B6

AIRPORT AND SURROUNDS

SURFACE WATER

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APPENDICES (REFER SEPARATE APPENDICES DISK)

B6:A Modelling Suite Development and Validation

B6 AIRPORT AND SURROUNDS SURFACE WATER

GLOSSARY

Bed Shear Stress	The amount of force created by the movement of water at the channel bed
Catchment	An area of land where surface water runoff converges to a single point
Event Mean Concentration (EMC)	A method for characterizing pollutant concentrations in runoff from a storm event
Flow duration curve (FDC)	A graphical representation of ranked flows in a given period, where the rank is the percentage of time the flow value is equalled or exceeded
Level of reporting (LOR)	Lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions
Particle size distribution (PSD)	A list of particle size of a sediment sample that indicates the relative amount, typically by mass or particle diameter, of particles present according to size
Settling velocity	The final velocity at which particulates settle to the bottom of a liquid and form a sediment
Tailwater	Water discharged from the Reclamation (construction) phase of the Sunshine Coast Airport Project.
Tidal limit	Location within a river or estuary where the hydraulic and salinity regime changes from tidal influences to freshwater river influences
Turbidity	Cloudiness apparent in water caused by suspended solids

6.1 INTRODUCTION

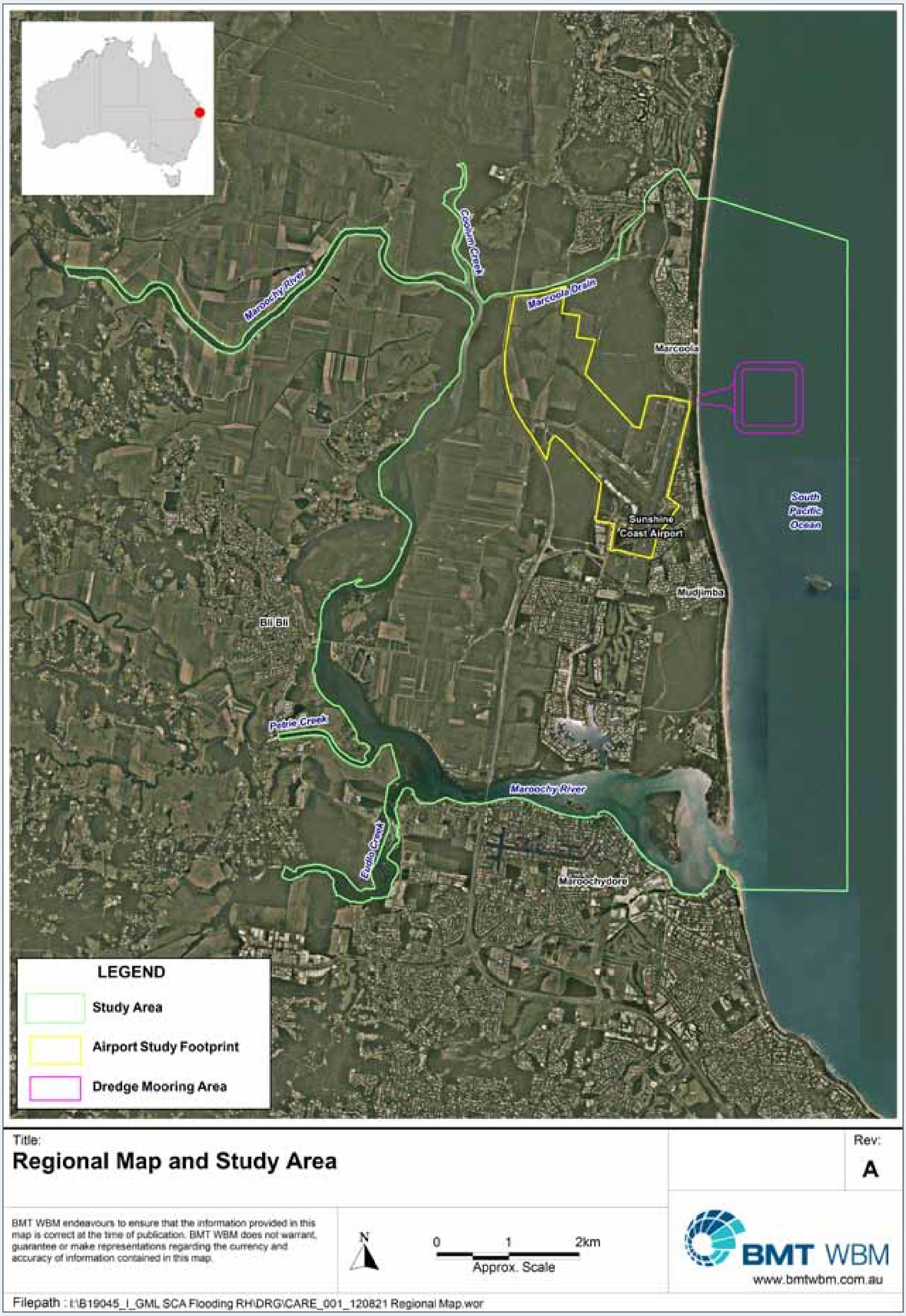
The Sunshine Coast Airport (SCA) Expansion Project (the Project) has the potential to influence water quantity and quality within the Maroochy River and the adjoining estuaries both during construction and operation. Potential impacts on water quantity and quality can result from tailwater discharge to surface water within the study area (see **Figure 6.1a**) during construction as well as stormwater discharge to surface water during operation. These influences are potentially both short term (construction) and long term (operation).

This chapter of the Environmental Impact Statement (EIS) addresses surface water quantity and quality issues within the airport (on-shore) study area. Characterisation of baseline marine water quality at the sand extraction area is addressed in Chapter B4 – Coastal Processes.

This chapter addresses the surface water aspects of the Project EIS Terms of Reference (TOR). The general structure of this document is as follows:

- **Section 6.2** provides the assumptions and limitations and the policy and legislative framework of this study
- **Section 6.3** summarises the existing (baseline) hydrology and water quality conditions of the study area
- **Section 6.4** provides a description of the significance criteria against which potential impacts will be assessed
- **Section 6.5** presents the assessment of the potential impacts in terms of significance, and the proposed mitigation measures to minimise or avoid impacts
- **Section 6.6** summarises the impact assessment, mitigation measures and the conclusions drawn from the analysis.
- **Appendix B6:A** of this chapter and contained in a separate appendices disk, describes the development and validation of the modelling tools used in the assessment of existing conditions and potential impacts.

Figure 6.1a: Regional map and study area



6.2 METHODOLOGY AND ASSUMPTIONS

6.2.1 Methodology

Baseline

The methods and approach used in the collection and analysis of baseline data are summarised below. These data were used, in most cases, both for baseline analysis and modelling tasks.

- All available hydrology and water quality monitoring data for the study region were collated (see **Section 6.3**). This included:
  - All Ecosystem Health Monitoring Program (EHMP) water quality data in the Maroochy River and surrounds. This includes in-stream physical, nutrient and algal data
  - Catchment flow gauge data
  - Hydrographic data, including tidal water levels
  - Acoustic Current Doppler Profiler (ADCP) measurements throughout the Maroochy River.
- Bathymetric data, including:
  - Marine boating charts
  - Previous survey data.
- Catchment data, including:
  - Land uses
  - Wastewater treatment plant discharges.
- Meteorological data, including:
  - Rainfall
  - Temperature.
- Where gaps in existing data were identified, additional data were collected to:
  - Ensure a complete and robust information set is available to the study
  - Inform baseline assessment
  - Inform subsequent modelling and analysis
- Relevant water quality guidelines.

All data were reviewed and analysed to define baseline conditions within the areas of interest to this study. Specifically:

- EHMP data was statistically analysed to provide percentile exceedence distributions for all key water quality data sets
- Gauge data was analysed and compared with catchment model predictions (see subsequent sections).

Impacts

The methods and approach used in the assessment of potential water quantity and quality impacts associated with the Project are:

- A suite of models was developed and integrated to enable the simulation of the catchment and receiving water conditions in the study area and associated catchments (see **Appendix B6:A**). These models simulated the following key processes:
  - Flows and pollutant loads from the entire Maroochy River catchment using Source, an eWater Cooperative Research Council (eWater CRC) whole-of-catchment hydrologic and pollutant export model
  - Flows, water levels and contaminant transport using the hydrodynamic and advection-dispersion model TUFLOW FV.

6.2.2 Assumptions and technical limitations

Baseline

- SCA has not conducted baseline stormwater quality monitoring from the airport facilities. This means that the quality of stormwater generated on the existing airport site is unknown and that alternative equivalent (or as close to equivalent as possible) data is required. Given this, a review of available data was conducted and those from the Brisbane Airport Corporation (BAC) New Parallel Runway Project EIS were used to estimate stormwater runoff water quality from the proposed SCA runway. These BAC data were adopted because:
  - They describe runoff from an airport facility in South East Queensland
  - The Maroochy and northern Brisbane coastal regions have similar climatological regimes so would experience similar rainfall patterns and associated runoff processes
  - The BAC data is the most recent airport related data available
  - It was not possible to locate (and then access) any other comparable data sets from the region that were as complete as those collected by BAC.
- Within the Maroochy River, all available monitoring and historical hydrologic and water quality data were used.
- The pump-out site does not have existing water quality data for characterisation of background conditions. Water quality conditions from most downstream EHMP in the Maroochy River (E01500; see **Figure 6.3g**) site have been considered in this study as surrogate. It is noted this site is at the entrance of the river and open ocean, and is likely influenced more by the river water quality dynamics than the pump-out site would be.

Impacts

- Tailwater discharge characteristics were estimated from general specifications provided by the marine engineer, however the exact nature of the tailwater quantity and water quality is unknown. These assumptions include:
  - A constant tailwater discharge flow rate
  - Tailwater water quality dependent on the phase of the reclamation
  - No interaction (loss or gain) with groundwater.
- Several different construction and tailwater discharge regimes were considered throughout the course of this assessment. These different configurations responded to a variety of matters, including design variation, dredge availability and similar. As a result, a range of different timings and configurations related to the tailwater discharge were simulated in the numerical model. In terms of predicted impacts however, the worst case scenario has been considered and presented in this analysis. In terms of water quality, this worst case is the option that spans the longest duration because assessment of water quality impacts relative to the water quality objectives (WQO) is based on an annual median concentration. Specifically, the longer the timespan within an annual period for which a discharge occurs, the greater influence it will have on the annual median calculation, and as such the 33 week program using a small dredge vessel is the worst case, compared to a shorter program. Importantly, (and noting that the WQOs are concentration based), the average discharge concentrations of all options remain the same (i.e. approximately 25 NTU) but flow rates of discharges are varied proportionately, with the shorter periods requiring greater tailwater discharge rates. This means that shorter duration operations do not rely on higher discharge concentrations to deliver the required tailwater to the receiving environment.
- Given the above, the tailwater discharge was simulated for a period of 33 weeks, at a flow rate of 0.3 m^3/s. The range of flow rates presented elsewhere in this assessment corresponds to different (not worst case) tailwater discharge options, with this flow rate being generally inversely proportional to the duration of tailwater discharge. For example 0.7 m^3/s corresponds to a 14 week tailwater discharge option, which is analogous to a 33 week program discharging at 0.3 m^3/s (as presented in this assessment).
- Further conservative assumptions were applied to ensure a robust analysis. These assumptions are described in greater detail in **Section 6.5.2.2**.

6.2.3 Applicable legislation, policies and guidelines

6.2.3.1 Environment Protection and Biodiversity Conservation Act 1999

The *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides for the protection of Matters of National Environmental Significance (MNES). These include listed threatened and migratory species and listed threatened ecological communities. Any activity that may have a significant impact on MNES requires approval from the Minister administering the EPBC Act.

MNES relevant to the Project include migratory shorebird species that utilise the sandbanks of the Maroochy River lower estuary, and threatened marine species that may utilise seagrass beds in the Maroochy River lower estuary, and threatened fish species that may occur in the middle estuary.

In addition to these matters, parts of the Maroochy River and Coolum Creek are part of the Coolum Creek and Lower Maroochy River Nationally Important Wetlands are recognised under the Directory of Important Wetlands Australia.

6.2.3.2 Environmental Protection Act 1994 and Environmental Protection (Water) Policy 2009

The *Queensland Environmental Protection Act 1994* is the principal legislative basis for environmental protection within the context of ecologically sustainable development in Queensland. The Environmental Protection (Water) Policy 2009 (EPP Water) seeks to achieve the object of the EP Act in relation to Queensland waters, being to protect Queensland waters while allowing for development that is ecologically sustainable. Queensland waters include water in rivers, streams, wetlands, lakes, aquifers, estuaries and coastal waters

The EPP Water includes a process for:

- Identifying environmental values (EVs) of waterways, including both aquatic ecosystems values and human use values
- Establishing corresponding WQO to protect identified EVs.

The EVs and WQOs for waters are contained in Schedule 1 of the EPP Water. Schedule 1 of the EPP Water provides that the “Maroochy River including all tributaries of the River” is part of “Basin 141” and that EV’s and WQO’s are set out in the “Maroochy River Environmental Values and Water Quality Objectives, published by the department in July 2010.” That document includes Plan WQ1411 which shows the spatial extent of water types in the Maroochy River.

The marine and estuarine waters of the Maroochy River and adjoining estuaries are classified as moderately disturbed by the EPP Water. Commensurate annual median WQOs have been defined for this status of waterways and these WQOs are used in subsequent sections of this report to categorise existing estuarine water quality.

6.2.3.3 ANZECC/ARMCANZ (2000) Guidelines for Fresh and Marine Water Quality

The Australian and New Zealand Environment and Conservation Council/Agriculture and Resource Management Council of Australia and New Zealand (ANZECC/ARMCANZ) Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000) guidelines can be used where regional guidelines Queensland Water Quality Guidelines (QWQG) are not adequate or available, for example when assessing toxicants such as metals and metalloids. These guidelines, therefore, are relevant in relation to an assessment of water quality parameters for metals and metalloids.

The main objective of the ANZECC/ARMCANZ (2000) water quality guidelines is to provide an authoritative guide for setting water quality objectives required to sustain current, or likely future, environmental values for natural and semi-natural water resources in Australia and New Zealand. The guidelines are intended to provide Government, industry, consultants and community groups with a sound set of tools for assessing and managing ambient water quality, according to designated environmental values. The guidelines similar to the QWQG were not intended to be applied as mandatory standards but do provide guidelines for recognising and protecting water quality.

6.2.3.4 Fisheries Act 1994

The *Fisheries Act 1994 (Queensland)* was enacted to:

- Manage the use and development of fisheries resources and fish habitat
- Protect fisheries resources and fish habitat
- Manage aquaculture activities.

The Maroochy River is classified as a Fish Habitat Area under the *Fisheries Act 1994*. A summary of the marine ecology conditions and fish habitat is provided within the Chapter B10 – Marine Ecology.

6.2.3.5 State Planning Policy (2013)

The State Planning Policy (SPP) released in December 2013 provides a single SPP for all ‘State Interests’ previously covered by other SPPs. The State Interest for water quality is designed to protect environmental values and health applicable to development and resulting issues.

The SPP, as a statutory policy, provides for matters to be incorporated into local land use planning schemes, including the protection and enhancement of environmental values and quality of Queensland waters. This is to be done through appropriate land use planning, assessment of development provision of infrastructure.

6.2.3.6 Description of Environmental Values, Water Quality Objectives and Guidelines

Table 6.2a summarises the relevant environmental values of the waterways within the study area as set forth by the EPP Water. There are several water types defined in the study area, where these are generally delineated by tidal regime and hydrodynamic connection to the open ocean. These water types and their geographical division are presented in **Figure 6.2a**. The associated water quality objectives, guidelines, and trigger values defined by the environmental values and water types are provided in **Table 6.2b** for slightly to moderately disturbed waters. The environmental values and water quality guidelines presented are used to assist in the evaluation of existing (baseline) water quality conditions of the Maroochy River study area and as a measure of the potential impact from the Project.

