

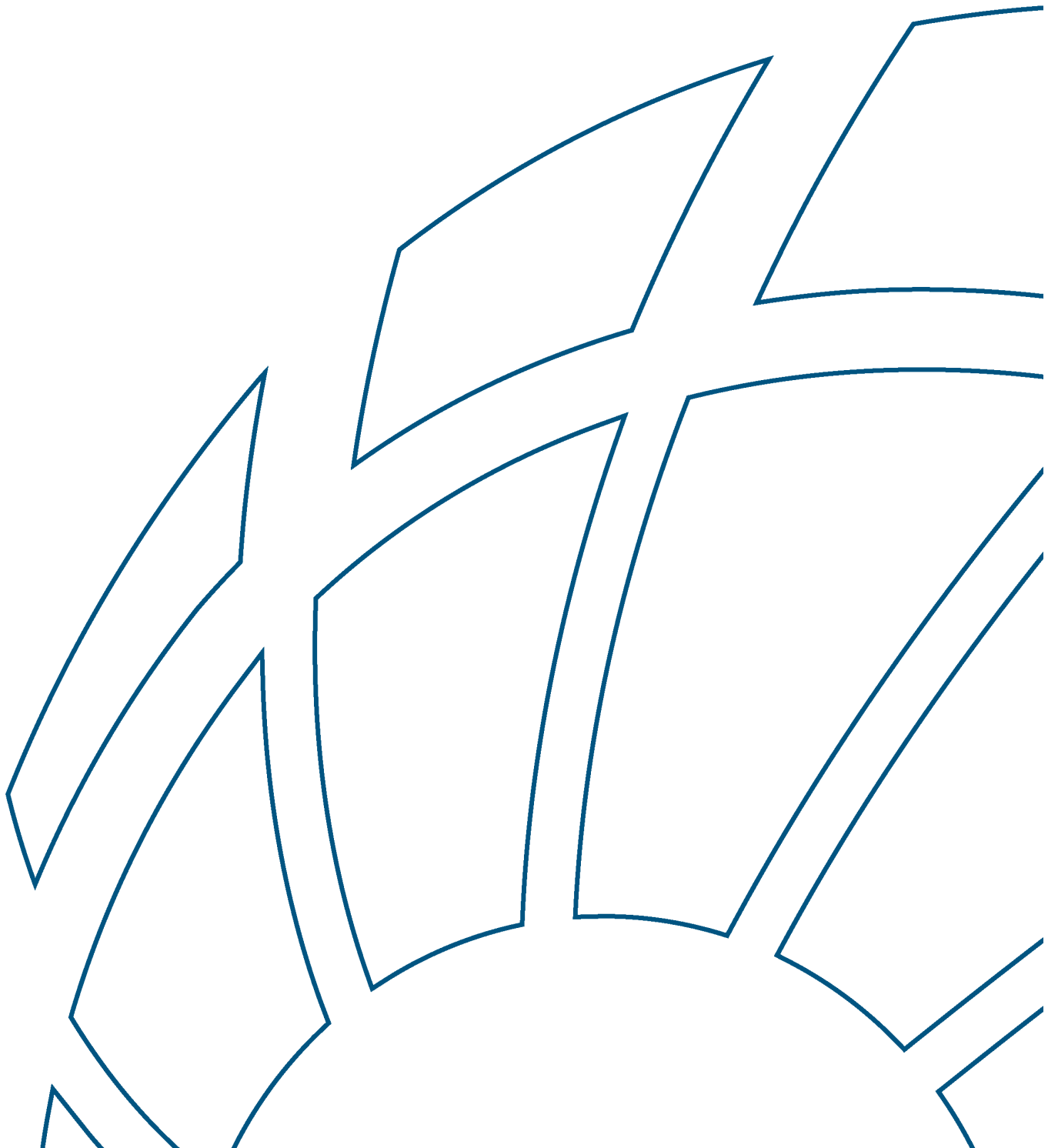


Perth Desalination Plant Discharge Modelling: Model Scenarios

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<p>Synopsis: This report presents results of a three dimensional numerical modelling study that examines the behaviour of a proposed second seawater desalination plant discharge to Cockburn Sound, Western Australia.</p>		

