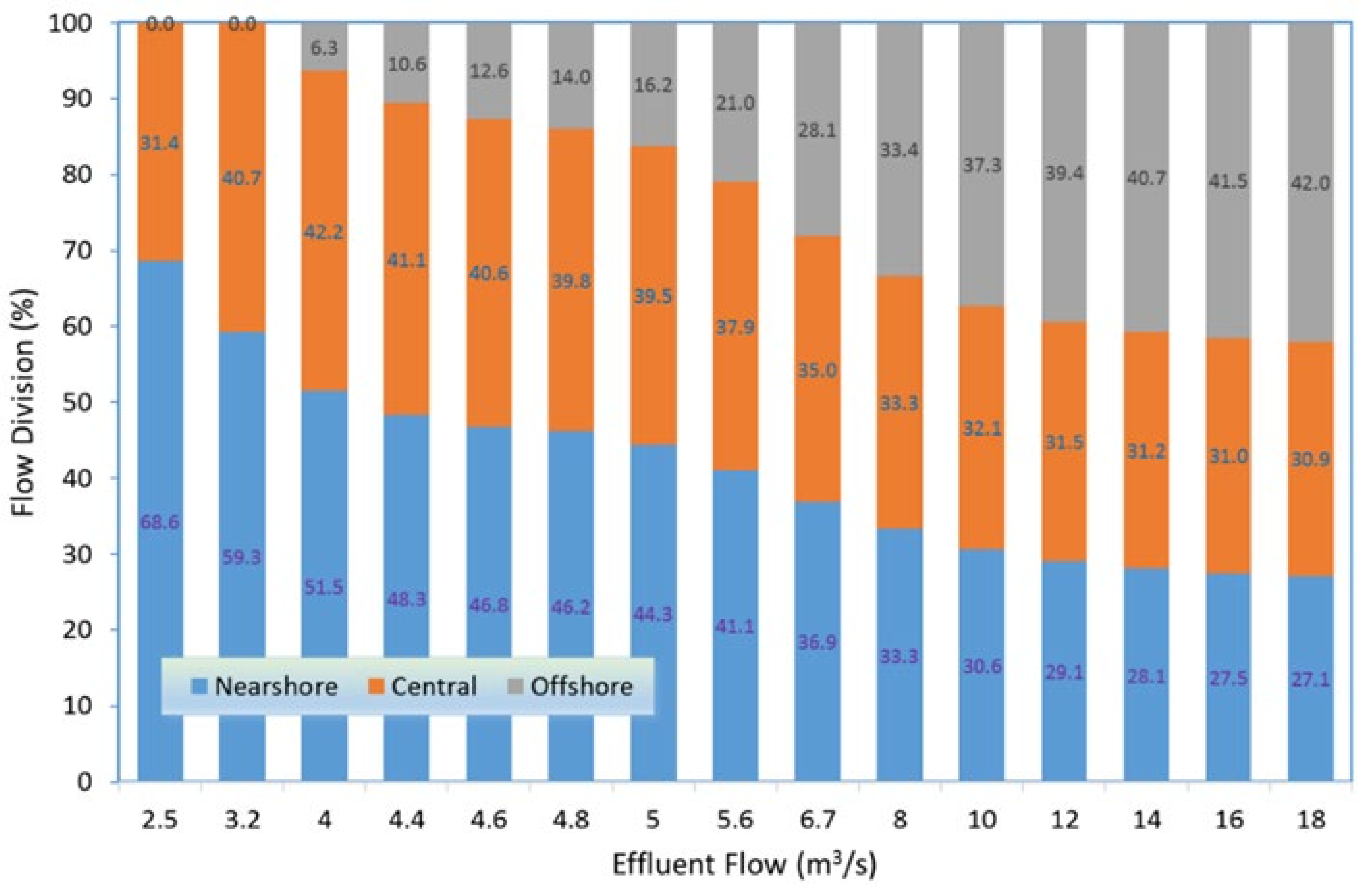
Summer 98 percentile → 6.7

Summer 60 percentile & Approx. average flow of dye study → 4.8

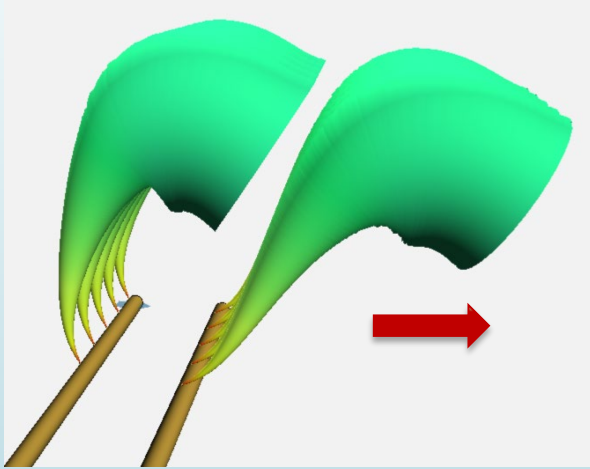
Summer Min. Flow → 2.5



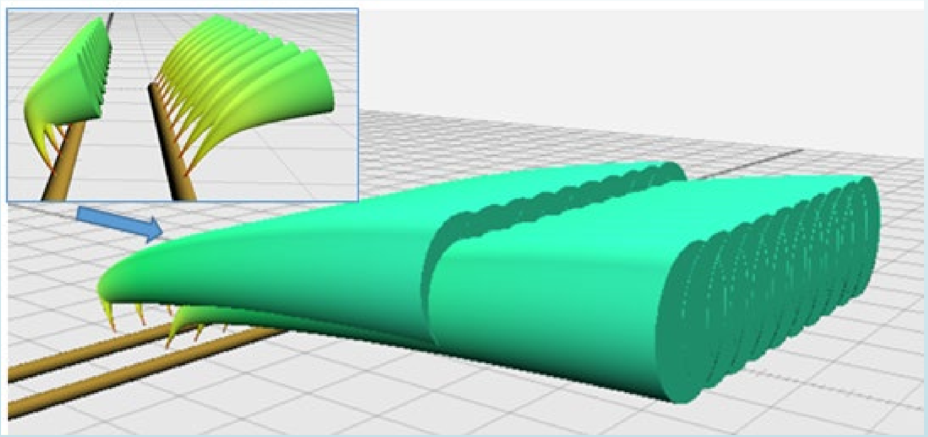
# Outfall internal Hydraulics – Flow Distribution



