3D hydrodynamic modeling of Lower Fraser River

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3D Hydrodynamic Modeling of Lower Fraser River

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Metro Vancouver

21 municipalities
one Electoral Area
and one Treaty First Nation working together for a livable region
Overview: Why 3-D modeling?

Estuary: density stratified flow, salinity intrusion

Salinity Wedge: Flow stratification reduces channel conveyance

Source: Ages and Woollard 1976

Salt Wedge boundaries for variable flow

Source: Ages and Woollard 1976
Overview: Physical Setting

Fraser River: Receiving GVRD’s WWTP discharges

Fraser Model: Model extent From Mission to Sand Head
Fraser Model: MIKE 3 FM software

Fraser Model mesh:
- 30,000 element mesh.
- A combination of triangular and quadrilateral elements
- 30 equidistant vertical layers for depth < 20m and 15 additional layer for depth > 20m.
Model Calibration And Validation: Data availability

Water Level Data

Legend
- 6 WSC Hydrometric Stations
- DFO Tide Gauge
- 9 Municipal Gauges

Salinity and Current Data

Discharge Data

Mission’s estimated Q for H > 3m
Model Validation: Water Level (March 2013)

Legend
- WSC Station
- DFO Tidal Station

<table>
<thead>
<tr>
<th>Gauge Name</th>
<th>Gauge Type</th>
<th>Standard Deviation or Root Mean Square Error in WL (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steveston</td>
<td>WSC (08MH028)</td>
<td>0.05</td>
</tr>
<tr>
<td>Dea’s Island Tunnel</td>
<td>WSC (08MH053)</td>
<td>0.06</td>
</tr>
<tr>
<td>Port Mann</td>
<td>WSC (08MH054)</td>
<td>0.10</td>
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<tr>
<td>Pitt River near Port Coquitlam</td>
<td>WSC (08MH035)</td>
<td>0.05</td>
</tr>
<tr>
<td>Whonnock</td>
<td>WSC (08MH044)</td>
<td>0.04</td>
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<tr>
<td>North Arm Vancouver</td>
<td>WSC (08MH032)</td>
<td>0.11</td>
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<tr>
<td>New Westminster</td>
<td>DFO</td>
<td>0.07</td>
</tr>
</tbody>
</table>
Model Validation: Current

Model Validation: March 2013-Low Flow

Model Validation: June 2009-Freshet
Low Flow Model Validation: Current

Fraser River

Black and Veatch (2013) ADCP measurement
Model Validation: Salinity (March 2013)
Bi-directional Current due to Salt Wedge
Model Validation: Discharge (March 2013)
Model Validation: Discharge/Flow Split

Flow split to North arm:
- 12 to 13.5%.
- Within the range (10-15%) reported for Fraser River North Arm (Thomson 1981 and nhc 2006)
Application

Transport and diffusion module evaluation using Rhodamine Dye dispersion in Fraser River

Sea consult Dye study (1994)

Rhodamine Concentration 2hrs after discharge from AIWTP

MIKE3 Fraser model prediction
Summary

• A numerical 3-D model is developed for Fraser River

• The model is calibrated and validated against measured data

• Future improvement: refined and updated bathymetry data, ADCP measurement of current and discharge, refined salinity and temperature boundary values by Salish Sea Model output (Under development).