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Executive Summary

Executive Summary

This report describes results from a series of numerical model simulations designed to assist in understanding the likely behaviour of brine discharged from a proposed second Perth Seawater Desalination Plant located on the eastern shore of Cockburn Sound, Western Australia. Simulations made use of an existing peer reviewed three-dimensional hydrodynamic, transport and dissolved oxygen model of Cockburn Sound and its surrounds. This model was built by BMT on behalf of Water Corporation and has been validated over a wide range of conditions (BMT, 2018a).

The discharge scenarios simulated were as follows:

- Saline discharge from the existing Perth Seawater Desalination Plant (PSDP1) only, at its current production rate, and
- Saline discharge from PSDP1 at its current production rate, plus the proposed second Perth Seawater Desalination Plant (PSDP2) discharging at a rate corresponding to the production of 50 GL of potable water per year.

Plume salinity, temperature, and dissolved oxygen signatures across the above combinations of discharges were examined under various environmental conditions. Predictions are presented in this report as a series of figures, using statistical metrics provided by others. A particle tracking module embedded in the hydrodynamic model was also deployed so that the potential interaction of fish larvae and desalination plant intakes could be understood.

Ecological impacts of the above model predictions are not discussed in this report.

List of Abbreviations

AED2 – Aquatic Ecosystem Model v.2
AMC - Australian Marine Complex
BMT – British Maritime Technology
BoM – Bureau of Meteorology
CFD – Computational Fluid Dynamics
CFSv2 – Climate Forecast System version 2
DEP – Department of Environmental Protection
DO – Dissolved Oxygen
EQC - Environmental Quality Criteria
GL - Gigalitre
HPC – High Performance Computing
HYCOM – HYbrid Coordinate Ocean Model
IWSS - Integrated Water Supply Scheme
KBT - Kwinana Bulk Terminal
LAT – Lowest Astronomic Tide
MMMP – Marine Monitoring and Management Plan
NCEP – National Center for Environmental Prediction
NCODA – Navy Coupled Ocean Data Assimilation System
OEPA - Office of the Environmental Protection Authority
OpenFOAM - Open Field Operation and Manipulation
PSDP – Perth Seawater Desalination Plant
PTM - Particle Tracking Module
SSDP - Southern Seawater Desalination Plant
TOPEX - Ocean Surface Topography Experiment