Table 6.2a: Study area environmental values

	Maroochy	Tidal	Other Estuarine	Open Coastal
Waterway Type	**River**	**Canals**	**Tributaries**	**Waters**
Aquatic Ecosystems	✓	✓	✓	✓
Seagrass	✓			✓
Irrigation				
Farm Supply/Use				
Stock Water				
Aquaculture	✓			
Human Consumer	✓	✓	✓	✓
Oystering	✓			
Primary Recreation	✓	✓	✓	✓
Secondary Recreation	✓	✓	✓	✓
Visual Recreation	✓	✓	✓	✓
Drinking Water				
Industrial Use				
Cultural and Spiritual Values	✓	✓	✓	✓

With reference to the objectives, guidelines, and trigger values summarised in **Table 6.2b** and as noted in **Section 6.2.3**, the EPP Water provides the quantitative measure of performance for the EV where applicable followed by the ANZECC (2000) in order of precedence. Compliance with the most stringent objectives (typically aquatic ecosystem values) will ensure achievement of all EV outcomes for the associated waterways.

Table 6.2b: Water quality objectives, guidelines and toxicant trigger values (TTV) to achieve EVs

Parameter	Unit	Open Coastal	Lower Estuary	Middle Estuary	Upper Estuary
EPP Water (2009) Water Quality Objectives					
Turbidity	NTU	1.0	6.0	8.0	25.0
Suspended Sediment	mg/L	10.0	15.0	20.0	25.0
Chlorophyll-a	µg/L	1.0	2.0	4.0	8.0
Total Nitrogen	mg/L	0.150	0.200	0.300	0.450
Oxidised Nitrogen	mg/L	0.003	0.003	0.010	0.015
Ammonia Nitrogen	mg/L	0.005	0.008	0.010	0.030
Organic Nitrogen	mg/L	0.140	0.180	0.280	0.400
Total Phosphorus	mg/L	0.016	0.020	0.025	0.030
Filterable Reactive Phosphorus	mg/L	0.005	0.006	0.006	0.010
Dissolved Oxygen	% Sat	95 – 105	90 – 105	85 – 105	80 – 105
pH		8.2 – 8.4	8 – 8.4	7 – 8.4	7 – 8.4
ANZECC/ARMCANZ (2009) Marine Toxicant Trigger Valuesa					
Arsenic	µg/L				5b
Antimony	µg/L				270c
Barium	µg/L				1000b
Cadmium	µg/L				0.7d
Chromium	µg/L				27.4
Cobalt	µg/L				1.0
Copper	µg/L				1.3
Lead	µg/L				4.4
Manganese	µg/L				70c
Mercury (inorganic)	µg/L				0.1d
Molybdenum	µg/L				23c
Nickel	µg/L				7d
Silver	µg/L				1.4
Vanadium	µg/L				100
Zinc	µg/L				15
Ammonia	µg/L				460e
NO_x	mg/L				13c

a TTVs assigned at the 95% protection level unless otherwise noted

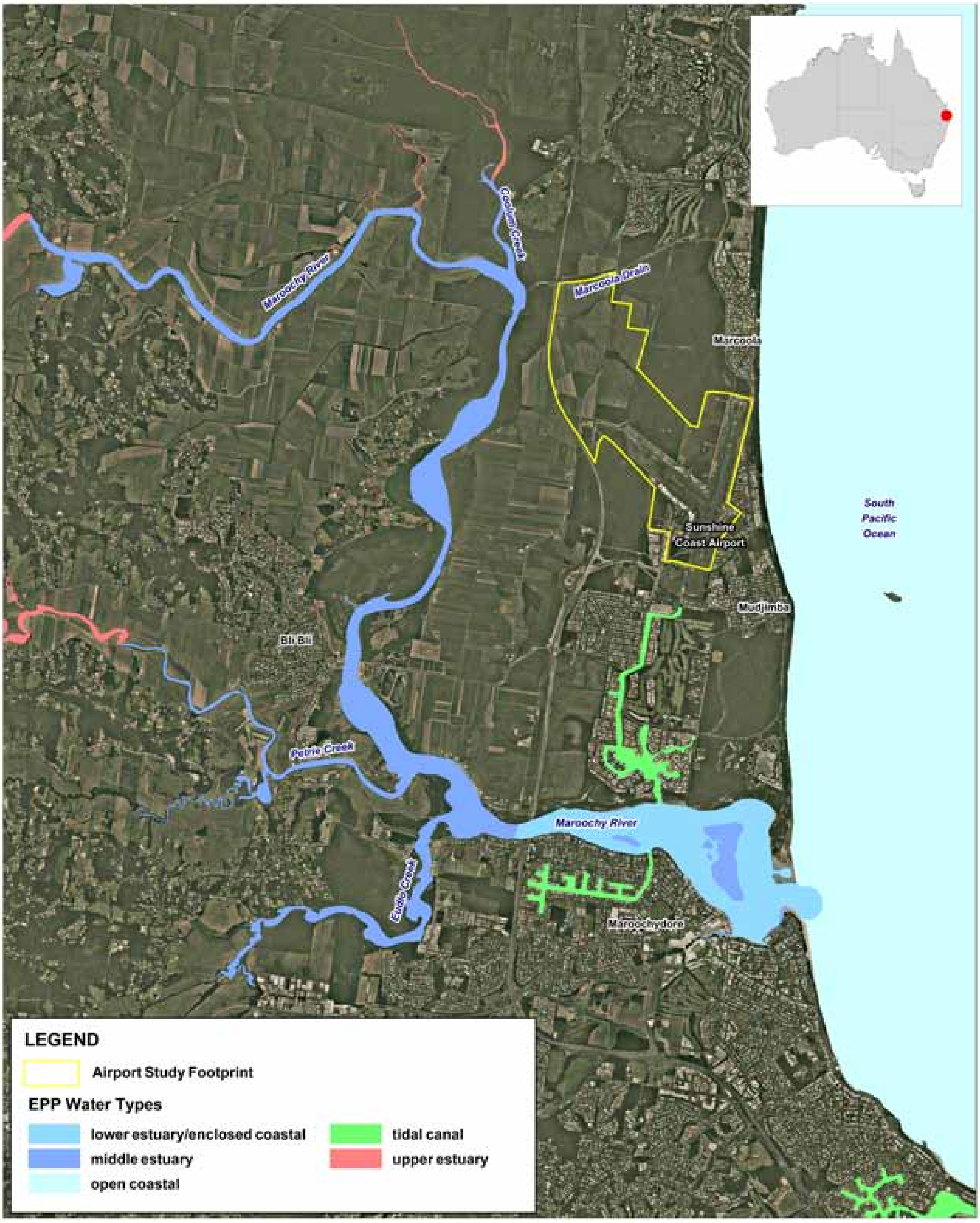
b Based on more stringent recreational guideline value

c Trigger value of low reliability, used as an interim value

d Set at the 99% protection level due to potential for bioaccumulation or protection of key species

e Ammonia trigger value based on Batley and Simpson (2009)

Figure 6.2a: EPP water Maroochy River water type boundaries



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EPP Water Maroochy River Water Type Boundaries

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6.3 EXISTING CONDITIONS

6.3.1 Water quantity conditions and hydrologic regimes

To assess potential changes to surface water hydrology which may arise from development of the Project, it is necessary to characterise the hydrological regime that currently exists on the site and its relevance in the context the Maroochy River catchment.

From a water quantity perspective, the three specific receiving environments of interest to the current study are:

- The Maroochy River at its confluence with Coolum Creek
- Within the Marcoola drain
- The Maroochy River downstream of Coolum Creek.

The following sections of this chapter quantify existing water quantity conditions in each respective waterway. This chapter does not address flooding impacts (see Chapter B5 – Flooding), but rather provides some hydrologic context to the existing conditions in the Maroochy River and airport surrounds. Note also that the impacts of changes to water quality as a result of the project on aquatic and marine ecology are presented in Chapter B9 – Aquatic Ecology and Chapter B10 – Marine Ecology.

In response to the TOR, the Project is not in a declared water storage area and there are no dams or weirs in the study area, although Cooloolabin Dam and Wappa Dam impound streams above the South Maroochy River. Land use, impoundments and extractions within the catchment affect water quantity within the Maroochy River and the Marcoola drain. Marcoola drain currently drains cane fields in the study area; changes to water quantity will occur with changes in land use and stormwater runoff. Sustainability of current water use in the study area, and conditions for users of water resources are unlikely to be significantly altered.

The Maroochy River and its catchments fall within the area covered by the Water Resource (Mary Basin) Plan 2006 (Subcatchment 5 – Maroochy River). The area covered by the plan stretches from Caloundra in the south to Burrum Heads in the north. The Water Resources Plan provides a framework for sustainably managing water and the taking of water, including consideration of future water requirements, establishment of water allocations, and addressing degradation of natural ecosystems.

3.3.1.1 Maroochy River

The Maroochy River system is a major waterway located in the Sunshine Coast area of Queensland. The entire river system extends more than 30 km inland from the river's mouth at Maroochydore and includes numerous tidal estuaries and freshwater inputs. The total catchment area is approximately 620 km^2 with predominant land uses of grazing, forested or native bush, and urban (DERM 2005). The catchment upstream of the confluence with Coolum Creek (**Figure 6.3a**) is approximately 360 km^2.

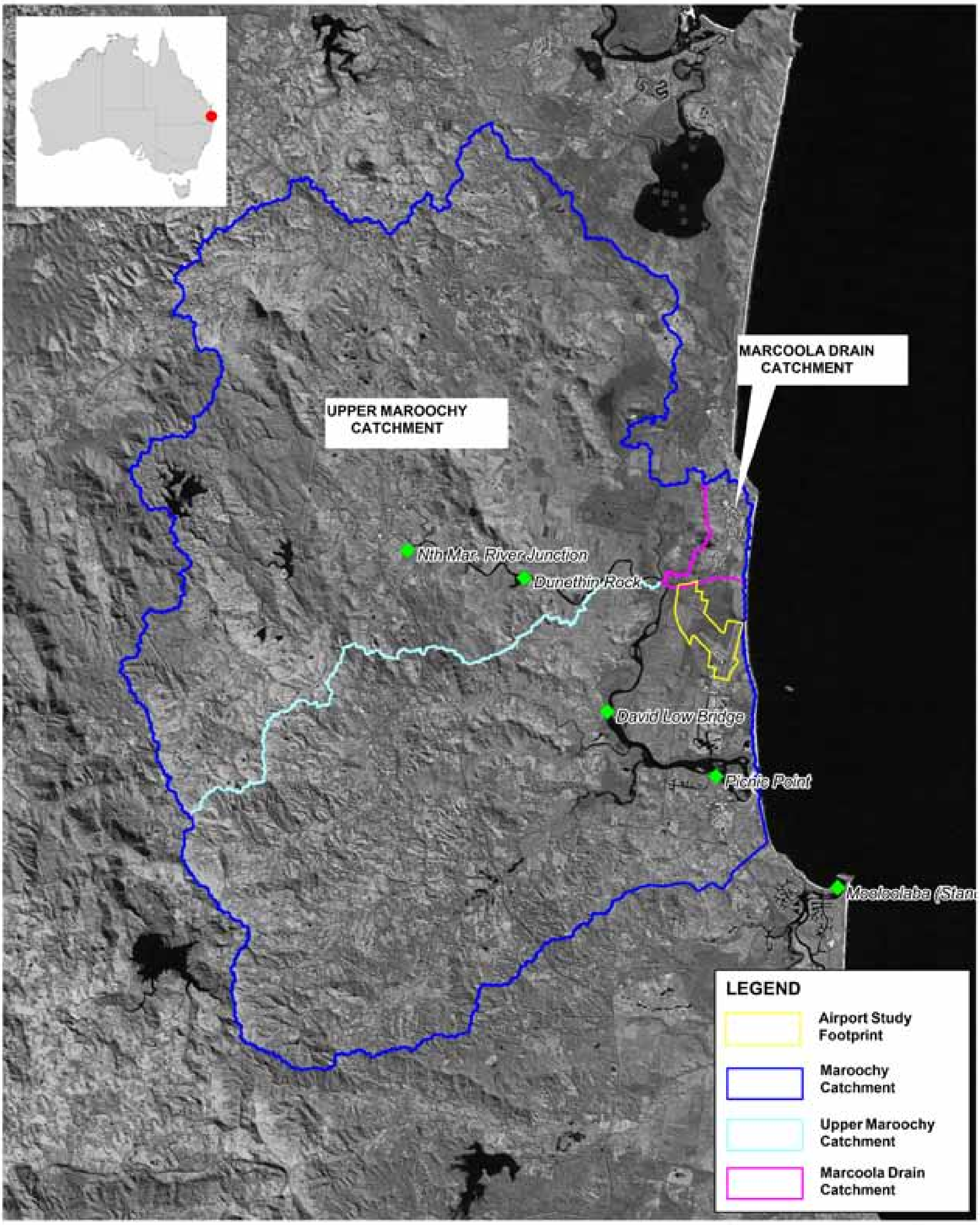
Near its tidal limit near Yandina, the river system bifurcates into the North and South Maroochy Rivers. The maximum tidal limit in the North Maroochy River is approximately 27 km upstream of the mouth (DTMR 2011) and approximately 13 km upstream of the Marcoola drain and airport site. Several creeks and waterways flow into the Maroochy River, including Coolum Creek, Petrie Creek, Paynter Creek and Eudlo Creek.

Except under heavy rainfall and high flow conditions, water quality in the Maroochy River is dominated by tidal flushing. The tidal times, heights and planes are published by Maritime Safety Queensland (MSQ) for the Standard Port of Mooloolaba in their publication Queensland Tide Tables 2012 (MSQ, 2011). Secondary tidal planes are also published for locations within the Maroochy River. These tidal planes are presented in **Table 6.3a**. See **Figure 6.3a** for geographic locations.

Table 6.3a: Maroochy River tidal planes (m LAT)

Maroochy River Tidal Planes	Mooloolaba (Standard Port)	Picnic Point	David Low Bridge	Dunethin Rock	Nth Mar. River Junction
Highest Astronomical Tide (HAT)	2.17	1.36	1.28	1.41	1.57
Mean High Water Spring (MHWS)	1.66	0.93	0.90	1.03	1.15
Mean High Water Neap (MHWN)	1.33	0.65	0.66	0.78	0.88
Mean Sea Level (MSL)	0.96	0.52	0.53	0.53	0.60
Australian Height Datum (AHD)	0.99	0.46	0.44	0.44	0.49
Mean Low Water Neap (MLWN)	0.58	0.27	0.30	0.28	0.34
Mean Low Water Spring (MLWS)	0.26	0.13	0.19	0.15	0.22
Lowest Astronomical Tide (LAT)	0.00	0.00	0.00	0.00	0.00

Figure 6.3a: Whole of Maroochy, Upper Maroochy and Marcoola drain catchments



Title:

Whole of Maroochy, Upper Maroochy, and Marcoola Drain Catchments

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The physical integrity of the lower Maroochy River is significantly influenced by riparian habitat and land use. The EHMP records a mix of modified and unmodified natural habitat areas along the river. Mangrove vegetation dominates areas of unmodified riparian zone. Background land use ranges from sugar to residential to vegetated areas (eucalypt, melaleuca and saltmarsh).

Fluvial processes and morphology of the Maroochy River estuary system is dominated by conditions and hydraulic behaviour at its entrance with the open ocean. The entrance morphology is highly transient as is evidenced by data presented in **Figure 6.3b** (McGarry 2010). Previous studies (WBM 1997) on this matter have determined that:

- The lower estuary is a highly dynamic environment with sediments continually shifting under the influence of waves, floods and tides
- When water flows predominantly through the north channel around Goat and Channel Islands, the southern channel is primarily shoaled
- When both the north and the south channels around Goat and Channel Islands are open, they are generally shallow.

The fluvial processes within the study area are highly influenced by tidal and estuarine processes, as well as inflows from a large catchment. The Maroochy River entrance is a well flushed and dynamic estuarine system. The lower estuary of the Maroochy River is a complex system of channels, intertidal shoals, islands and coastal bars. The river entrance is an important controlling factor on the tidal regime in the estuary. The shoals and sand bars at the entrance generally restrict the propagation of the tide from the ocean into the estuary with corresponding reduction in the tidal range when the entrance area is relatively small. Natural river entrances on sandy coastlines have been shown to exhibit a dynamic equilibrium wherein there is a relation between the tidal prism and the cross-sectional area of the entrance. The present river entrance is considered to be in such dynamic equilibrium.

