Modelling Metocean Processes And Interactions On The Gold Coast For Recycled Water Release Planning

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The City of Gold Coast

By 2066 the City of Gold Coast’s population will grow from 535,000 to 1.2 million

Water based lifestyle....

• 52km of coastline and beaches
• 480 km of rivers and streams
• 774 hectares of lakes, dams and canals

Over 10 million tourists visit each year
Water Cycle Management

The numbers...

- **Supplied** - Approx. 156 ML/d of water supplied
- **Treated** - Approx. 163 ML/day of sewage collected and treated. 4 Sewage Treatment Plants (STP’s)
- **Produced** - Approx. 146 ML of recycled water generated each day. Up to 20% reused across the City (ADWF)
- **Released** - Approx. 115 ML/d requiring release in ADWF conditions
Recycled Water Release System

So where does it go?

- All 4 STP’s release excess recycled water at the Gold Coast Seaway
- 2 release points on Northern and Southern Seaway wall
- Approx. 65ML/d released from the Northern system
- Approx. 50ML/d released from the Southern system
- Ebb staged release
- Operational since the 1980’s
- Regulated by DEHP
- 2.4 tonnes of TN annually as apposed to 555 tonnes of TN from the catchment
- By 2066 will increase to approx. 275 ML/d ADWF and > 800 ML/d PWWF
**Project Requirement**

**Current Situation**

- Both systems nearing hydraulic capacity
- Investigations underway for a number of years
- Need to progress a staged long term release solution
- Currently finalising options assessment process
- Ultimately looking at a staged offshore ocean release system that:
  - Services ADWF and PWWF until 2066
  - Protects health and safety of the community
  - Performs regulatory requirements
  - Prevents unacceptable impacts on the environment and the community
  - Develop, operate and maintains assets efficiently and effectively.
- Using far-field hydrodynamic modelling to inform site selection and assess environmental performance
Modelling Studies To Date

DHI commissioned by City of Gold Coast since 2007;

1) Broadwater Assimilative Capacity Study

2) Seaway SmartRelease Project (Northern Diffusers)

3) Southern SmartRelease Project (Southern Diffusers)

4) LTRWR study
LTRWR Study

- Designed to assess offshore release options
- Used to compare existing recycled water releases on the northern and southern side of the Seaway

Key Conditions
- Tides
- Wind
- Waves
- Atmospheric Pressure
- Ocean Currents

(Source: IMOS, http://oceancurrent.imos.org.au/)
Model Framework

Hydrodynamic/Advection Dispersion Modelling
- HICOM Ocean Circulation Model
  - u and v (non-tidal) current residuals
  - u and v (tidal) current residuals
  - Tidal Water Level Boundaries
  - BOM Modelled Wind Fields
  - Hydrodynamics

Wave Modelling
- NOAA Satellite Measured Winds Fields
- Wave Energy Spectra Boundaries
- BOM Modelled Wind Fields
- Wave radiation stresses

Hydrodynamics
- BOM Modelled Wind Fields
- Tidal Water Level Boundaries
- u and v (tidal) current residuals
- u and v (non-tidal) current residuals

AO Model

Key
- GCWB
- Release sites

Bathymetry [m]
- Above 0
- 4 - 0
- 8 - 4
- 12 - 8
- 16 - 12
- 20 - 16
- 24 - 20
- 28 - 24
- 32 - 28
- 36 - 32
- 40 - 36
- 44 - 40
- 48 - 44
- 52 - 48
- 56 - 52
- Below -56
- Undefined Value
HD Model Mesh Development

- Large model extent selected to prevent the loss of mass through the boundaries
- Comparable resolution between optimized Gold Coast Mesh and Southern SmartRelease Mesh
- Key: maintain computational efficiency while incorporating the resolution required to represent the physical processes important to resolve detailed transport through the Seaway (eddy structures)
  - 7 vertical layers (~3m spacing)
  - ~20m horizontal resolution
Development of Boundary Conditions (HD model)

Combined and forced using a Flather boundary construction

Global Tidal Model
tidal currents and water levels

non-tidal current residuals

ADCP2 (filtered)

Global Tidal Model

N/S velocity Southern HYCOM point [m]
N/S velocity Northern HYCOM point [m]
N/S residual ADCP2 [m]
Model Sensitivity

• Over 50 calibration runs for the HD model were undertaken, testing sensitivity of:
  
  - Model geometry,
  - Wind forcing,
  - Offshore boundary conditions, and
  - Model parameters: resolution, friction, viscosity, wind friction, etc.
Wave Model Calibration

- GCWB - Measured [m] (0 to 20 seconds)
- AECM - Whole Spectrum [m] (3 to 20 seconds)
- AECM - Spectrum truncated at 3 secs [m] (6 to 20 seconds)

Gold Coast Wave Rider Buoy (17m depth)
HD Model Calibration - Monitoring Campaign

• Deployed by DHI;
  2 ADCPs deployed for 6 week deployment (23rd November 2012 to January 8th 2013)
  located approx. 500m south of the Spit at 2km and 3km offshore currents & water levels

• Deployed by Griffith University;
  One located ~3km south of the Spit at 2.5km offshore Deployed or 12 months currents, water levels & waves
Assessment standards (Evens, 1993)
Water level: < 10%
Velocities: < 20%

<table>
<thead>
<tr>
<th>Variable</th>
<th>ADCP 1: RMS (%)</th>
<th>ADCP 2: RMS (%)</th>
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<tbody>
<tr>
<td>Water Level</td>
<td>7.4</td>
<td>-</td>
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<tr>
<td>U velocity</td>
<td>17</td>
<td>21</td>
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<tr>
<td>V velocity</td>
<td>14</td>
<td>13</td>
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HD Model Calibration (Nearshore)
Model Performance – Northern Release Comparison
HD Model Calibration (Nearshore)
Model Performance – Southern Release Comparison

<table>
<thead>
<tr>
<th>ADCP</th>
<th>Surface Elevation RMS (%)</th>
<th>Current Speed RMS (%)</th>
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<tbody>
<tr>
<td>ADCP1</td>
<td>2.6</td>
<td>4.6</td>
</tr>
<tr>
<td>ADCP2</td>
<td>2.7</td>
<td>4.3</td>
</tr>
<tr>
<td>ADCP3</td>
<td>2.8</td>
<td>4.9</td>
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</tbody>
</table>

Assessment standards (Evens, 1993)
Water level: < 10%
Velocities: < 20%
Plume Dynamics

Resultant offshore current influenced by:
- Ocean residual currents
- Wind and wave driven currents

Northward directed currents vs Southward directed currents

Effecting the level of:
- Plume recirculation
- Entrainment back into the Broadwater
Plume Dynamics

Neap tide with weak offshore currents
Long Term Recycled Water Release Marine Modelling

Next Steps

- Inform regulatory approvals process
- Identify an optimal diffuser design – minimise near field mixing zone
- Ensure overall environmental performance of the system
Recycled Water Release System
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