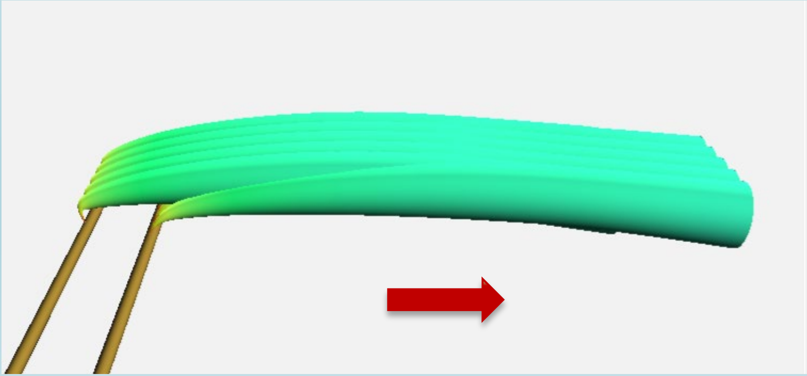
# Near Field Mixing Modelling – VISJET



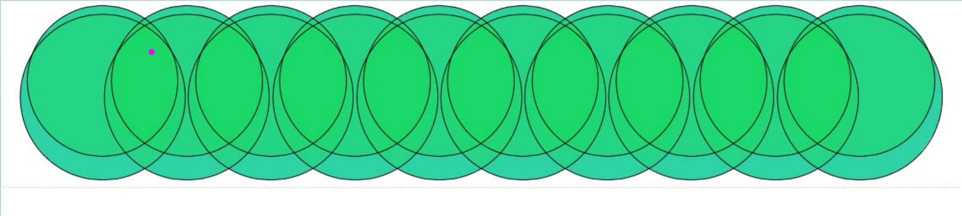