At the Maroochy River entrance there is a strong relationship between coastal and estuarine processes. Coastal sediment transport plays a significant role in the development of coastal spits and the migration of the entrance channels. It is also an important factor in the overall dynamic behaviour of the lower river by supplying sand which is transported into the estuary under the influence of the prevailing tide and wave conditions.

As part of the process of the Maroochy River entrance relocating to the south of Pincushion Island in 1999, a large quantity of sand, which was the beach and dune system connecting to Pincushion Island, moved into the entrance. This caused substantial shoaling in the lower part of the estuary. This sand has largely remained within the estuary and is reworked by the prevailing coastal and estuarine processes. Under major riverine flood conditions much of this material would be scoured and naturally distributed back to the sea with the flood flow discharge.

Following a major flood event, areas where sandy material has been removed via natural processes are expected to gradually infill with sediment from neighbouring and offshore areas as the estuary morphology finds a new dynamic equilibrium. Similar sedimentation processes will occur following the removal of sand via anthropogenic methods however the scale of impact is typically smaller and therefore the system returns to dynamic equilibrium more rapidly.

6.3.1.2 Marcoola drain

Investigations into the bathymetry, hydraulics and hydrology of the Marcoola drain were undertaken for this study in order to provide baseline conditions. The Marcoola drain is a shallow, partially tidally influenced waterway that drains to the Maroochy River approximately 320 m south of the confluence with Coolum Creek which is within the tidal limits of the Maroochy River. The approximate upstream catchment area (**Figure 6.3a**) is 7.2 km^2 and is predominantly comprised of urban land use including two golf courses, residential and forest or native bush.

At the Finland Road causeway, which crosses over the Marcoola drain, there is a system of three culverts in parallel that hydraulically separate the lower and upper portions of the drain. Average bed elevation in the lower Marcoola is approximately 0.0 m AHD, as determined from 2008 SCRC LiDAR data, and the average bed elevation in the upper drain is approximately 0.5 m AHD. These elevations were generally confirmed during ecological field investigations conducted in August 2012. **Figure 6.3c** shows these culverts on the Marcoola drain at Finland Road. Modelling of baseline water levels in the Marcoola drain (see **Appendix B6:A**) indicate water from the estuary inundates upstream of the culverts at certain high tide periods, which can reach up to 1.2 m AHD. **Figure 6.3c** shows these culverts partially inundated.

For freshwater events passing into or along the Marcoola drain from the upstream catchment, separate hydrologic modelling was undertaken (see **Appendix B6:A**) to support and inform catchment inflows and pollutant loads in the receiving water quality modelling. This modelling has been interrogated for flow exceedances. **Figure 6.3d** shows the daily flow duration curve (FDC) in the Marcoola drain. An FDC shows the percentage of time a flow within a waterway is exceeded for a given time period. For example, the 10th percentile flow for the Marcoola drain is 0.28 m^3/s. That is, only 10 per cent of the flows within the canal are greater than 0.28 m^3/s. The FDC for the data shown in **Figure 6.3d** represent mean daily flows from 1/01/1980 to 31/10/2011. This includes an extremely wet period towards the end of 2011, though this only has a small impact at the higher end of the FDC.

Furthermore, flood elevations were recorded for the 22 February 1992 flood in the Sunshine Coast, which had an estimated 100-year ARI in the Maroochy River floodplain (McGarry 2010). The elevations relative to the Marcoola drain are shown in **Figure 6.3e**. For context the average ground elevation around the Marcoola drain is approximately 1.5-3.0 m AHD. It is likely much of the Marcoola drain would have been inundated during this event.

Figure 6.3b: Maroochy River mouth morphology (McGarry 2010)

6.3.1.3 Airport stormwater drainage

The approximate drainage patterns of the airport and surrounds, including the National Park to the north are included in **Figure 6.3f**. The main areas consist of the two drains that discharge directly to the Maroochy River and one that discharges a portion of airport stormwater plus some urban catchment runoff to the canals to the south (airport east). Flows generated from the catchments were also estimated using the hydrologic modelling discussed previously. The airport west catchment includes the areas generally west of Runway 18/36 which flows to the Maroochy River along the southern perimeter drain. **Figure 6.3d** shows the FDCs of the two airport catchments.

6.3.2 Existing water quality conditions

Water quality within the Maroochy River and associated waterways is affected by hydrological processes as described above, as well as a range of anthropogenic influences in the catchment and coastal areas. This section characterises current water quality conditions within the Maroochy River for key parameters using the range of water quality monitoring data available for these waterways.

6.3.2.1 Maroochy River

The Ecosystem Health Monitoring Program (EHMP; www.health-e-waterways.org), a multi-agency funded environmental monitoring program (led by Queensland Government) has been collecting water quality data at monthly intervals at a number of sites within the Maroochy River for more than 10 years. The locations and identification numbers for these sites, and their relationship to the Project site are illustrated in **Figure 6.3g**. These data were reviewed as part of the study and the following summarises key water quality patterns, trends and processes.

Figure 6.3c: Marcoola drain culverts at Finland road

Figure 6.3d: Flow duration curves for Marcoola drain and airport catchments

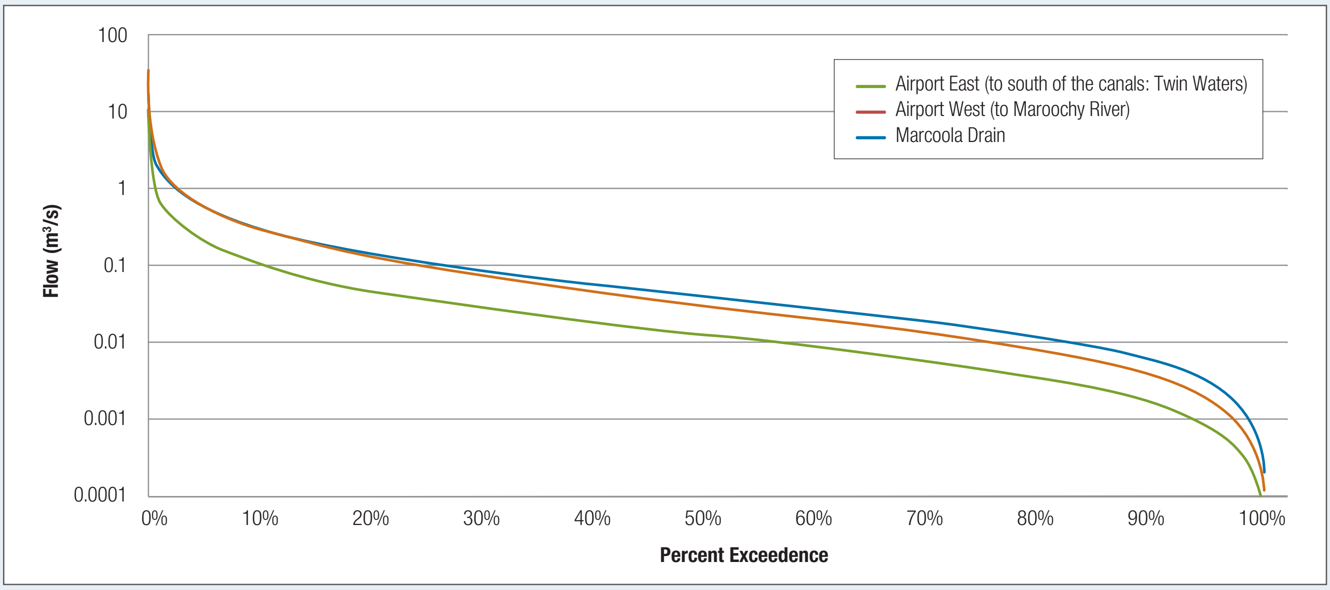


Figure 6.3e: Flood elevations of Marcoola drain, 22 February 1992

Title:
Flood Elevations of Marcoola Drain 22 February 1992 (heights in m relative to gauges)

Rev: A

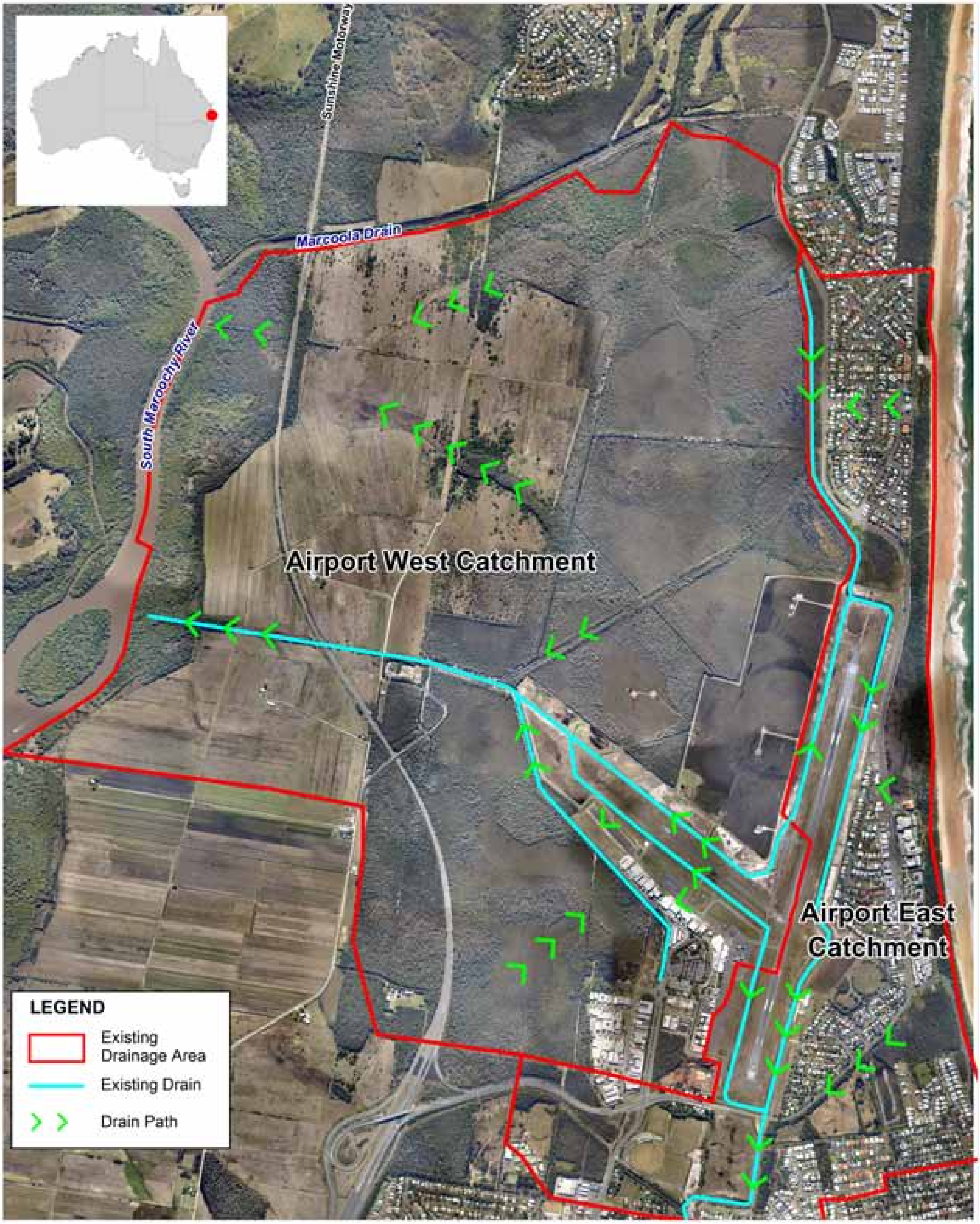
BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N 0 400 800m Approx. Scale

BMT WBM www.bmtwbm.com.au

Filepath : I:\B19045_I_GML SCA Flooding RH\DRG\CARE_005_maroochy_flood_elevations.wor

Figure 6.3f: Existing drainage of airport and surrounds



Title:

General Existing Drainage of Airport and Surrounds

Rev:

A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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0 400 800m

Approx. Scale

BMT WBM

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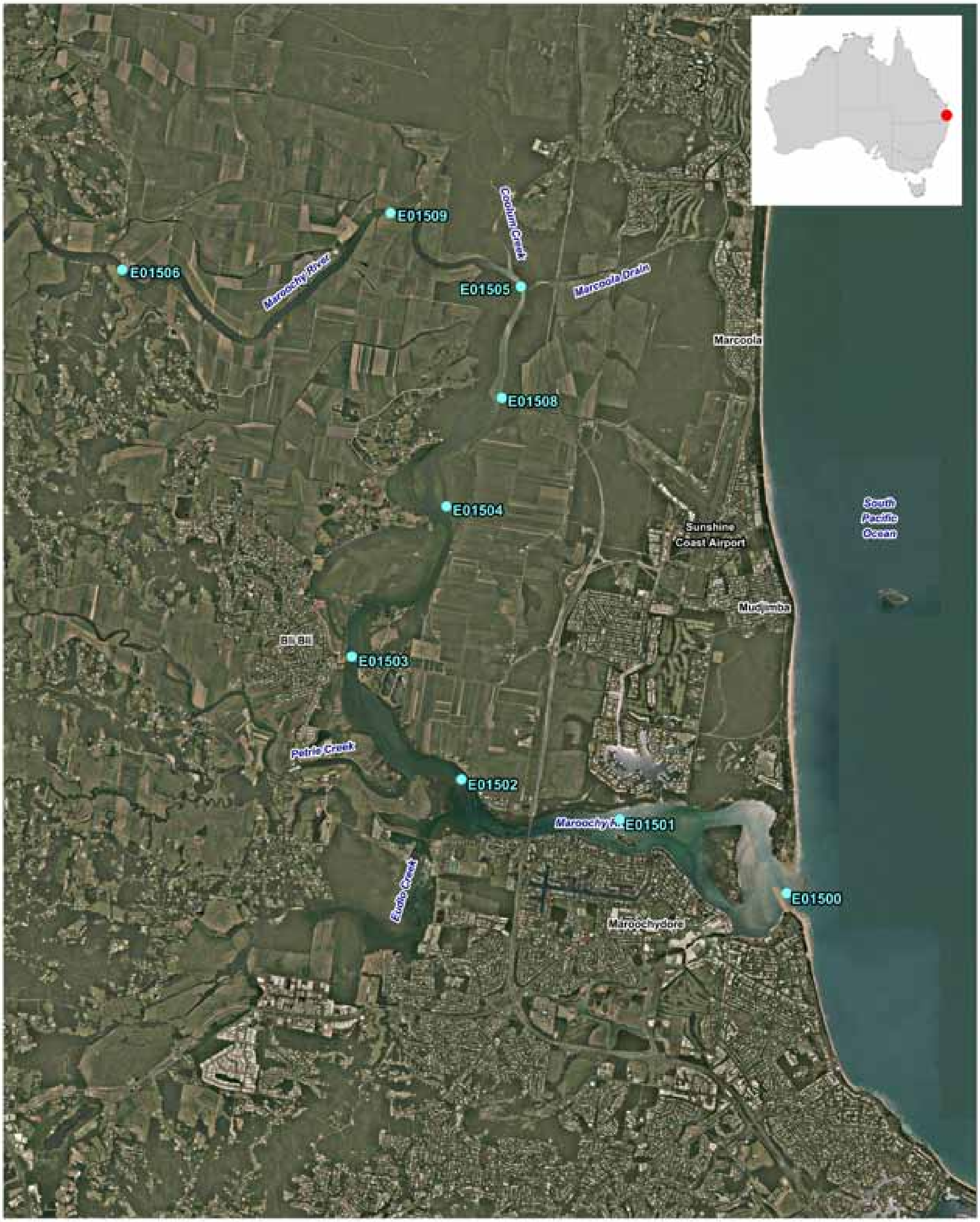
Figure 6.3g: Maroochy River EHMP water quality sites



Title:
EHMP Water Quality Site Locations

Rev: A

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0 1 2km
Approx. Scale

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www.bmtwbm.com.au

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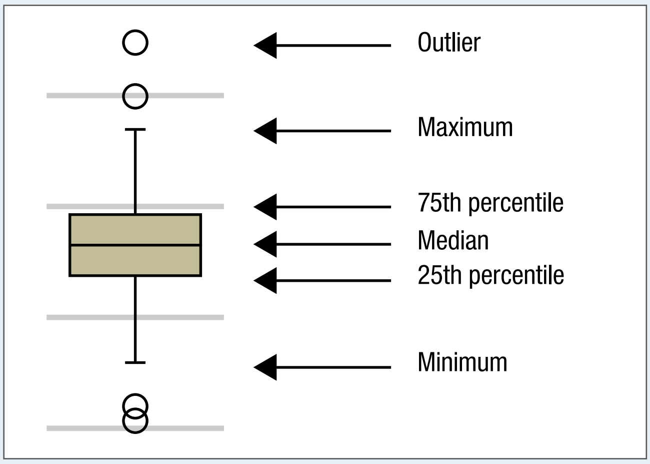
In all cases, the following are presented for each relevant water quality parameter:

- 'Box and whisker' plots based on the entire available EHMP data set (Oct 2001-Mar 2012, 125 surveys in total) showing overall water quality distribution in the Maroochy River, presented in **Figure 6.3i**. Box and whisker plots graphically depict groups of numerical data through five-number summaries: the smallest observation (sample minimum), lower quartile (Q1 or 25th percentile), median (Q2 or 50th percentile), upper quartile (Q3 or 75th percentile), and largest observation (sample maximum). Box and whiskers plots also indicate which observation, if any, might be considered outliers. Box and whisker plots are non-parametric and not influenced overall by very large or very small values. The spacing between the different parts of the boxes helps indicate the distribution and skew of the data. Please refer to **Figure 6.3h** for an example and explanation.