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Introduction

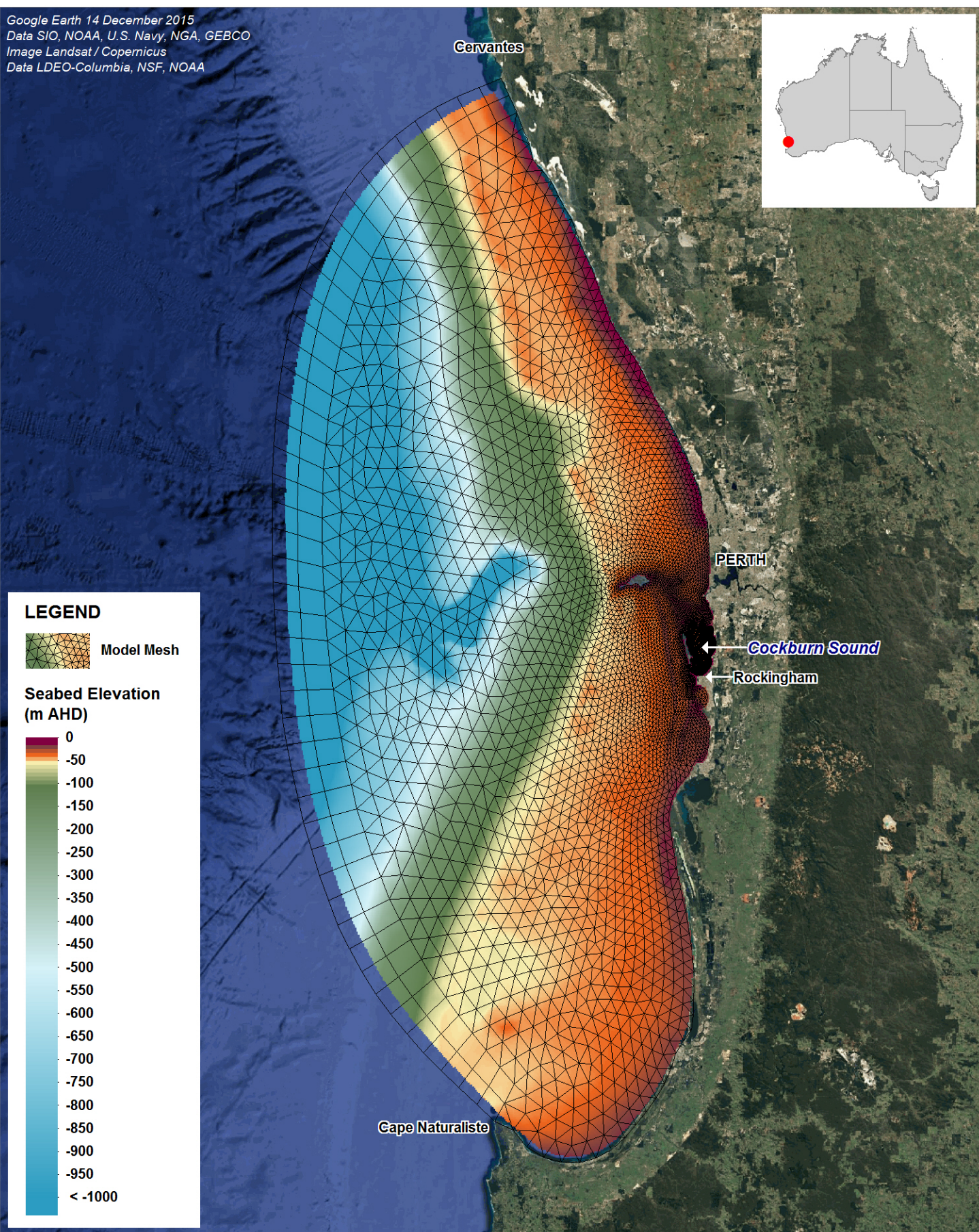
1 Introduction

1.1 Background

Water Corporation engaged BMT to develop a three-dimensional hydrodynamic and water quality numerical model of Cockburn Sound and its surrounds, Western Australia (Figure 1-1). This model included simulation of both hydrodynamic and dissolved oxygen (DO) processes, and its construction and validation are described in detail in BMT (2018a). The model included the existing PSDP1 diffuser and intake and was reconfigured in the current study to additionally simulate a series of scenarios for a proposed PSDP2 discharge and intake (Figure 1-2).

This report presents the results of these simulations.

Google Earth 14 December 2015
 Data SIO, NOAA, U.S. Navy, NGA, GEBCO
 Image Landsat / Copernicus
 Data LDEO-Columbia, NSF, NOAA