$u_a$=0.05 m/s



3D Visualization

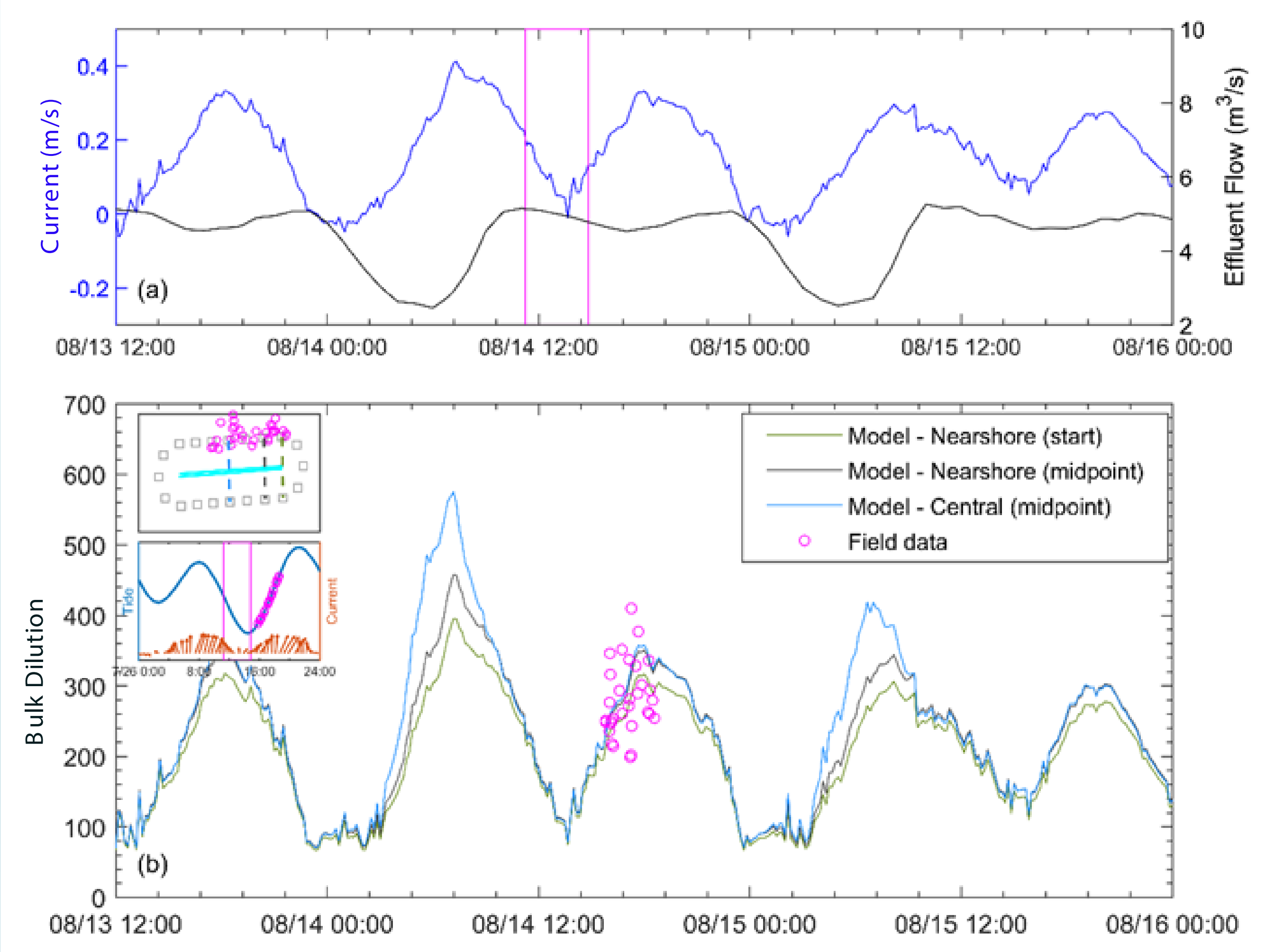


$u_a$=0.3 m/s

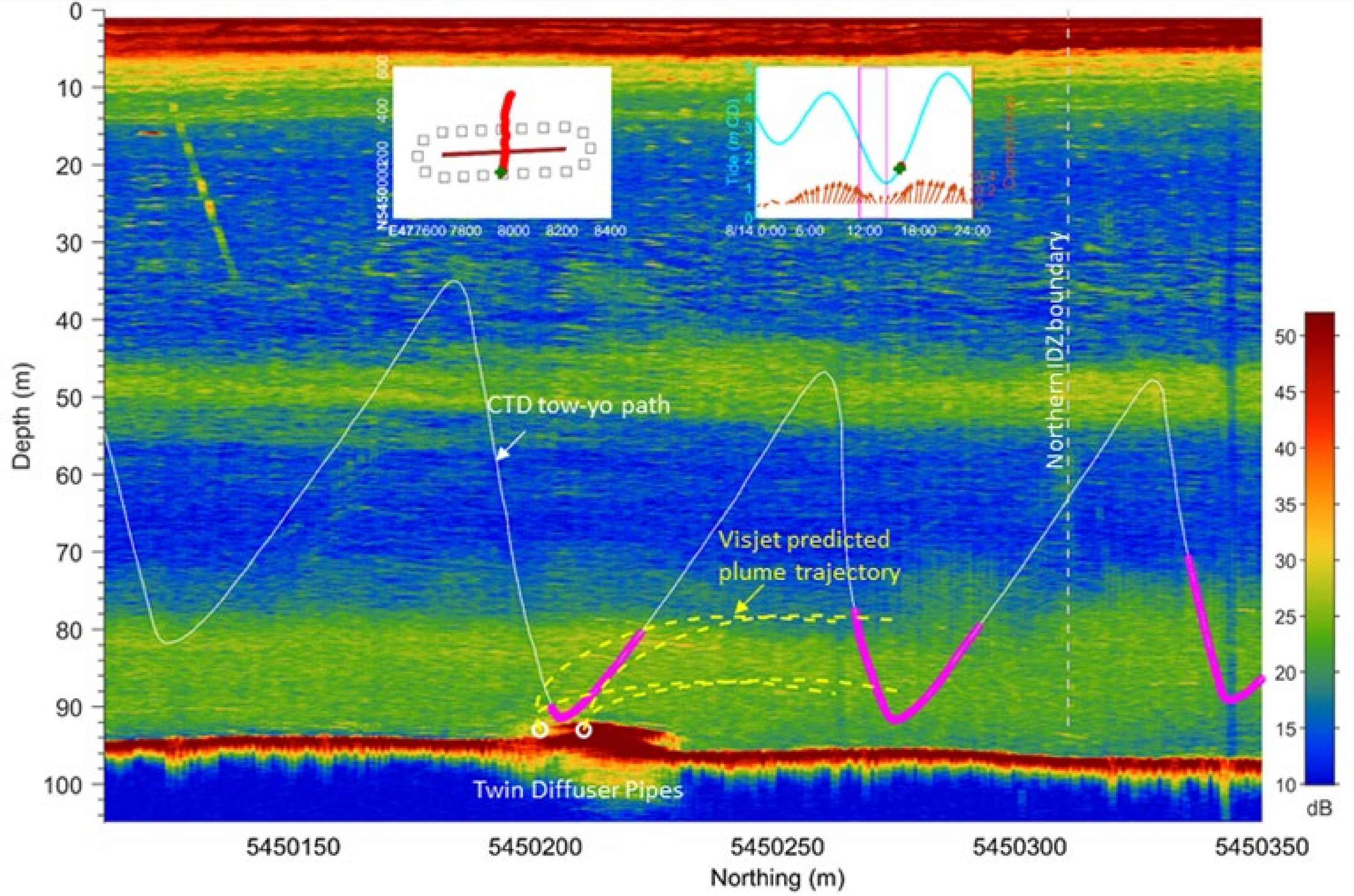