Figure 6.3h: Box and whisker plot key



- Time series plots of data for EHMP sites 1509, 1505 and 1508 are presented in **Figure 6.3j**. Included in these plots are daily rainfall data to provide hydrologic context to the water quality data.
- The annual median values of each of the past three years (2009-2011) for the major pollutants monitored for. These are presented in **Table 6.3b**.
- A brief discussion of salient observations relating to the presented data.

Discussion

Salinity

The data presented demonstrate the following:

- The Maroochy River at the entrance demonstrates salinity levels similar to that of ocean levels (~25,000-34,000 ppm) with little variation regardless of upstream catchment conditions due to the strong connection to the open sea. Immediately inside the entrance, the median salinity levels begin to decrease and the variation increases, due to decreased flushing and stronger influence from freshwater catchment inputs.
- Salinity levels are sensitive to catchment inflows and at the location of the Coolum Creek and Maroochy confluence (Sites 1508, 1505, and 1509), the salt recovery in the estuary may take 2-3 months, with the most upstream site recovering more slowly and the most downstream site recovering faster.
- There are no salinity recommendations by way of WQOs within the EPP Water.

Temperature

The data presented demonstrates the following:

- Temperatures are largely constant along the length of the Maroochy River with mean annual temperatures approximately 22 to 24 °C, with slightly less variation and range in values moving toward the entrance.
- Temperatures in the Maroochy River appear to be similar to those observed elsewhere in South East Queensland, typically varying from a minimum of around 15 °C in winter to a maximum of around 30 °C in summer.
- There are no specific temperature recommendations by way of WQOs within the EPP (Water).

Dissolved oxygen

The data presented demonstrate the following:

- Dissolved oxygen (DO) levels in the Maroochy River are generally poor, especially in the upper reaches where eutrophication, low tidal velocities (limited re-aeration), and long residence times occur.
- Median DO concentrations are at approximately 70 per cent of saturation for Sites 1509, 1505, and 1508, and approximately 80 per cent at 1504, whereas the WQO is 85 – 105 per cent of saturation.
- In regard to compliance with WQOs (**Table 6.3b**), only the four most downstream EHMP sites in the estuary comply with WQOs on a consistent basis, while the middle to upper reaches, including those near Coolum Creek, demonstrate consistent non-compliance.

pH

The data presented demonstrate the following:

- Of the 11 years of monitoring data, only once (2009) has the pH WQO at one site (1501) demonstrated non-compliance. This annual median value (7.85) was slightly lower than the lower pH value in the WQO range (8.0).
- Freshwater from catchment inflows are generally neutral and the lowest pH recorded was 5.96 at Site 1505. The highest recorded value was pH 8.49 observed at the entrance site (1500).
- There does not appear to be any temporal trends in pH, with the exception of more frequent measurements of lower pH (< 7.0) beginning in 2007. This has not changed the overall statistical measures against which the WQOs are applied.

Figure 6.3i: Maroochy River EHMP water quality data – box and whisker plots

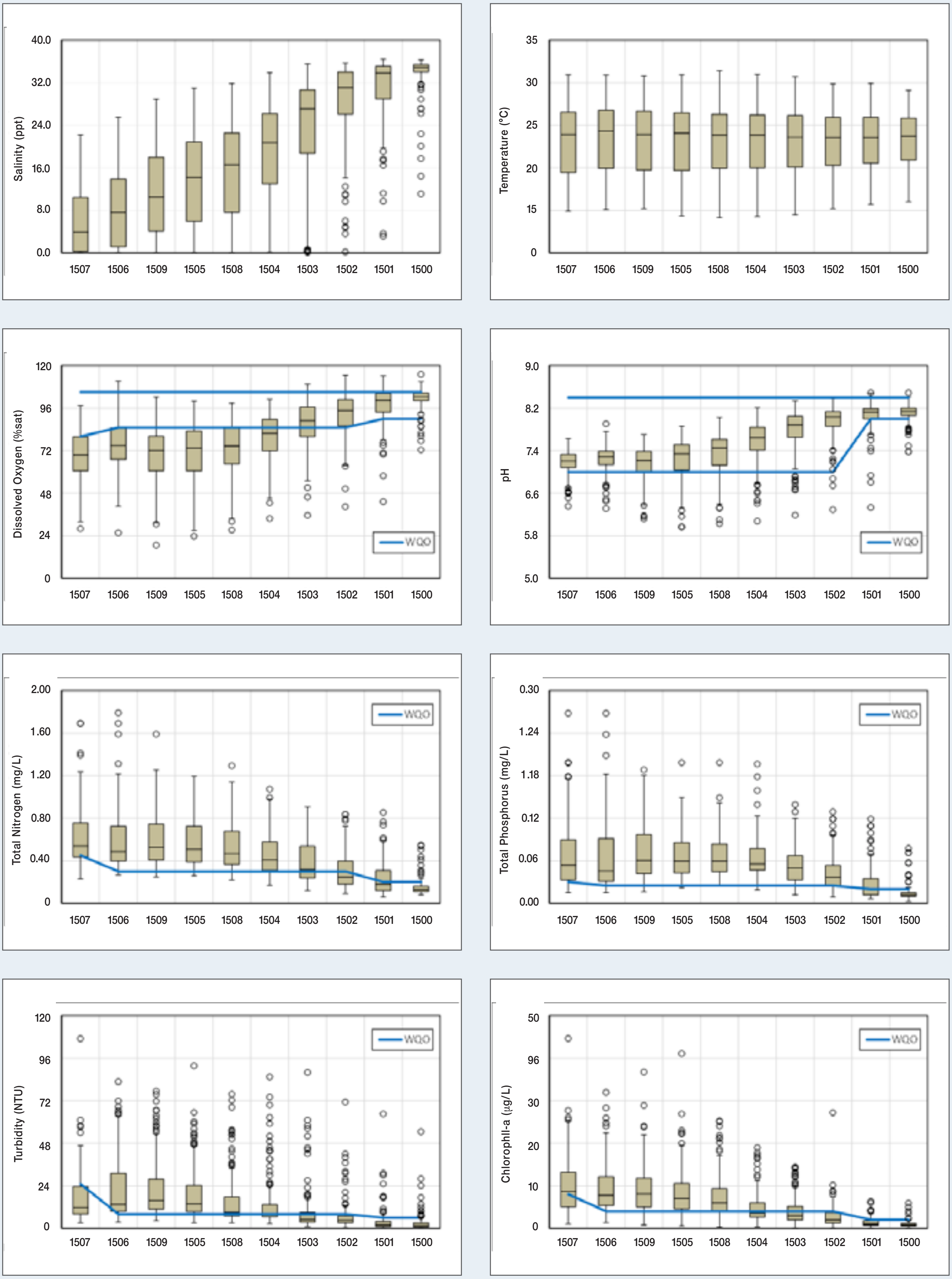


Figure 6.3j: Maroochy River EHMP water quality data – time series plots

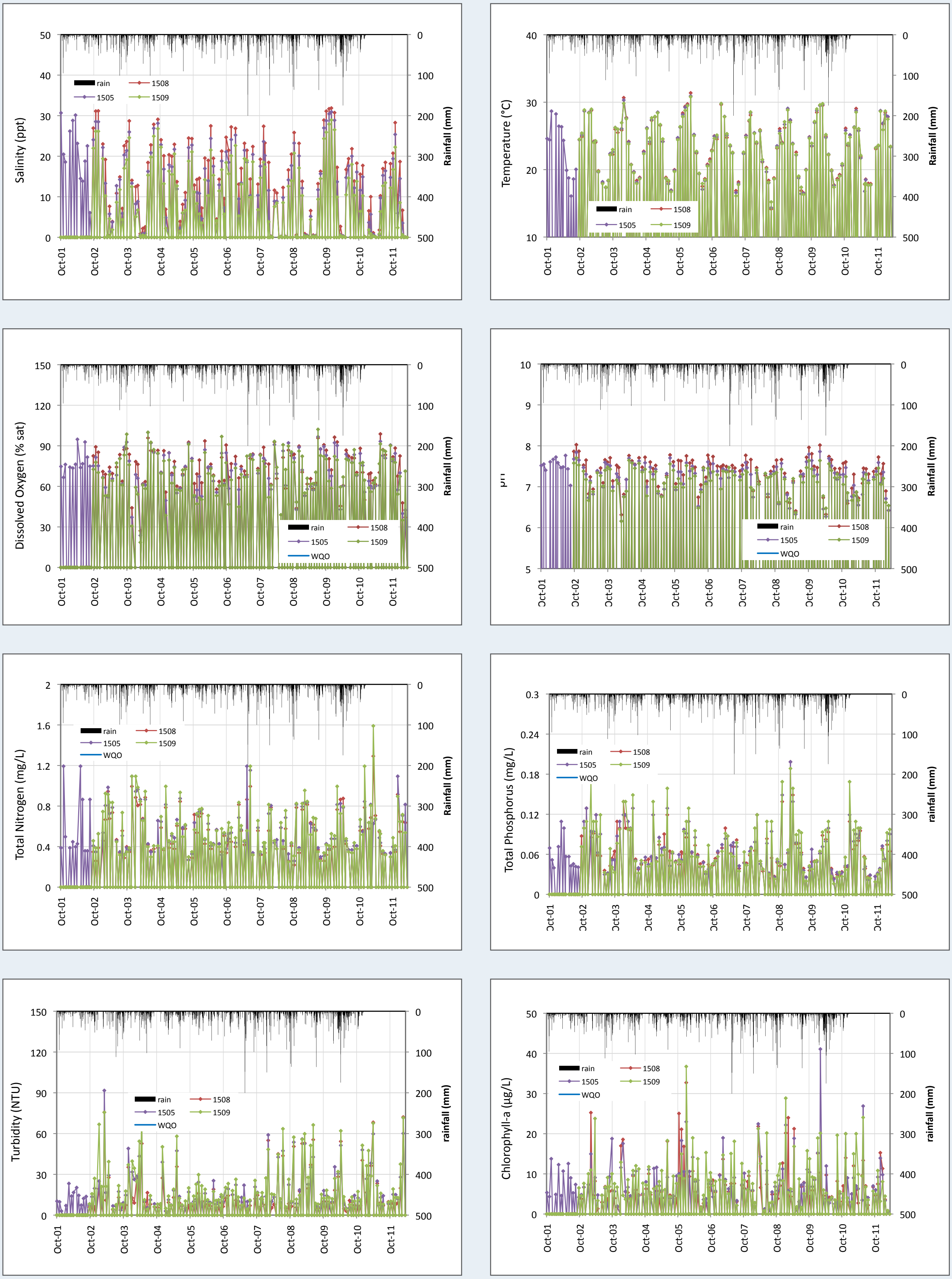


Table 6.3b: Median water quality values at Maroochy EHMP sites, 2009-2011

Parameter	Year	1500	1501	1502	1503	1504	1508	1505	1509	1506	1507
Salinity (ppt)*	2009	34.3	30.5	27.6	21.9	16.8	13.5	11.9	9.8	5.8	3.3
	2010	34.5	33.6	29.9	26.9	21.0	17.0	14.2	10.3	6.4	3.3
	2011	34.5	33.8	30.3	25.9	15.6	10.3	7.8	4.4	2.0	0.3
Temperature (°C)*	2009	23.6	23.3	22.8	23.1	23.6	23.7	23.7	23.8	24.0	23.7
	2010	23.3	23.1	23.0	22.8	22.8	22.9	23.0	23.1	23.3	22.8
	2011	22.9	22.6	22.9	22.9	23.3	23.3	23.4	23.4	23.5	23.7
DO (% sat)	2009	102.7	98.6	92.9	87.1	80.9	71.3	69.8	68.2	75.8	78.4
	2010	104.2	103.7	96.1	87.6	83.1	81.0	78.9	77.5	75.6	72.1
	2011	103.6	100.7	97.7	91.4	85.4	76.0	71.3	77.2	76.9	77.3
	WQO	90-105	90-105	85-105	85-105	85-105	85-105	85-105	85-105	85-105	80-105
pH	2009	8.03	7.85	7.84	7.63	7.46	7.29	7.26	7.19	7.19	7.03
	2010	8.09	8.13	8.03	7.86	7.63	7.46	7.30	7.23	7.22	7.21
	2011	8.10	8.06	8.00	7.80	7.55	7.31	7.12	7.13	7.20	7.20
	WQO	8.0-8.4	8.0-8.4	7.0-8.4	7.0-8.4	7.0-8.4	7.0-8.4	7.0-8.4	7.0-8.4	7.0-8.4	7.0-8.4
Total Nitrogen (mg/L)	2009	0.17	0.29	0.32	0.54	0.45	0.47	0.52	0.52	0.45	0.48
	2010	0.14	0.15	0.22	0.31	0.38	0.49	0.51	0.51	0.47	0.49
	2011	0.13	0.20	0.24	0.34	0.40	0.48	0.46	0.54	0.52	0.52
	WQO	<0.20	<0.20	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.45
Total Phosphorus (mg/L)	2009	0.01	0.02	0.03	0.04	0.05	0.06	0.06	0.06	0.05	0.04
	2010	0.01	0.01	0.03	0.03	0.04	0.04	0.04	0.05	0.04	0.05
	2011	0.01	0.02	0.03	0.04	0.04	0.05	0.04	0.05	0.06	0.05
	WQO	<0.020	<0.020	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.030
Turbidity (NTU)	2009	3.50	3.50	6.33	7.50	11.17	13.83	18.25	16.75	14.17	11.50
	2010	0.58	1.00	5.17	5.25	8.00	9.33	11.50	13.42	12.50	8.75
	2011	2.50	3.28	4.88	6.18	12.00	9.54	15.13	17.60	15.50	14.40
	WQO	<6.00	<6.00	<8.00	<8.00	<8.00	<8.00	<8.00	<8.00	<8.00	<25.00
Chlorophyll-a (µg/L)	2009	1.10	1.90	2.59	3.27	4.52	6.85	7.48	8.84	8.88	7.21
	2010	0.68	0.94	1.44	2.40	3.00	5.79	4.54	5.38	7.24	7.08
	2011	0.75	1.00	2.61	3.13	3.38	6.87	6.63	8.10	7.57	10.36
	WQO	<2.00	<2.00	<4.00	<4.00	<4.00	<4.00	<4.00	<4.00	<4.00	<8.0

Entries highlighted in red indicate exceedances of WQOs or values outside of the acceptable WQO range

** No specific water quality objectives within the EPP Water*

Total nitrogen

The data presented demonstrate the following:

- The Maroochy River demonstrates higher nitrogen concentrations in the middle and upper reaches, likely due to its presence in catchment runoff and sewage treatment plant (STP) discharges (see next bulleted item). The five upper sites demonstrate typical nitrogen levels of 0.45-0.55 mg/L.
- Four STPs discharge treated effluent directly to the Maroochy River (SCRC 2008):
  - Suncoast STP
  - Maroochydore STP
  - Nambour STP
  - Coolum STP.
- The Maroochydore and Nambour STPs share a discharge outfall near the Sunshine Motorway Bridge. Combined, these STPs discharge a total of 39 million litres of water per day and an average of 71 tonnes of total nitrogen per annum (NPI 2012). These nitrogen loads have a definite impact on the water quality in the Maroochy River, and the EHMP data likely reflect those impacts.
- The variation in total nitrogen levels also provides indication of the degree to which the Maroochy River flushes out. Only the lowest site (1500) shows little variation in nitrogen concentrations demonstrating the dominance of its hydraulic and water quality connection to the open sea, whereas all of the inland sites demonstrate a wide range of nitrogen levels.
- In terms of compliance, only the lowest three sites demonstrate regular compliance with WQOs, though 1501 and 1502 have seen some observed median concentrations greater than the WQOs. Site 1503 did record some years of compliance (2001, 2002, and 2007), though it is typically non-compliant.

