Watermatex 2015
9th IWA Symposium on Systems Analysis and Integrated Assessment
14-17 June 2015, Gold Coast, Australia

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

Hollingsworth, A.*, Symonds, A., Schmied, L.***, Mortensen, S.**, Hibberd, W.**, Baker, K.* and Capati, G.***

*Gold Coast Water, City of Gold Coast, Australia. PO Box 5042 Gold Coast Mail Centre Qld 9729
** DHI Water and Environment Gold Coast, Australia. Level 2, 12 Short Street, Southport QLD 4215
*** DHI Water and Environment Houston, Texas USA. PO Box 7268Houston, TX 77248 USA

Keywords: Modelling; Metocean; Gold Coast

Background

The Gold Coast Seaway ebb-staged release scheme has been utilised since the 1980's to disperse excess recycled water produced by the City of Gold Coast's (City) four sewage treatment plants. By releasing on the ebb tide, the release system has been effective in meeting the water quality objectives of the receiving estuarine system; the Broadwater. The Broadwater is a semi-enclosed coastal lagoon which forms the southern boundary of the Ramsar protected Moreton Bay Marine Park. The Seaway is a man-made channel connecting the Broadwater to the Pacific Ocean and is one of two entrances to the Broadwater. Two diffuser systems located on the northern and southern Seaway training walls, currently release approximately 115 million litres of excess recycled water per day on the ebb tide of a semi-diurnal cycle. This scheme is regulated by Environmental Authorities (EA) issued by the Department of Environment and Heritage Protection under the *Environmental Protection Act* (1994), which specifies the timing, duration, volume, quality and mass loads of recycled water released to the Seaway.

Current situation

Population growth is placing increasing pressure on the City's recycled water release system. Gold Coast Water (GCW) holds primary responsibility for the City's recycled water and sewage assets. Recognising the recycled water release system infrastructure was approaching capacity under the current ebb-staged scheme; GCW instigated a series of investigations to assess the short to medium options for managing recycled water releases.

To deliver upon this aim, GCW have partnered with DHI Water and Environment (DHI) since 2007 to both understand and optimise the existing release system. As an outcome of this partnership, the City has effectively been able to release greater volumes of recycled water through the northern release system with improved receiving water quality outcomes. This has allowed the deferment of costly infrastructure upgrades to meet existing and future demands. However, the system is now reaching its capacity under the current infrastructure arrangement and DA conditions.

As such, the City has been investigating long term options for releasing excess recycled water for a population that is predicted to increase to approximately 1.3 million by 2066. A wide range of options have been investigated, with detailed investigations for a staged long term release solution currently underway. To support this investigative planning process, the City commissioned DHI to build and calibrate a 3D far-field hydrodynamic model of the Gold Coast to assess the environmental performance of a range of potential long term release options.

This paper describes the model set up and calibration method and further provides interpretation of the modelled metocean processes and interactions on the Gold Coast.

Model Set-Up and Calibration

Due to the varied range of options for the staged long term release solutions, the far-field model setup had to maintain a geographic extent suitable to capture the dominant physical processes that drive far-

field plume dispersion offshore, and local resolution high enough to capture the dominant physical processes that drive the details of plume entrainment in the vicinity of the Gold Coast Seaway. As such, the model setup utilized a flexible mesh approach that allowed for detailed high resolution areas while maintaining extents over 200 km alongshore, and over 50 km offshore. The model was constructed to incorporate large scale physical processes such as tides, wind driven circulation, prevailing oceanic currents, and wave driven currents. In addition, the higher resolution areas in the Seaway were constructed to be able to resolve smaller scale flow structures such as the eddies generated inside the Seaway and the ebb jet eddy structures formed offshore of the Seaway. These local flow structures are extremely important to the transport and entrainment of the plume from the existing diffuser structures and continue to have importance in some of the long term strategy options.

The model was calibrated to data collected in 2012-2013 at two Acoustic Doppler Current Profilers placed 2 and 3 km offshore just south of the Seaway. Extensive sensitivity and testing was done to ensure that the model represented the best combination of offshore forcing combinations and demonstrably captured the range of processes to be expected in a long term assessment of potential release options. It was also validated to measurements used in the original Northern and Southern *Smart*Release model development. These two activities ensure that the model is fit for purpose in evaluating both offshore and Seaway based release options.

Processes and Interactions on the Gold Coast

The Seaway is situated between two bodies of water; the semi-enclosed coastal lagoon of the Broadwater to the west and Pacific Ocean to the east. The interaction between the tidal dynamics through the Seaway and physical processes outside of the Broadwater is complex. The key physical processes within the study area include tide, wind, waves and ocean currents. The behaviour of the recycled water plume is influenced by an intricate combination of the following physical processes which vary on differing timescales, ranging from hours to days:

- The variation in tidal amplitude and phase of the tide (spring or neap),
- The trajectory of the ebb jet from the Seaway (and associated eddy structures) due to metocean conditions (wind, ocean currents residuals and waves),
- The degree of recirculation (backwash) through the Seaway,
- The circulation and mixing inside the Broadwater, and
- The timing of the recycled water releases.

The variation in tidal amplitude at the Seaway and phase of the tide (e.g. spring or neap) control the tidal excursion which can affect the distance the recycled water plume propagates into and out of the Seaway. The walls of the Seaway assist to channelize the flow. On the ebb phase of the tidal cycle this creates a jet which assists to push the recycled water plume offshore. Eddy features can form to the north and south of the jet, with an anticlockwise eddy to the north and clockwise eddy to the south. The trajectory of the ebb jet and prevalence of the associated eddy structures are influenced by the strength and direction of wind, wave and ocean current conditions. The model results have shown that during periods where weak offshore residuals prevail the trajectory of the ebb jet typically aligns with the orientation of the Seaway (approximately northeast). During periods with strong northward residuals the trajectory of the jet is pushed further northwards while during periods of strong southward residuals the jet is diverted slightly further east causing the anticlockwise eddy located to the north of the jet to become less pronounced.