Cut Plane

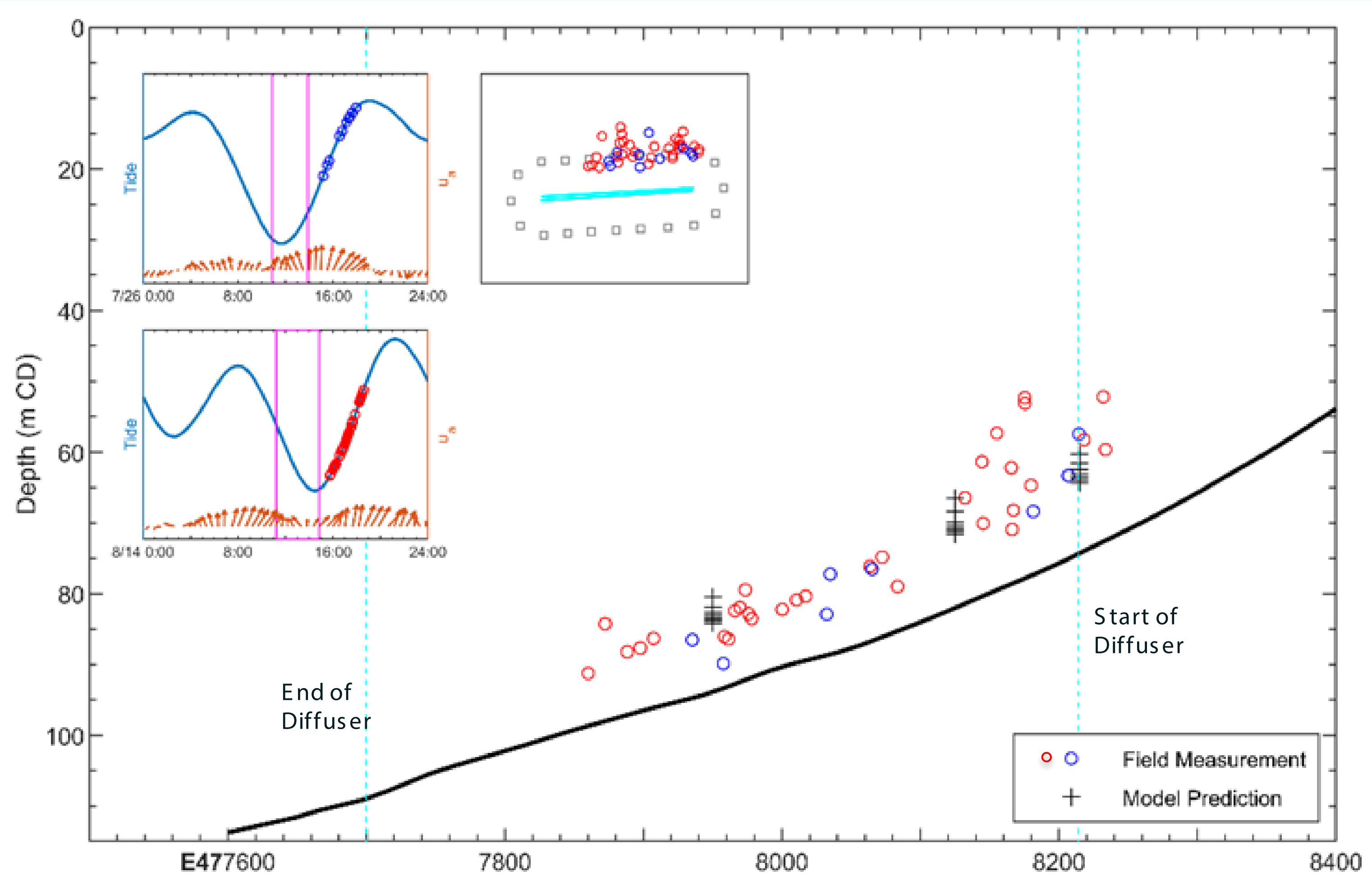
# Near Field Mixing Model Validation – Bulk Initial Dilution