Total phosphorus

The data presented demonstrate the following:

- Similar to nitrogen, the Maroochy River demonstrates higher phosphorus concentrations in the middle and upper reaches due to its presence in catchment runoff and STP discharges. The five upper sites demonstrate typical phosphorus levels of 0.05-0.06 mg/L.
- Again, the variation in total phosphorus levels also provides an indication of the degree to which the Maroochy River flushes. Only the most downstream site (1500) shows little variation in phosphorus concentrations suggesting its hydraulic connection to the open sea. The remaining inland sites demonstrate a large range of phosphorus levels.
- The Maroochy River is in generally poor condition with regard to compliance, as only the lowest site (1500) demonstrates regular compliance with WQOs. Site 1501 has seen some compliant observed annual median concentrations, however, the median of the total dataset is slightly noncompliant, and 5 of the 11 years are out of compliance with the WQO. The remaining sites do not comply with WQO during most years.
- Similar to nitrogen, STP discharges to the Maroochy River have an impact on phosphorus levels in the Maroochy River. Overall, the four main discharges mentioned in the discussion of nitrogen also discharge an average of 8.3 tonnes per annum to the Maroochy River estuary (NPI 2012). These STP loads influence phosphorus levels in the Maroochy River.

Turbidity

The data presented demonstrate the following:

- Median turbidity concentrations at the four upstream sites (approximately 11-16 NTU) are typically highest, reflecting the combination of maximum catchment influences, longest residence times and lowest salinities. The turbidity levels decrease at the sites closer to the entrance.
- There does appear to be some signal or change in turbidity levels over the previous (wetter) 2-3 years compared to drier years (2005-2006), supporting the linkage between catchment inflows and receiving water quality.
- The Maroochy is in compliance at the uppermost site (1507) due to the different applicable WQO (< 25 NTU for upper estuaries) compared to the middle estuarine sites. Annual medians for the four downstream sites demonstrate compliance during the entire period of record, whilst site 1504 demonstrates compliance in 7 of the 11 years overall. The middle estuarine sites (1508, 1505, 1509 and 1506) are generally non-compliant.

Chlorophyll a

The data presented demonstrate the following:

- There appears to be a trend of increasing chlorophyll a levels and increased variance with passage upstream in the Maroochy River, which reflects the behaviour of high nutrient inputs from the catchment and longer residence times in the estuary.
- The five downstream sites are generally in compliance with two years of exceedances of WQOs at 1503 and three at 1504. Sites 1506, 1509 and 1505 typically demonstrate chlorophyll a concentrations twice that of the WQO (4 μg/L) while Site 1508 demonstrates concentrations ~30 per cent greater than the WQO.

Summary

The following summary characterises water quality in the Maroochy River estuary and associated waterways:

- Overall, the hydraulics of the system have a significant influence on the quality of the water within the estuary. Long residence times and limited tidal flushing result in an accumulation of nutrients and sediments, especially in the upstream reaches of the estuary. Chlorophyll a and dissolved oxygen concentrations are then affected, resulting in frequent or consistent exceedances of the WQOs
- Salinity is variable, but influenced significantly by freshwater inputs and estuarine flushing characteristics. Salinities at the Marcoola drain range from 0 to near ocean water (~35,000 ppm)
- Dissolved oxygen concentrations are routinely lower than the minimum WQO value for a majority of the EHMP sites in the Maroochy, likely as a result of breakdown of organic matter within the water column and sediments
- Nutrients, turbidity and chlorophyll a are all elevated in the Maroochy River, especially in the upper reaches, where WQOs are typically exceeded. These concentrations are influenced by the delivery of both catchment and STP pollutant loads to the system combined with generally poor flushing characteristics of the estuary.

The Healthy Waterways Partnership monitors and reports on water quality within the Maroochy Catchment. 'Report Cards' are published for both the freshwater and estuarine reaches of the system. Since the inception of the program in 2001, report 'grades' for the catchment have been fairly consistent, ranging from C- to B. The grades include indices relating to a variety of physico-chemical, biological and nutrient cycling measures. A grade of C represents 'fair' ecosystem processes. The Maroochy estuary improved to a grade of B, largely due to decreased nitrogen and algae concentrations.

Monitoring data does not suggest unsustainable changes or significant declines in water quality.

6.3.2.2 Marcoola drain

Water quality

The Marcoola drain currently is not monitored for water quality parameters. Additionally, the EPP Water does not account for the drain specifically, but does so by setting EVs and WQOs for other tidal canals and estuarine tributaries. Nevertheless, due to its proximity to EHMP Site 1505, it is assumed the water quality in the tidally influenced regions of the drain will have similar characteristics to that of the Maroochy River in that location. Please refer to the presentation of the data for the Maroochy River, including **Figure 6.3i**, **Figure 6.3j**, and **Table 6.3b**. The discussion regarding the water quality data at the applicable sites is also pertinent to the discussion regarding water quality in the Marcoola drain.

Sediment quality and scour potential

To address the potential for the Project to mobilise sediment within the Marcoola drain as a result of tailwater discharge, Golder Associates (2013a) performed sediment sampling for particle size distribution and sediment contaminant concentrations. The primary concern is that the tailwater discharge could increase localised velocities within the Marcoola drain and cause scour of the existing bed material, resulting in potential contaminants in the sediment becoming suspended within the water column.

A total of four samples were collected at two locations (CD1 and CD2), upstream and downstream of the proposed northern perimeter drain connection (see **Figure 6.3k**). Samples were collected at two depths within the sediment, 0.05 to 0.15 m and 0.25 to 0.35 m.

The results of the sediment sampling are as follows:

- The bed material at CD1 was classified as predominantly fines (silt), with typically greater than 80 per cent of the material passing through a 0.075 mm sieve for both shallow and deep samples. CD2 showed higher coarse material content with only 57 per cent of the surface material passing through the 0.075 m sieve and only 16 per cent of the deeper material passing the 0.075 m sieve. The median particle size (d50) of the deeper material at CD2 is between 0.2 and 0.3 mm
- **Table 6.3c** presents the metals sediment concentrations with comparison to the sediment screening values. The metals concentrations of the sediments are typically lower than the ANZECC/ARMCANZ (2000) low interim sediment quality guideline (low ISQG) as shown in the table. Also presented in the table are the high ISQG values. Within the low and high ISQG values, Nickel is the only metal that presents at concentrations higher than the low ISQG
- Pesticides were not detected in the sediments at concentrations greater than the laboratory level of reporting (LOR), however the LORs for pesticides were typically greater than the screening values.

Figure 6.3k: Sediment sampling locations (Golder Associates 2013a)

Table 6.3c: Sediment metals concentrations in Marcoola drain

Metal	Low ISQG	High ISQG	CD1 0.05-0.15 m	CD1 0.25-0.35 m	CD2 0.05-0.15 m	CD2 0.25-0.35 m
Arsenic	20*	70	10	10	16	2.5
Cadmium	1.5	10	0.5	0.5	0.5	0.5
Chromium	80	370	42	33	41	15
Copper	65	270	12	9	14	2.5
Lead	50	220	15	14	17	7
Nickel	21*	52	28	23	35	13
Zinc	200	410	86	66	125	31

** Australian sediments typically have high arsenic and nickel (ANZECC/ARMCANZ 2000).*
Entries highlighted in red indicate exceedances of sediment screening level.

6.3.2.3 Airport stormwater quality

The SCA currently does not monitor runoff from its facilities (Smith 2012, pers. comm). As such, proxy stormwater quality values have been sourced from the BAC New Parallel Runway Project EIS (BAC 2005). These values have been used as they relate to an airport with similar climatic conditions, are derived from a comparable stormwater strategy, and provide an estimate for impacts that is conservative, given the scale of the Project will be less that the New Parallel Runway project. For this baseline characterisation, these values will be surrogates for the likely quality of water present during the operational stage of the Project.

The BAC monitoring program commenced in February 2000 and was designed to characterise baseline water quality conditions across the airport. Water quality was monitored regularly at the 10 sites where water enters or leaves the airport. The sites were divided into categories:

- Reference – drains on the site that receive little to no discharge from current airport activities
- Discharge – airport operational discharge locations.

Box and whisker plots for nutrient (total nitrogen and phosphorus) and turbidity concentrations for both reference and discharge locations are provided in **Figure 6.3l**.

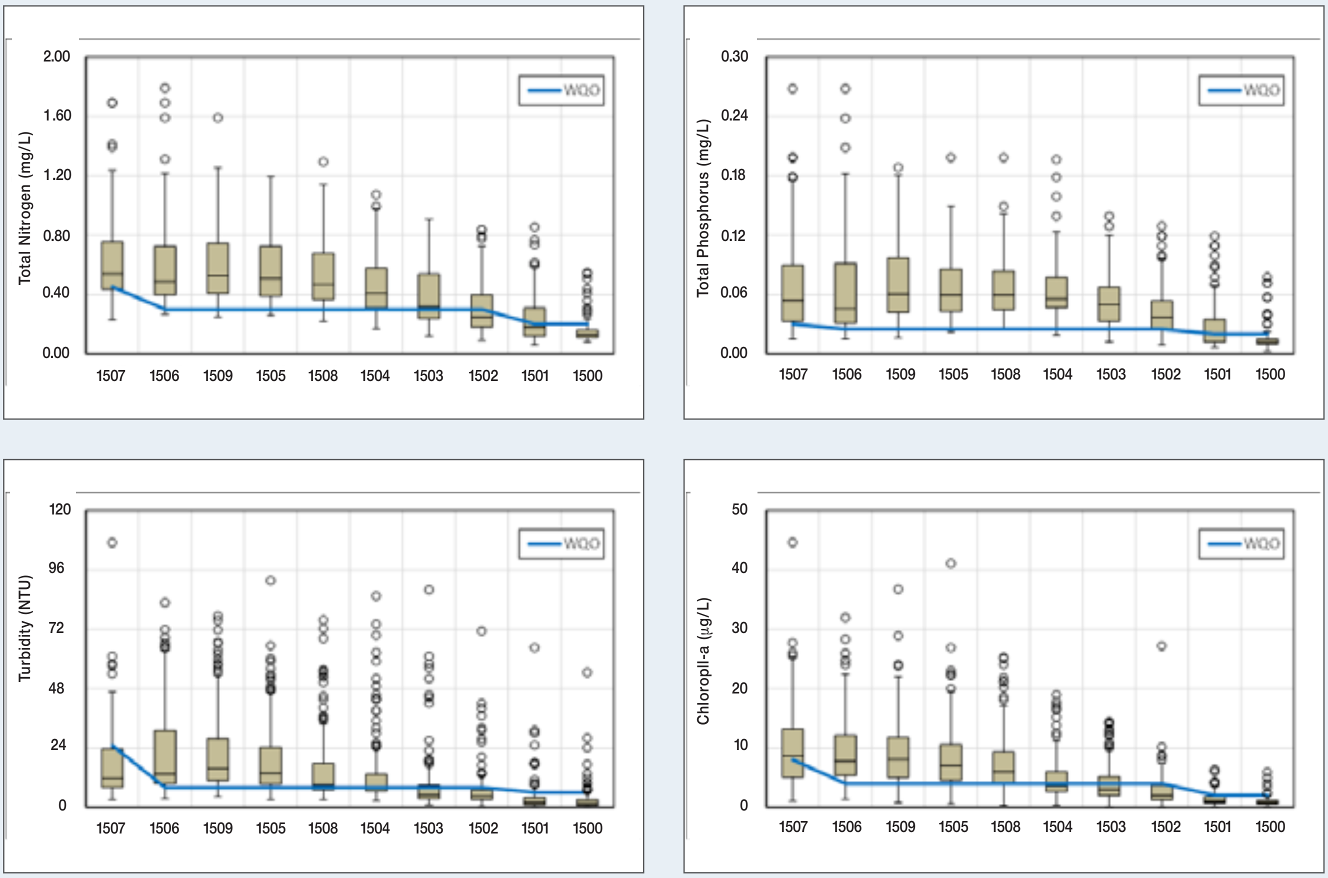
With the exception of turbidity, nutrients at the discharge sites demonstrated levels greater than those observed in the reference site data. As a baseline comparison, the EPP Water WQOs for middle estuarine water type have been included in the graphs. Both reference and discharge values are in excess of the WQOs.

It is likely that the use of data from Brisbane Airport, which is larger and busier than the SCA, is conservative as stormwater quality is likely to be more degraded at the larger airport. However, the proximity of the Brisbane Airport also removed some of the uncertainty associated with using these values as surrogates, as regional climate and environmental factors are likely to influence stormwater drainage and water quality in a similar manner.

6.3.3 Baseline modelling

A system of modelling tools was developed to enhance the understanding of existing conditions in the Maroochy River, Marcoola drain and surrounds. These tools include an integrated system of catchment (Source) and receiving water quality (TUFLOW FV) modelling developed to assess impacts of the Project against baseline conditions. Due to the technical nature of the modelling, **Appendix B6:A** of this chapter discusses the development and validation of those modelling tools.

Figure 6.3l: Turbidity and nutrient concentrations for Brisbane Airport stormwater runoff



6.4 DESCRIPTION OF SIGNIFICANCE CRITERIA

A risk-based approach has been used to assess water quantity and quality impacts, and is based on the consideration of the following:

- Significance of Impact – made up of assessment of the intensity, scale (geographic extent), duration of water quantity or quality impacts and sensitivity of environmental receptors to the impact (as prescribed in the EPP Water). **Table 6.4a** is a summary of the categories used to define impact significance.
- Likelihood of Impact – which assesses the probability of the impact occurring. **Table 6.4b** is a summary of the categories used to define impact likelihood.
- Risk rating – which assesses the level of risk for key impacting processes. The risk table (**Table 6.4c**) adopted is generated from the Significance and Likelihood scores, based on the overall matrix presented in Chapter A9.