Title:
Hydrodynamic Model Extent and Bathymetry

Figure:
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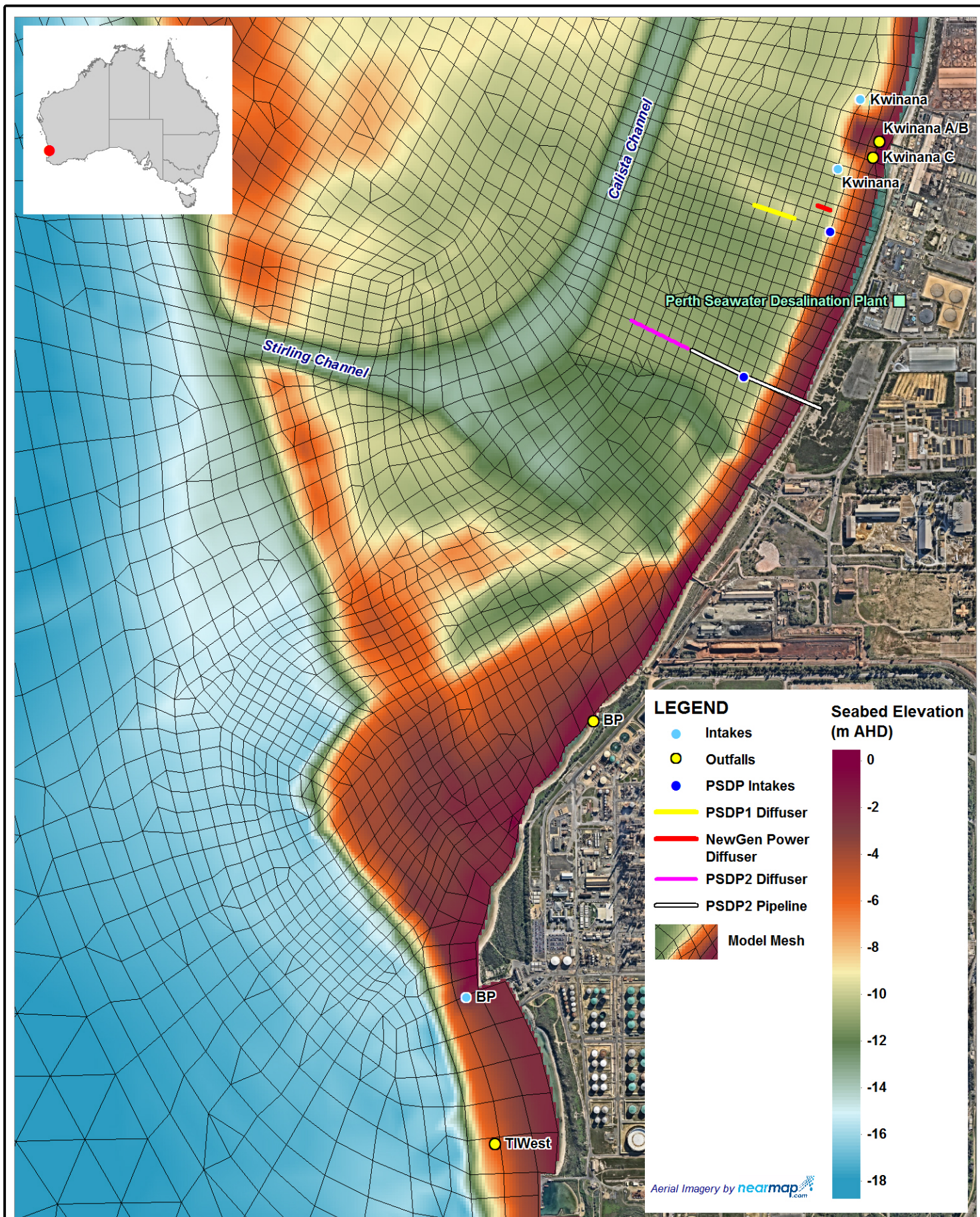
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Introduction

1.2 Study objectives

The overarching objective of this modelling study was to provide information to support others in undertaking an Environmental Impact Assessment (EIA) of the operation of PSDP2 (the outcomes of which are reported elsewhere). As such, the model simulations were configured to:

- (1) Quantify the combined effects of PSDP1 and PSDP2 discharge plumes on the temperature, salinity and dissolved oxygen of Cockburn Sound.
- (2) Assess the effects of entrainment into PSDP1 and PSDP2 intakes on recruitment of snapper (*Pagrus auratus*) populations in Cockburn Sound.