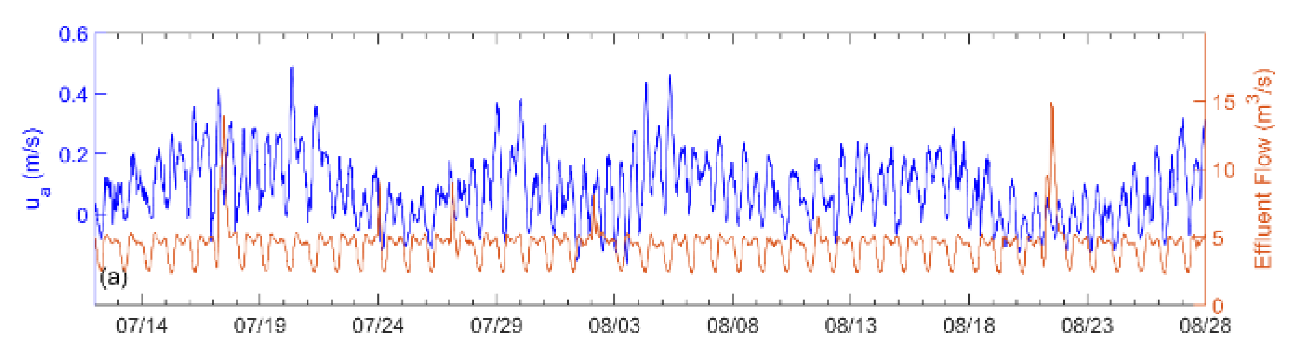
# Near Field Mixing Model Validation – Plume Trajectory

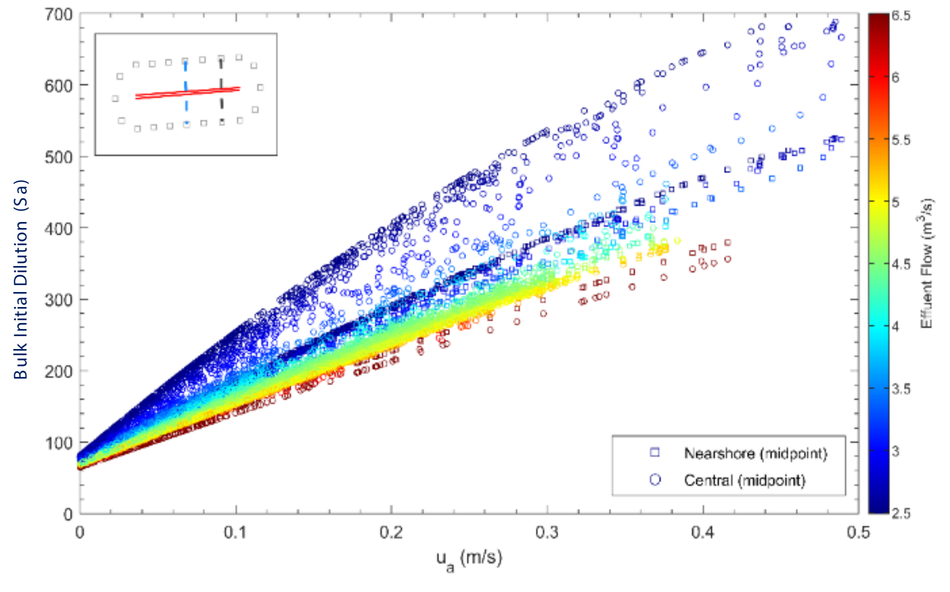


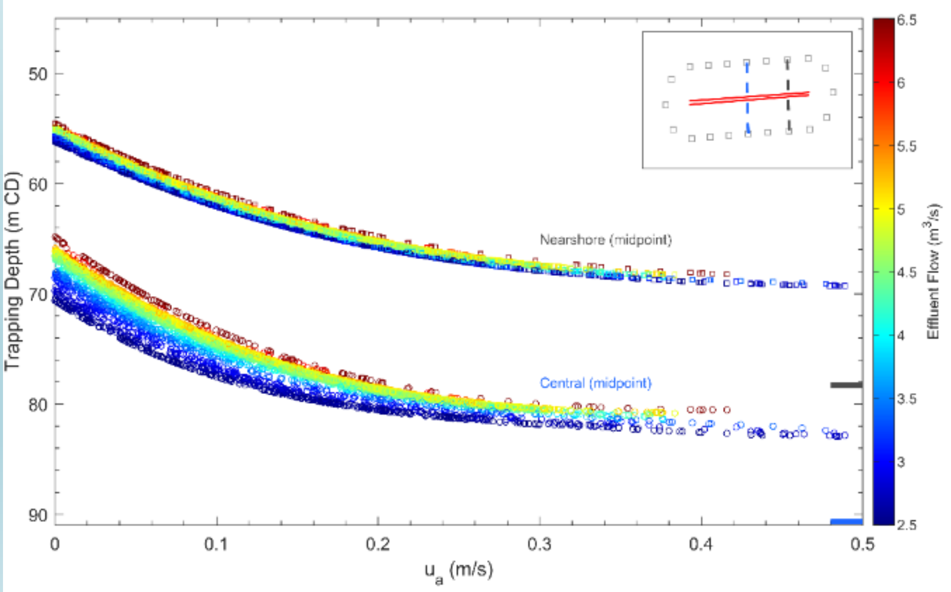
# Near Field Mixing Model Validation – Trapping Depth