Table 6.4a: Categories used to define significance of impact (water quantity and quality)

Impact Significance	Description for Water Quantity and Quality (includes magnitude, duration, and sensitivity of receiving values)
Very High	The water quantity or quality impact is considered critical to the decision-making process as it would represent either: • A permanent or adverse change to the water quality in the Maroochy River that underpins the ecosystem role as habitat for threatened and migratory species listed under the EPBC Act; or • A permanent or adverse change to the water quality in the Coolum Creek and Lower Maroochy River Nationally Important Wetland.
High	The water quantity or quality impact is considered important to the decision-making process as it would represent: • A long-term loss of a prescribed environmental value in the Maroochy River estuary under the EPP Water (e.g. the water quality objective measured as an annual median is not achieved and this change is attributable to the development); or • A long-term and adverse change to the water quality in the Maroochy River that underpins the ecosystem role as a fish habitat area
Moderate	While important at a state or regional or local scale, these impacts are not likely to be key decision making issues. This would be indicated by: • Some short-term exceedances of relevant water quality objectives for waters in the Maroochy River Estuary under the EPP Water measured as an annual median where this change is attributable to the development but the overall environmental values are protected; or • A short-term change to water quality or hydrology that adversely affects the ecosystem role as a fish habitat area
Minor	Impacts are recognisable and detectable but acceptable. These impacts are unlikely to be of importance in the decision making process. Nevertheless, they are relevant in the consideration of standard mitigation measures. This would be indicated by a reduction in water quality for some parameters but at levels that still achieve the relevant water quality objectives measured as an annual medians and thereby protecting environmental values.
Negligible	Minimal change to the existing situation. This could include, for example, impacts that are below levels of detection, impacts that are within the normal bounds of variation or impacts that are within the margin of forecasting error.
Beneficial	Any beneficial impacts as a result of the project such as for example, an improvement to water quality in the receiving waters or otherwise returning the hydrological regime to a pre-disturbance condition.

Table 6.4b: Categories used to define likelihood of impact (water quantity and quality)

Likelihood	Categories
Highly Unlikely/Rare	Highly unlikely to occur but theoretically possible
Unlikely	May occur during construction/life of the project but probability well <50 per cent; unlikely but not negligible
Possible	Less likely than not but still appreciable; probability of about 50 per cent
Likely	Likely to occur during construction or during a 12 month timeframe; probability >50 per cent
Almost Certain	Very likely to occur as a result of the proposed project construction and/or operations; could occur multiple times during relevant impacting period

Table 6.4c: Risk matrix for water quantity and quality

Likelihood	Significance				
	Negligible	Minor	Moderate	High	Very High
Highly unlikely / rare	Negligible	Negligible	Low	Medium	High
Unlikely	Negligible	Low	Low	Medium	High
Possible	Negligible	Low	Medium	Medium	High
Likely	Negligible	Medium	Medium	High	Extreme
Almost certain	Low	Medium	High	Extreme	Extreme

6.5 ASSESSMENT OF POTENTIAL IMPACTS AND MITIGATION MEASURES

The Project construction and operation, including tailwater discharge to the Marcoola drain, has the potential to impact surface water hydrologic and water quality issues. In terms of construction, these potential impacts include:

- Changes to hydrology in the Marcoola drain. It should be noted this assessment only addresses the changes in flow patterns and statistical flow volumes
- Changes to water quality (turbidity and TSS) within the Maroochy River and the Marcoola drain
- Changes to salinity regimes in the Maroochy River and the Marcoola drain
- Impacts of nutrients in the tailwater on water were assumed to be negligible due to the likely very low level of nutrients in the sand dredged from Moreton Bay and the make-up water from the pump-out site at Marcoola
- Water level impacts in the upper reaches of the Marcoola drain, especially during high tides or high catchment inflow events
- Impacts on water quality at the offshore pump-out site, including material spillage. Potential impacts on water quality from normal operation of the dredge vessel are addressed in Chapter C3 – Coastal Processes and Water Quality with mitigation measures detailed in Chapter E4 – Dredge Management Plan.
- Scour and mobilisation of existing bed sediments in the Marcoola drain due to tailwater discharge from the north perimeter drain.

In terms of operation, these potential impacts include:

- Changes to hydrology in the Marcoola drain. It should be noted this assessment only addresses the changes in flow patterns and statistical flow volumes
- Localised stormwater impacts in terms of water quality
- Changes to salinity regimes in the Maroochy River and the Marcoola drain.

The impacts on downstream aquatic and marine environments are presented in Chapters B9 – Aquatic Ecology and B10 – Marine Ecology. Chapter E6 – Risk Management Plan provides information relating to the risk assessment associated with the potential for uncontrolled releases to water due to system or catastrophic failure of the reclamation bund and the strategies to prevent, minimise and/or contain impacts.

6.5.1 Changes to hydrology in the Marcoola drain and airport surrounds from the development of new drainage infrastructure

Stormwater flow paths through the airport site are expected to be modified with the implementation of the northern and western perimeter drains. As discussed in the baseline conditions, much of the flow currently discharges to the Maroochy River from one of two drains as shown in **Figure 6.3f**. Modification of the drainage pattern is expected to divert some flows generated within the north part of the sites (Mt Coolum National Park) through the north and west perimeter drains and to the lower portion of Marcoola drain. Additionally, runoff from changes in land use, converting existing green (open space) to impervious area for the runway is likely to change. These drainage modifications are shown in **Figure 6.5a**.

It is expected that the changes in flow patterns within the Marcoola drain and the airport surrounds will have hydrologic impacts. The changes to the FDCs shown in **Figure 6.3d** are as follows:

- Increases are observed in flows in the lower Marcoola drain as a result of the Project. The top graph in **Figure 6.5b** shows these changes. Flows are increased by approximately 40 per cent at low flow conditions and approximately 50 per cent for high flow conditions. These changes in flows are observed at the north perimeter drain entrance, close to the Maroochy River. These are likely to be minor to negligible due to the proximity of the discharge to the Maroochy River, and provided that target pollutant reduction rates for sediments and nutrients in the stormwater are maintained
- The southern perimeter drain that served as drainage for most of the airport catchment (see **Figure 6.3f**) demonstrates approximately 20-40 per cent lower flows with an average decrease of 30 per cent. These changes are likely negligible, as this drain discharges directly to the Maroochy River
- The eastern airport drain that discharges to the south tidal canals (Twin Waters) demonstrates lower flows by an average of 20 per cent. These changes are likely negligible, as this drain discharges directly to the tidal canals south of the airport and are likely to be influenced primarily by tidal waters
- The period of data for which these FDCs were developed is 1/01/1980 to 30/10/2011
- **Figure 6.5c** shows the changes in the Marcoola drain FDC during the worst-case period of sand delivery (33 weeks). All exceedance flows are increased, especially low flows, due to the constant tailwater discharge flow. Nevertheless, these impacts are only observed during the 33-week reclamation program (or less if a shorter reclamation period is adopted). Impacts to flows during operation would be reduced significantly, as seen in **Figure 6.5b**. It is also noted that modelled flow magnitudes are very low, especially where the divergence of baseline and due to tailwater discharge is greatest. These modelled flows are at, or close to, the reliability of the modelling.

6.5.2 Tailwater discharge assessment for potential TSS, turbidity and salinity impacts

Impacts of construction of the new runway, the tailwater discharge in particular, were assessed using Source and TUFLOW FV modelling as discussed in **Appendix B6:A**. **Figure 6.5d** shows the modification of the process diagram using the integrated modelling tools. The baseline modelling domain discussed in **Appendix B6:A** was modified from baseline conditions to include the northern perimeter drain which is the primary conduit for the tailwater discharge prior to release to the Marcoola drain. Additionally, the western perimeter drain will be blocked off during the reclamation to prevent tailwater flowing south into the southern perimeter drain.

It should be noted that the Source and TUFLOW FV modelling simulate TSS rather than turbidity. Turbidity was derived by applying a multiplicative conversion factor of 1.5 (i.e. Turbidity [NTU] = 1.5 TSS [mg/L]), and is based on monitoring data as part of a monitoring program for dredge material in Moreton Bay (BMT WBM 2011) where fill for the Project will be sourced. This conversion factor was also applied in the calibration of the TUFLOW FV model (see **Appendix B6:A**) with satisfactory outcomes.

Also of note, the groundwater input into the model, shown in **Figure 6.5d**, has been included from groundwater modelling conducted for Chapter B3 – Geology, Soils and Groundwater. This chapter does not address existing groundwater conditions or potential impacts but uses information obtained through the groundwater modelling as part of those assessments for input into the surface water impacts. It is noted that groundwater flux into or from the reclamation area (bund area) will be minimal as a result of mitigation measures to mitigate the impacts of saline intrusion.

Figure 6.5e shows the modification of the TUFLOW FV model mesh to account for the northern perimeter drain and its discharge to the Marcoola drain.

Figure 6.5a: General drainage of airport and surrounds during and after reclamation

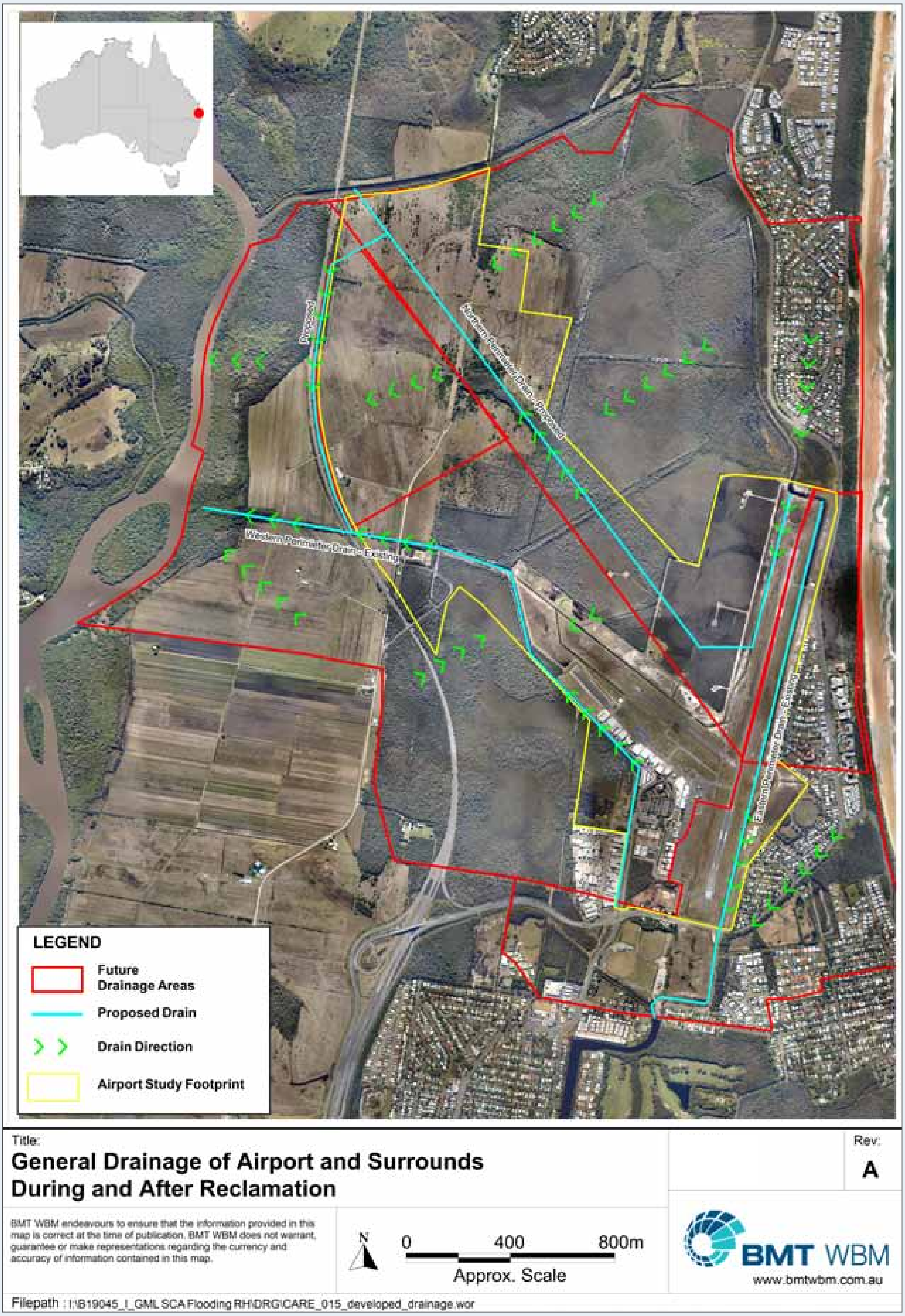


Figure 6.5b: FDCs for airport and surrounds catchments – baseline (without development) and operational impacts (with development)

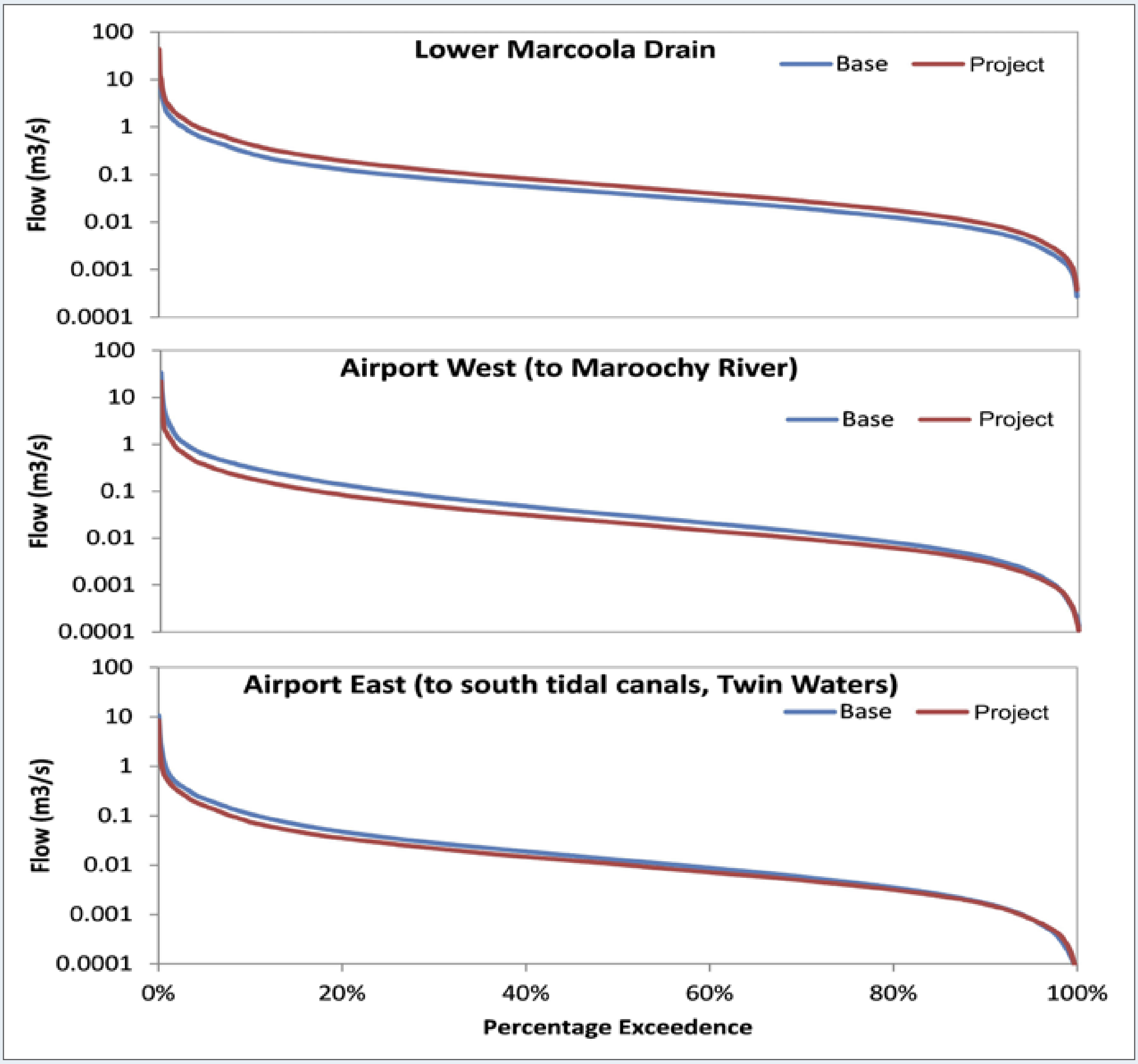


Figure 6.5c: FDC for Marcoola drain during construction – baseline (without development) and construction impacts