1.3 Scope of this report

The project scope included the following:

- Configuration of the farfield model previously validated (BMT, 2018a, including PSDP1) for a range of:
 - Ambient conditions; and
 - Simulation periods.
- Development of a PSDP2 diffuser design to ensure a suitable near field dilution.
- Prediction of the likely effects of the PSDP1 and PSDP2 discharges on salinity, temperature and dissolved oxygen (DO) concentrations on the marine environment of Cockburn Sound.
- Assessment of the potential for effluent accumulation within Cockburn Sound.
- Deployment of the hydrodynamic model particle tracking module to simulate the fate of Snapper (*Pagrus auratus*) larvae following spawning events.
- Quantification of larvae dispersion, mortality and their potential entrainment into PSDP1 and PSDP2 intakes.

It is not within the scope of this report to assess potential environmental impacts associated with the PSDP1 or proposed PSDP2 discharges. However, the method of presentation of model results in this report is such as to support those assessments.

Modelling to support impact assessments associated with the marine construction of PSDP2 is also outside the scope of this report.

1.4 Assessment components

The assessments described in this report were divided into two components.

1.4.1 Discharge signatures

In this component, the salinity, temperature, and dissolved oxygen signatures of the PSDP1 and PSDP2 discharges within Cockburn Sound are presented. These simulations cover a range of ambient conditions and two plant production rates.

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1.4.2 Intake assessments

In this component, the quantum of entrainment of snapper (*Pagrus auratus*) larvae to both PSDP1 and PSDP2 intakes during the peak spawning season is presented.

A brief description of these models and modules is provided below. Full details are presented in BMT (2018a).