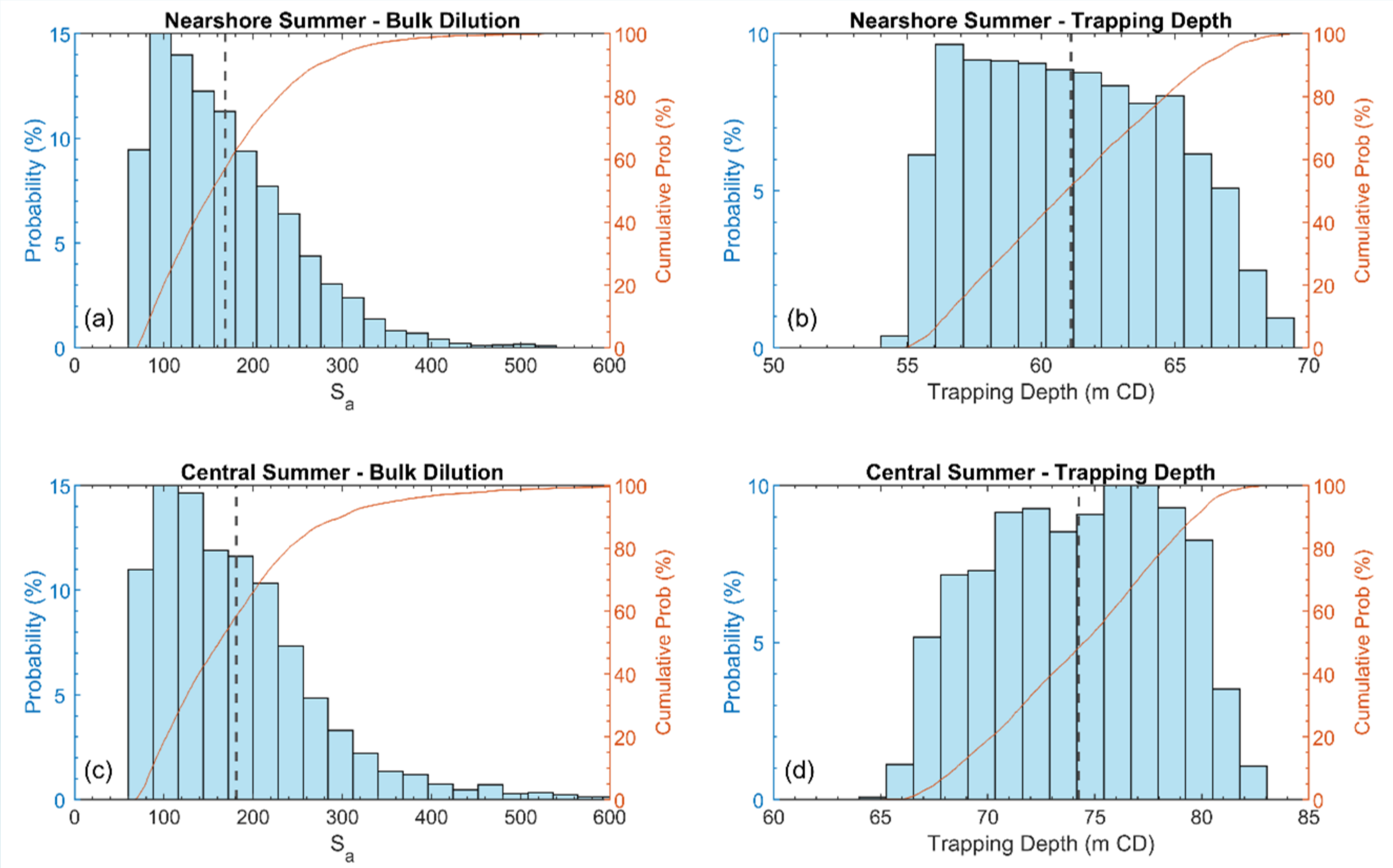
# Summer Variability: Bulk Initial Dilution and Plume Trapping