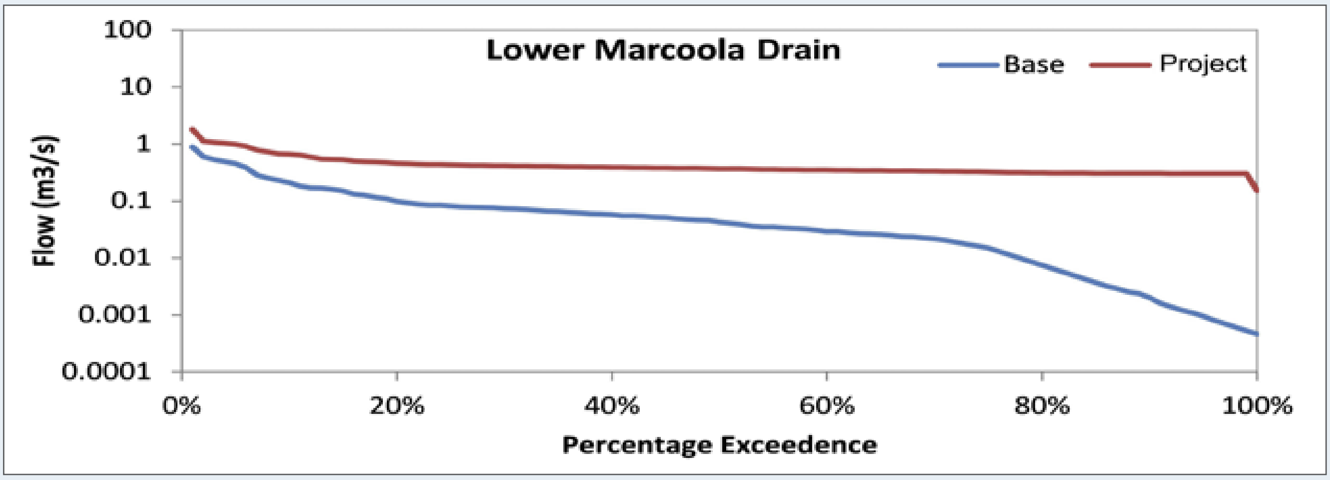
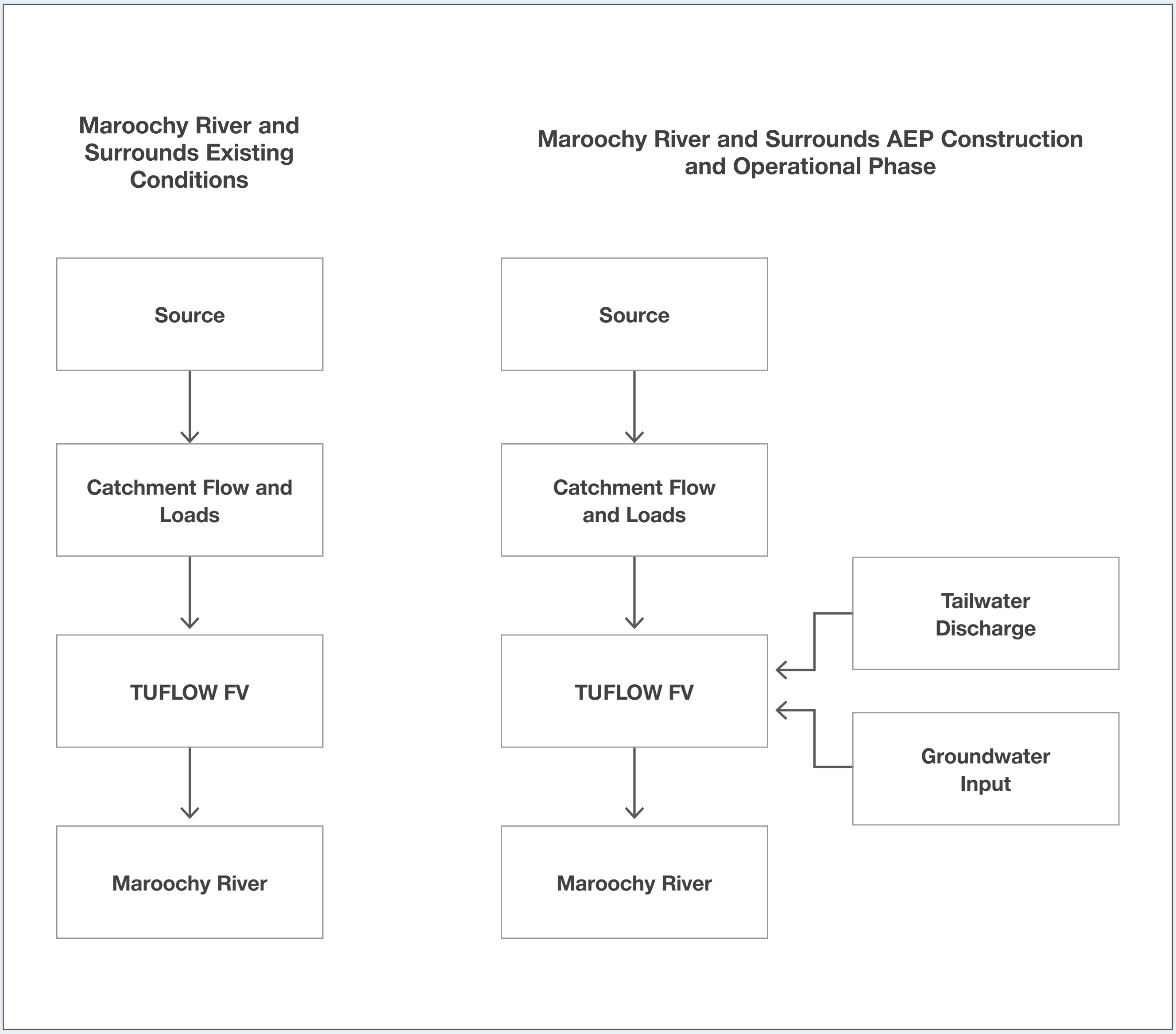


Figure 6.5d Baseline and impacts assessment modelling process diagrams



6.5.2.1 Selection of 'typical year' for tailwater scenarios

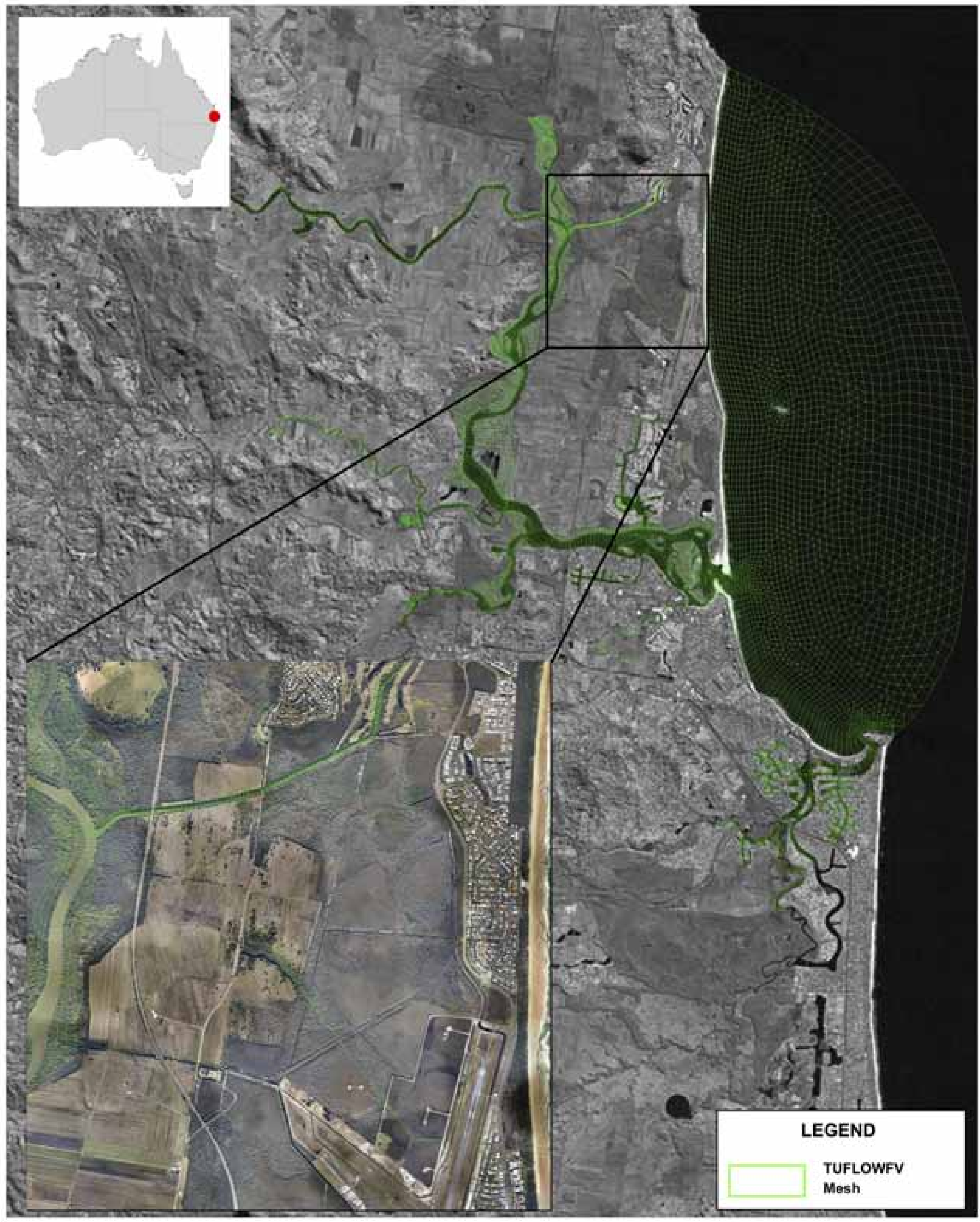
The 'typical year' analysis was undertaken in a two-step process by:

1. Ranking annual rainfall depths from 1950 to 2010 and selecting a calendar year with an annual rainfall total close to the median (50th percentile) value +/- 10 per cent. **Figure 6.5f** shows the annual rainfall depths, the median rainfall depths of all years, and the thirteen years initially selected for consideration for a 'typical year'
2. Comparing monthly rainfall total for the initially selected years to mean monthly rainfall totals over the 60-year period with the intent of selecting a year where the differences between the monthly rainfall totals of the selected and the mean monthly rainfall totals were minimised. **Figure 6.5g** shows the selected year (2004) and the comparison of monthly rainfall totals to mean monthly rainfall.

The selected typical year (2004) demonstrated slightly lower rainfall (1,483 mm) than the median year rainfall observed in 1965 (1,620 mm). The overall average difference between the mean monthly rainfall over all 12 months in 2004 was the least of the 13 initially selected years. In 2004, a majority of the rainfall (86 per cent) occurred during the 6-month period of November through April. For the purposes of this assessment, the typical year demonstrates characteristics of average summer and shoulder rainfall amounts, with an especially dry winter. In the context of turbidity, this is a conservative condition because turbidity is lowest during dry periods when catchment flows are not contributing sediment into the water column.

The timing of the commencement of construction was considered, as there may be the potential for impacts to vary in magnitude based on, for example, a winter commencement versus a summer commencement. Initial investigations into when discharge begins showed, however,

Figure 6.5e TUFLOW FV model domain including the northern perimeter drain



Title:

TUFLOW FV Model Domain Including the Northern Perimeter Drain

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Figure 6.5f: Initial typical year selection – total annual rainfall

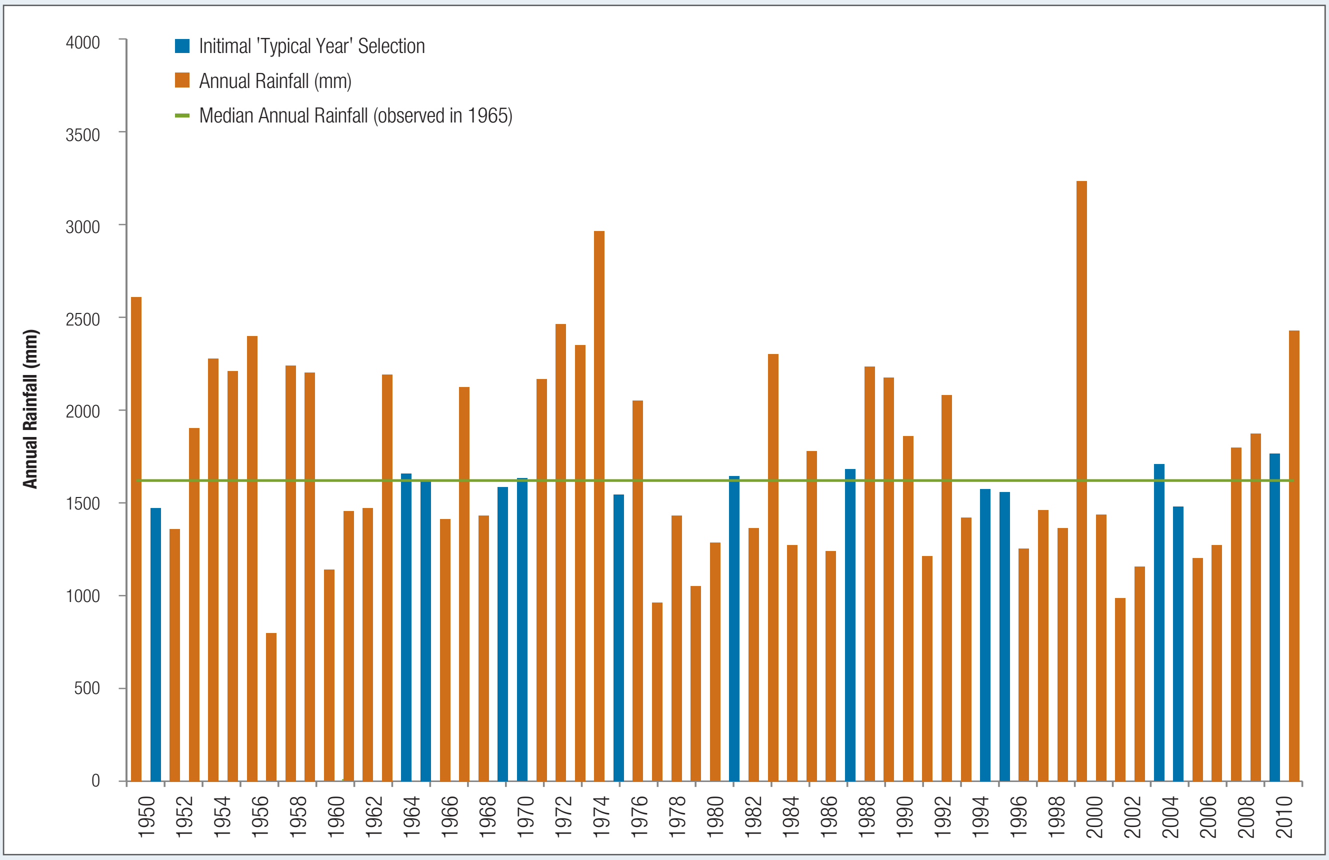
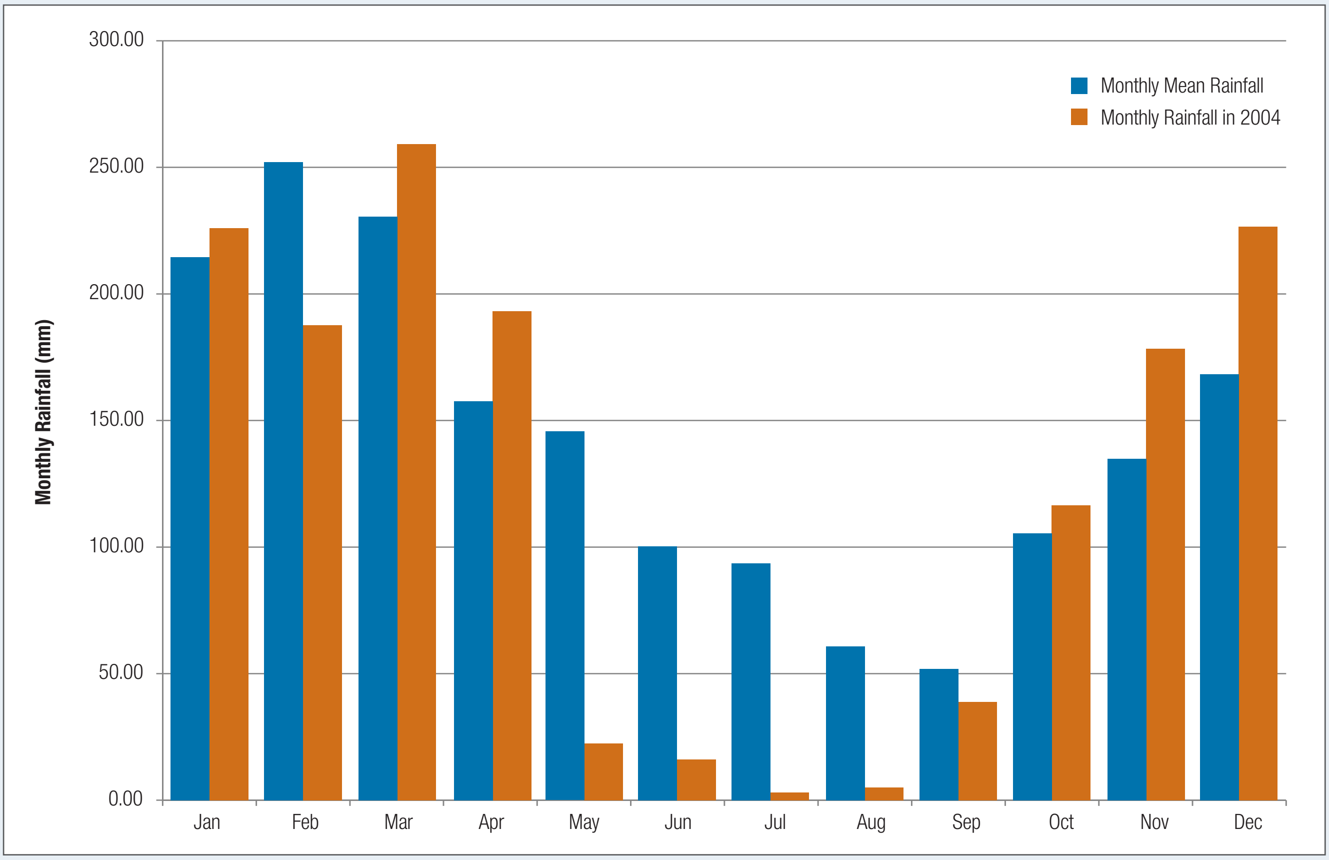