2 Modelling Assessments

2.1 Modelling platforms

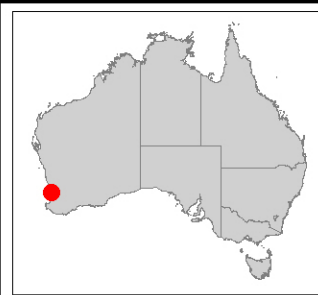
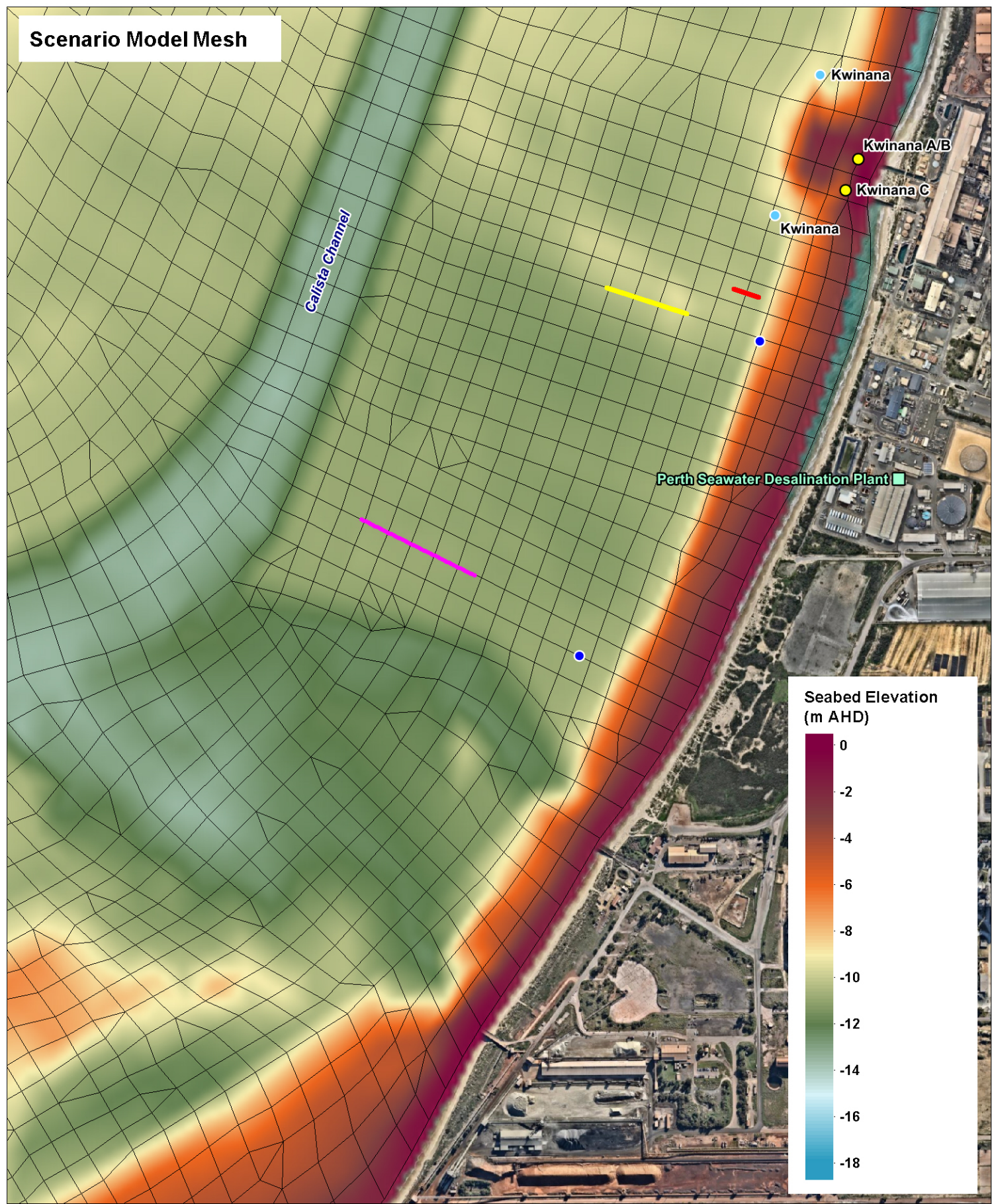
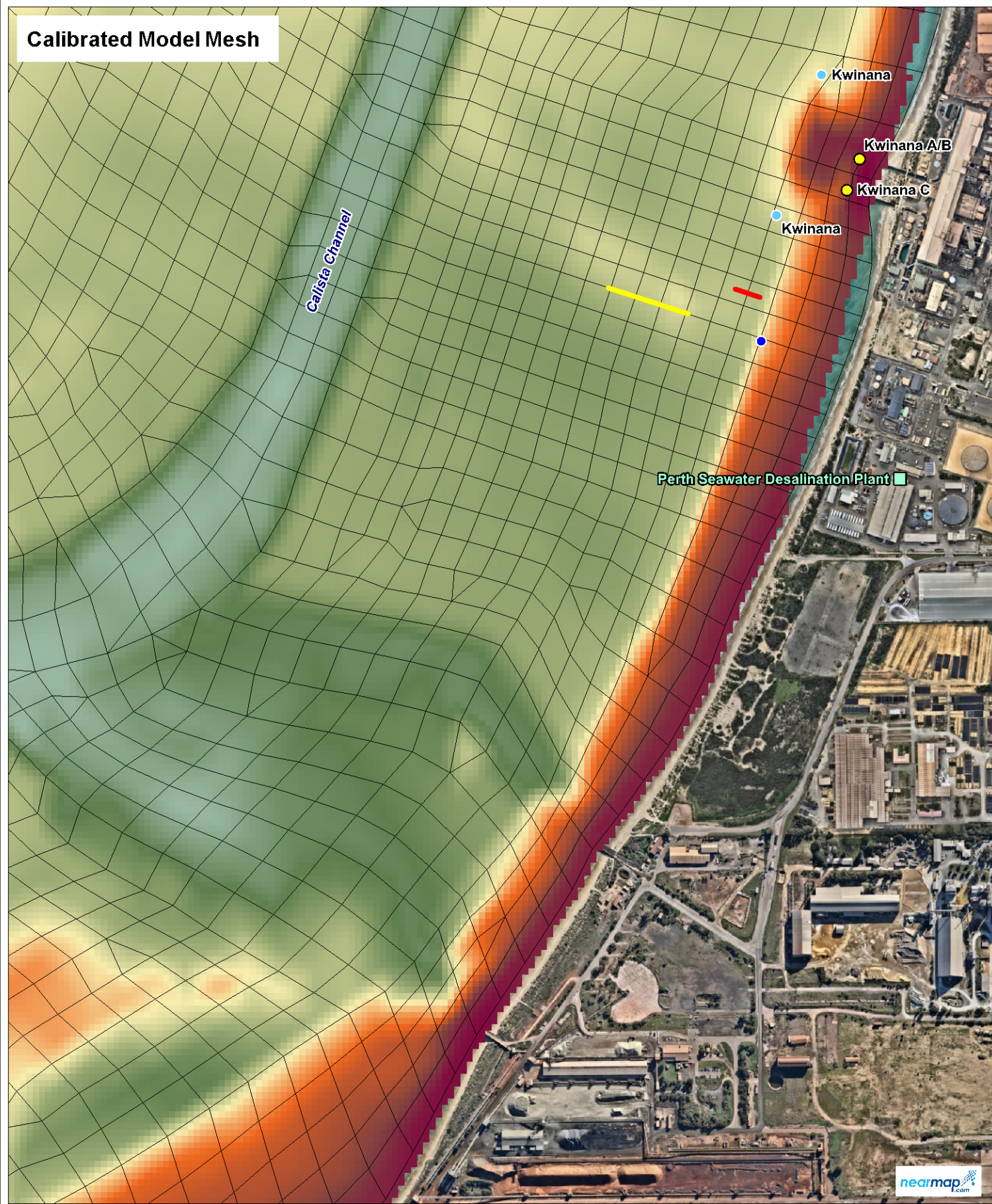
BMT (2018a) developed and validated a three-dimensional hydrodynamic, transport and dissolved oxygen (DO) model of Cockburn Sound and its surrounds (the farfield model) on behalf of Water Corporation. The farfield model comprises the hydrodynamic model TUFLOW FV coupled to the water quality model AED2. The PSDP1 discharge plume was represented in that model by linking the results of a high-resolution three-dimensional nearfield model of the PSDP1 discharge to the coupled TUFLOW FV-AED2 farfield model. These nearfield simulations adopted the computational fluid dynamics model (CFD) OpenFOAM (Open Field Operation and Manipulation).

In the current study, the farfield model was upgraded to include the diffuser and intake of the proposed PSDP2. A similar OpenFOAM CFD model of the PSDP2 discharge was constructed and then linked to this upgraded model in the same manner as was the case for PSDP1. The TUFLOW FV Particle Tracking Module (PTM) was also deployed in this study.

Some key model features are described below, with full details presented in BMT (2018a).

2.1.1 Model domain, mesh and bathymetry

The hydrodynamic model domain is the same one adopted in BMT (2018a), as shown in Figure 1-1. It extends from Cape Naturaliste in the south to Cervantes in the north, covering approximately 400 km of the coastline. Offshore, the model extends approximately 140km into the Indian Ocean to depths greater than 4,000m. The mesh applied in BMT (2018a) was slightly modified to enforce additional resolution at the PSDP2 diffuser and intake locations. A comparison of the model mesh in BMT (2018a) and the one adopted in the simulations presented in this report is shown in Figure 2-1.



LEGEND

- Intakes
- Outfalls
- PSDP Intakes
- PSDP1 Diffuser
- NewGen Power Diffuser
- Model Mesh
- PSDP2 Diffuser

Title:

Comparison of calibrated model mesh and scenario model mesh

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