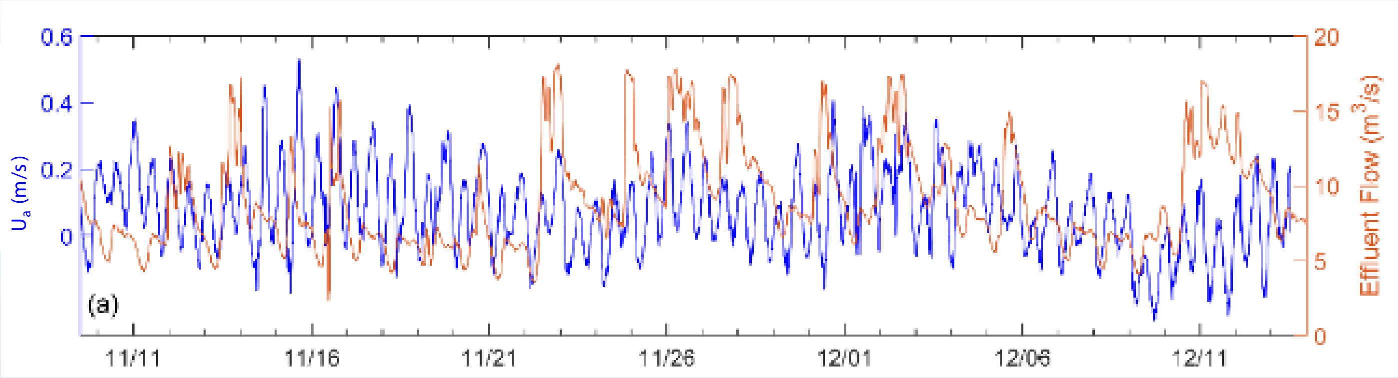



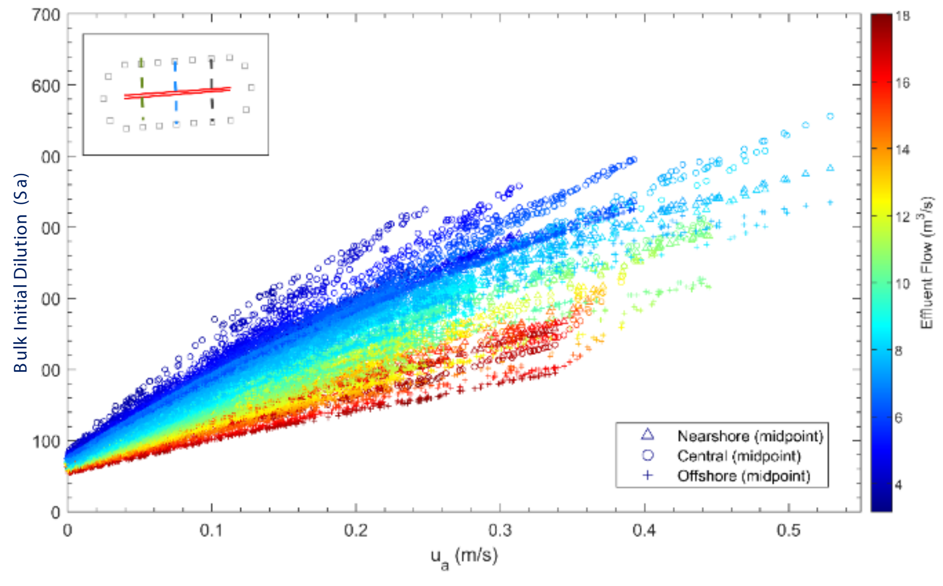



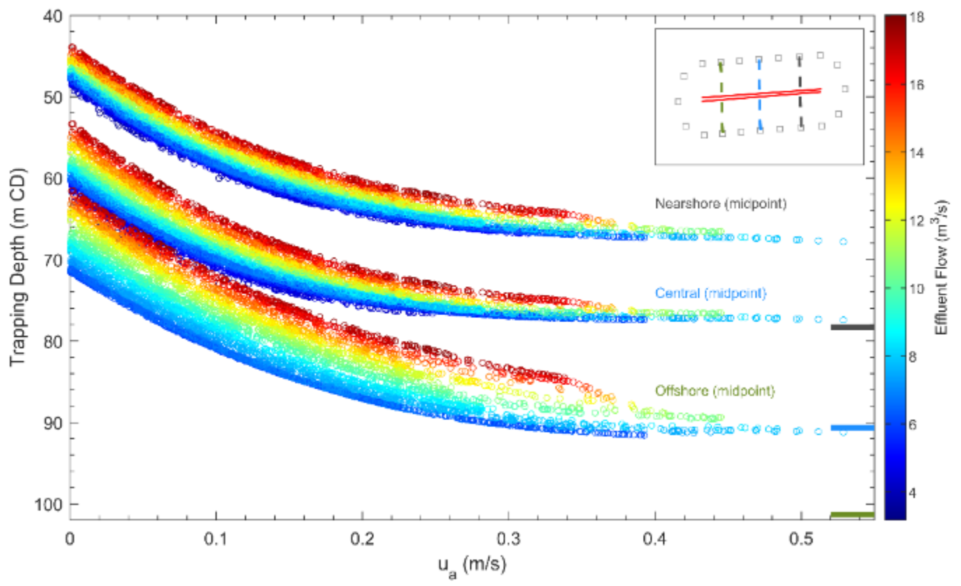
# Summer Probability Distribution: Bulk Initial Dilution and Plume Trapping



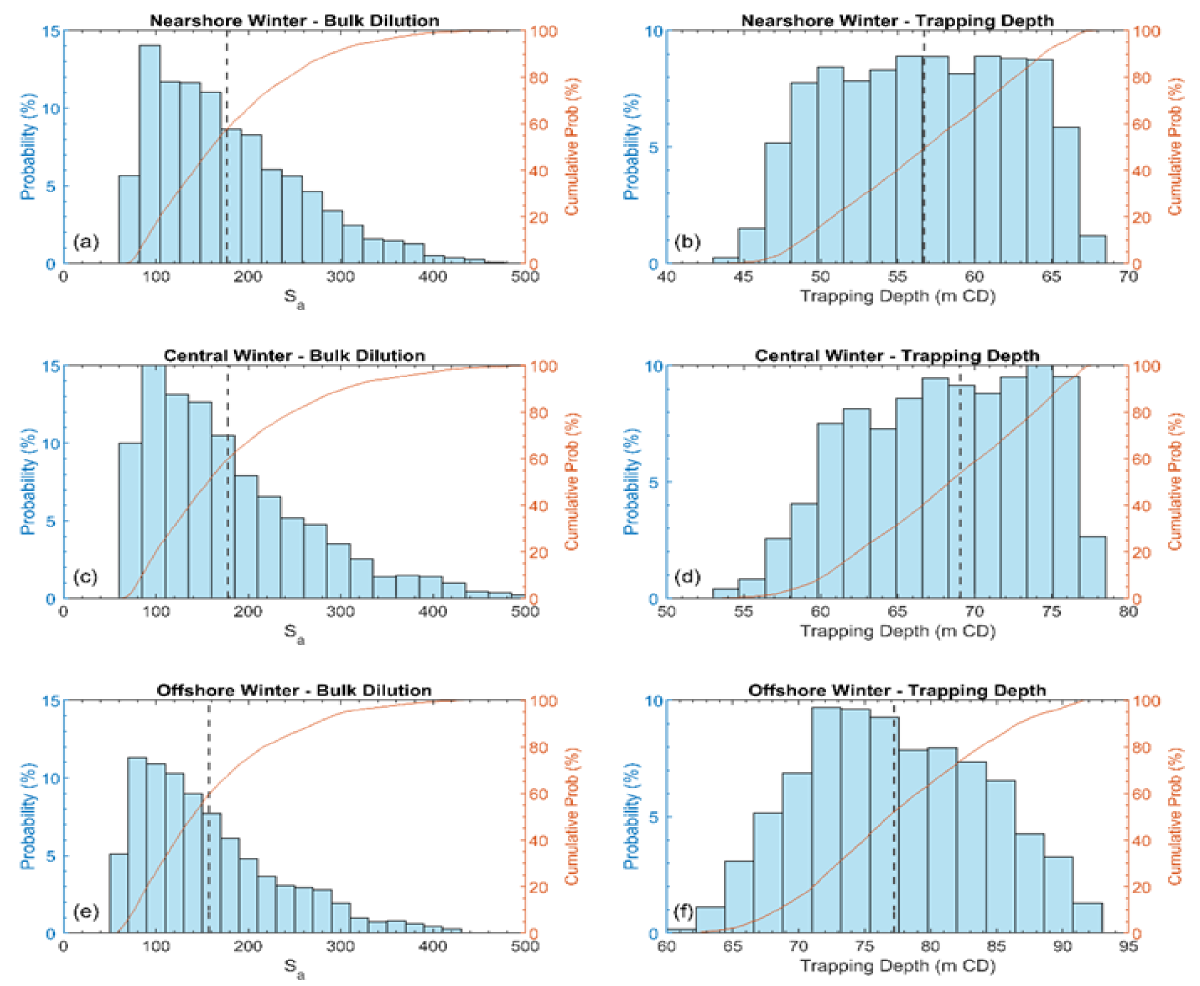
# Winter Variability: Bulk Initial Dilution and Plume Trapping



# Winter Probability Distribution: Bulk Initial Dilution and Plume Trapping



# Conclusions

- The internal diffuser hydraulics model and the near-field mixing model compared well with field observations.
- The outfall is subject to saltwater intrusion under almost all summer effluent flow conditions.
- Effluent dilution is influenced by plume merging, current speed and effluent flow rate.
- The predicted 5 percentile bulk initial dilutions range from 68:1 to 81:1 along the length of the diffuser.
- Average initial dilutions in winter were found slightly lower than those in summer mainly due to the higher winter effluent flow.
- Although the plume was found to span over a wide depth range through the ambient water column, it is not expected to surface even under the most unfavorable environmental conditions.

# Acknowledgments


- Metro Vancouver: Denise Vieira, Braeden Haliuk, Carrie Hightower, Sara Legros, Chris Martin, Shaheli Masoom Darren Broughton, Rod Cooke, Rod Hatfull, Andrew Hunt, Wayne Hung Thomas Jackman, Jesse Montgomery

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# Thank You!

# Questions ?

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