Figure 6.5g: Comparison of monthly mean rainfall to selected 'typical year' monthly rainfall



very little influence on the magnitude of the impacts. As such the seasonal discharge (summer) that resulted in the greatest impacts in general was selected for impact assessments as the more conservative case.

6.5.2.2 Tailwater characteristics

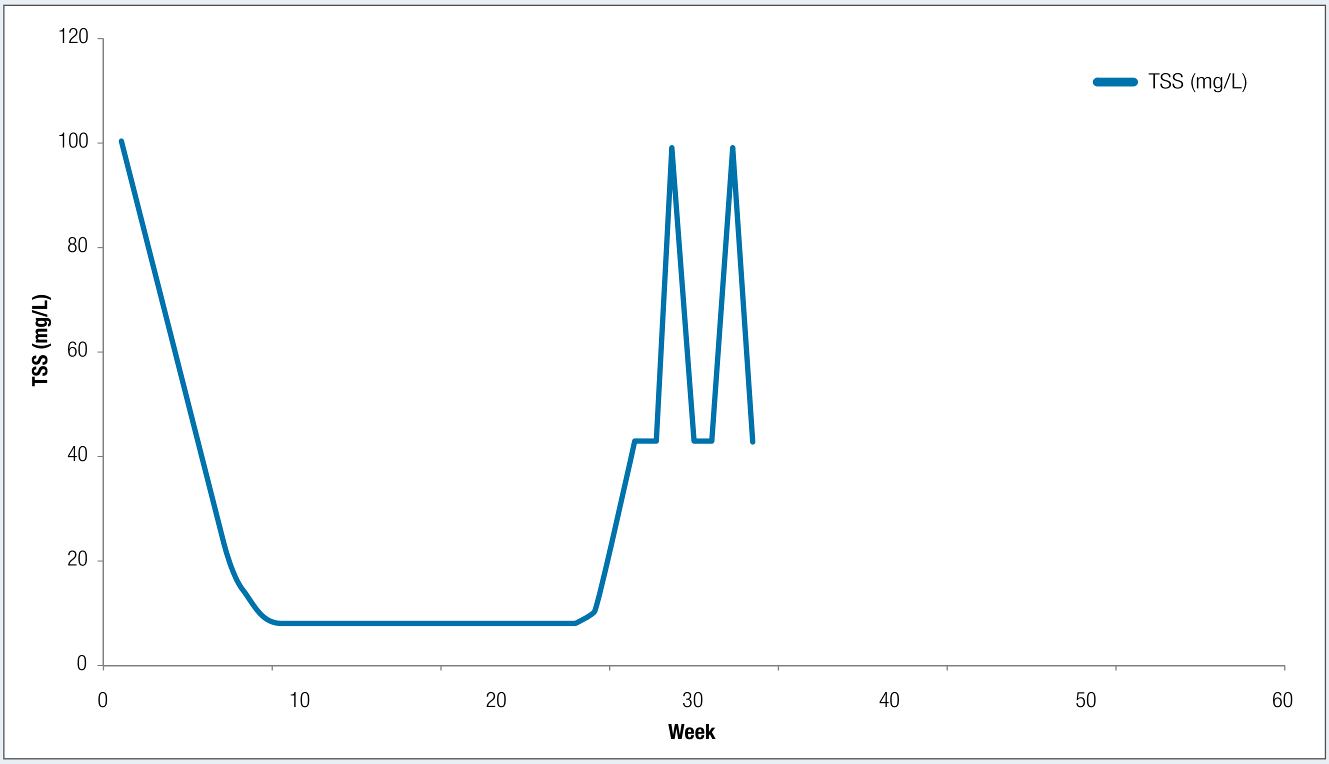
The tailwater discharge was a model input with the following assumptions based on information provided by the marine engineer:

- The reclamation option likely to have the greatest impact to water quality is that which has the longest duration because assessment of water quality relative to the WQOs is based on an annual median values. The longest reclamation program is therefore approximately 33 weeks. Other reclamation options dependent on the vessel size (larger) involved a shorter duration (e.g. 14 weeks), however, to ensure the worst-case scenario formed the basis of the potential impacts and mitigation, the 33 week program was modelled and assessed
- Discharge rate – 0.30 cubic metres per second (m^3/s) which represents the maximum expected discharge rate of the reclamation phase
- Salinity – at open ocean values. No specific salinity values were available for the open ocean salinity, and therefore a value relative to the maximum values observed at the closest EHMP locations for the Maroochy River and within Moreton Bay (see Chapter C3 – Coastal Processes and Water Quality). These were EHMP Sites E00524 and E00525
- Tailwater sediment concentration estimates were provided by the marine engineer and were based on four phases of construction within the overall reclamation schedule. These concentrations are resultant from the inclusion of a settlement pond in the design of the reclamation. From these estimates, a timeseries of the tailwater was developed and input into the model in the northern perimeter drain near the Marcoola drain. The timeseries of TSS concentrations is presented in **Figure 6.5h** while **Table 6.5a** shows the modelled TSS concentrations. There were minor discrepancies in the modelled values to those provided which were corroborated by additional advice from the marine engineer. These variations are conservative as they relate to higher TSS concentrations and a larger tailwater sediment load
- Three periods of the maximum expected TSS concentration (100 mg/L) were included: one that occurred at the beginning of the reclamation, and two occurring within the last quarter of the reclamation.

Table 6.5a: Tailwater TSS assumptions

Reclamation Period	Model Input TSS mg/L
Mean of First 25 per cent of Project	50
Mean of Last 25 per cent of Project	50
Mean of Total Project	29.6
Maximum Expected	100

Figure 6.5h: Tailwater discharge TSS timeseries



Two sediment settling velocities were modelled for the tailwater sediment discharge to provide some sensitivity around the model predictions:

1. Settling velocity 1 = 1.0 x 10^{-4} m/s: the Moreton Bay TUFLOW FV model settling rate for the fines fraction of the dredge material (see Chapter C3 – Coastal Processes and Water Quality). This tailwater sediment settling velocity represents the expected case of water quality impacts.
2. Settling velocity 2 = 3.6 x 10^{-6} m/s: a conservative settling rate based on a relationship developed by Ferguson and Church (2004). This settling velocity corresponds approximately to the settling velocity used to calibrate the Maroochy TUFLOW FV sediment transport model. This tailwater sediment settling velocity represents the worst case of water quality impacts.

6.5.2.3 Groundwater flux

Groundwater modelling (see Chapter B3 – Geology, Soils and Groundwater) was conducted to determine impacts of the Project on groundwater (Golder Associates 2013a). To mitigate seepage and impacts to groundwater quality, a high-quality liner is to be installed under the reclamation area. The modelling provided by Golder indicates inflows to the drains are negligible (< 1 L/s) with low salt concentrations (~500 ppm). Consequently, groundwater inflows to the drains were not included in the surface water modelling.

6.5.2.4 Tailwater discharge modelling results

These tailwater and groundwater inputs, in addition to other boundary forcing conditions (see **Appendix B6:A**) were input into the TUFLOW FV model and run for the specified 'typical year' to determine the impacts. Results of modelled tailwater discharge scenarios are presented in two ways:

- For the entire Maroochy River estuary (e.g. exceedance plots)
- At discrete locations representative of key areas (e.g. timeseries). The locations of the discrete sites where results have been extracted and summarised are also shown in **Figure 6.5i**. The description of each site as follows:
  - E01502 – Downstream Maroochy River, close to seagrass beds near the mouth of the Eudlo Creek
  - E01504 – Middle Maroochy River
  - E01508 – Maroochy River downstream of Marcoola drain
  - E01505 – Maroochy River at the entrance of Marcoola drain
  - E01509 – Maroochy River upstream of Marcoola drain
  - Coolum Creek – Within Coolum Creek limb
  - Downstream (D/S) Marcoola drain – Immediately downstream of the northern perimeter drain discharge
  - Upstream (U/S) Marcoola drain – Upstream of the culverts at Finland Road.

Results are presented in terms of existing conditions (base case) and development impacts in order to assess the magnitude of changes, if any, due to the construction. Results are presented in the following formats and in the following order:

- Box and whisker plots of turbidity, TSS and salinity at the selected locations (**Figure 6.5j** through **Figure 6.5l**, respectively)
- Statistics of the spread of the data in tabular format (**Table 6.5b**)
- Exceedance plots of median turbidity levels for the basecase, settling velocity 1 and settling velocity 2 (**Figure 6.5m** through **Figure 6.5o**). These are presented in terms of exceedances of the water quality objectives up to 100 per cent greater than the WQO
- Exceedance plots of median and 95th percentile (high) salinity levels for the existing conditions (basecase) and the reclamation case (**Figure 6.5p** and **Figure 6.5q**, respectively). That is, the median and 95th percentile values of the developed case are compared to the median and 95th percentile values of the basecase, respectively. The figures present the amount (absolute) by which the median and 95th of the developed case are greater than the existing conditions
- Total bed deposition (in mm accumulation of the tailwater TSS) is presented in **Figure 6.5r** for settling velocity 1. For settling velocity 2, the deposition at any point within the model domain was not greater than 0.5 mm. Therefore, those results have been excluded from display
- Representative timeseries plots of changes in water levels at the lower and upper Marcoola drain sites, and at the Maroochy River EHMP site at the Marcoola drain (E01505; see **Figure 6.5s**).

It is noted these impacts are assessed based on annual statistical comparisons (e.g. the annual median concentration), however the assessed program has a duration of 33 weeks. The assessment based on annual statistical values is due to the manner in which the WQOs are applied.

Figure 6.5i: Model output locations

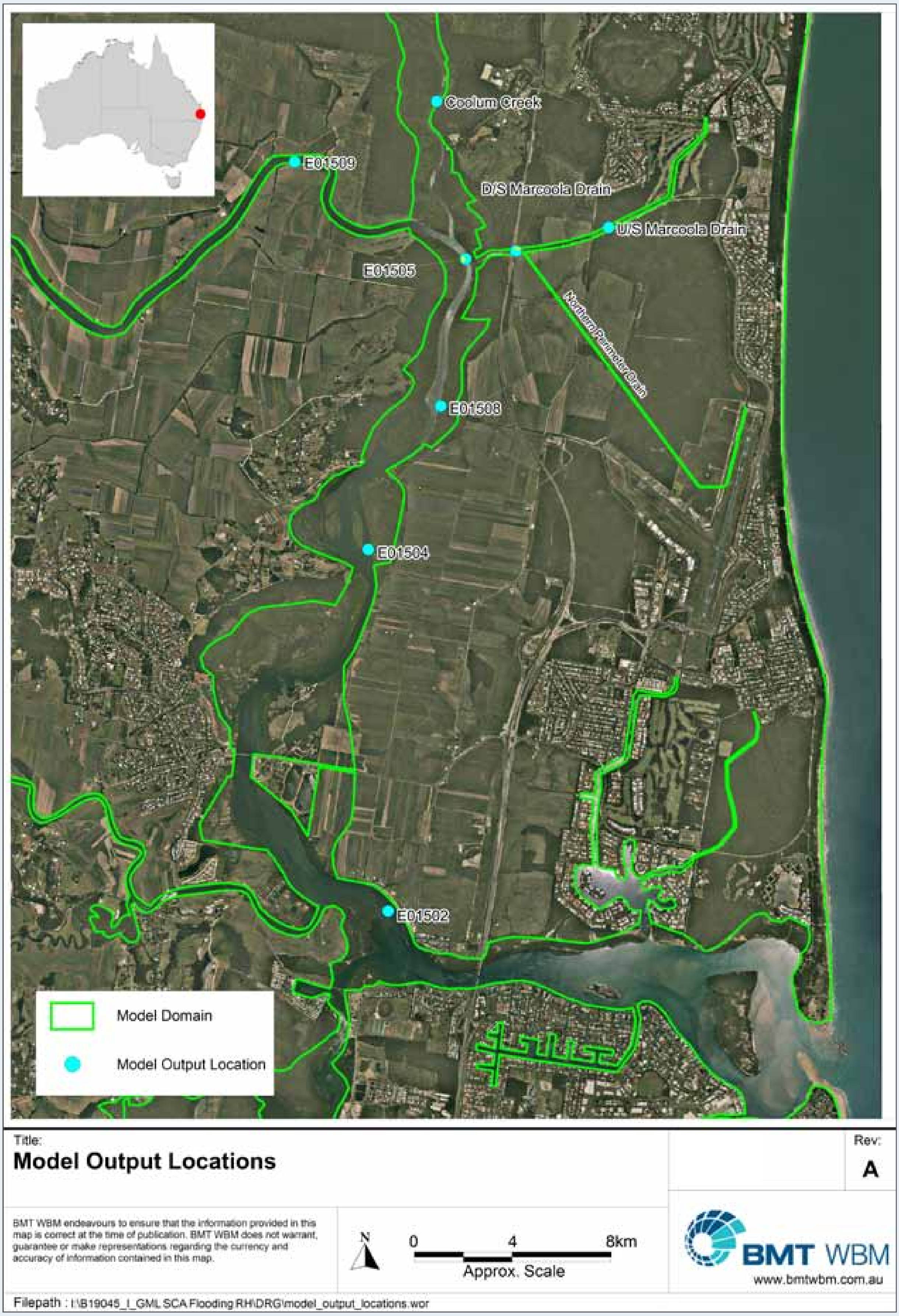


Figure 6.5j: Box and Whisker plots – turbidity impacts during construction

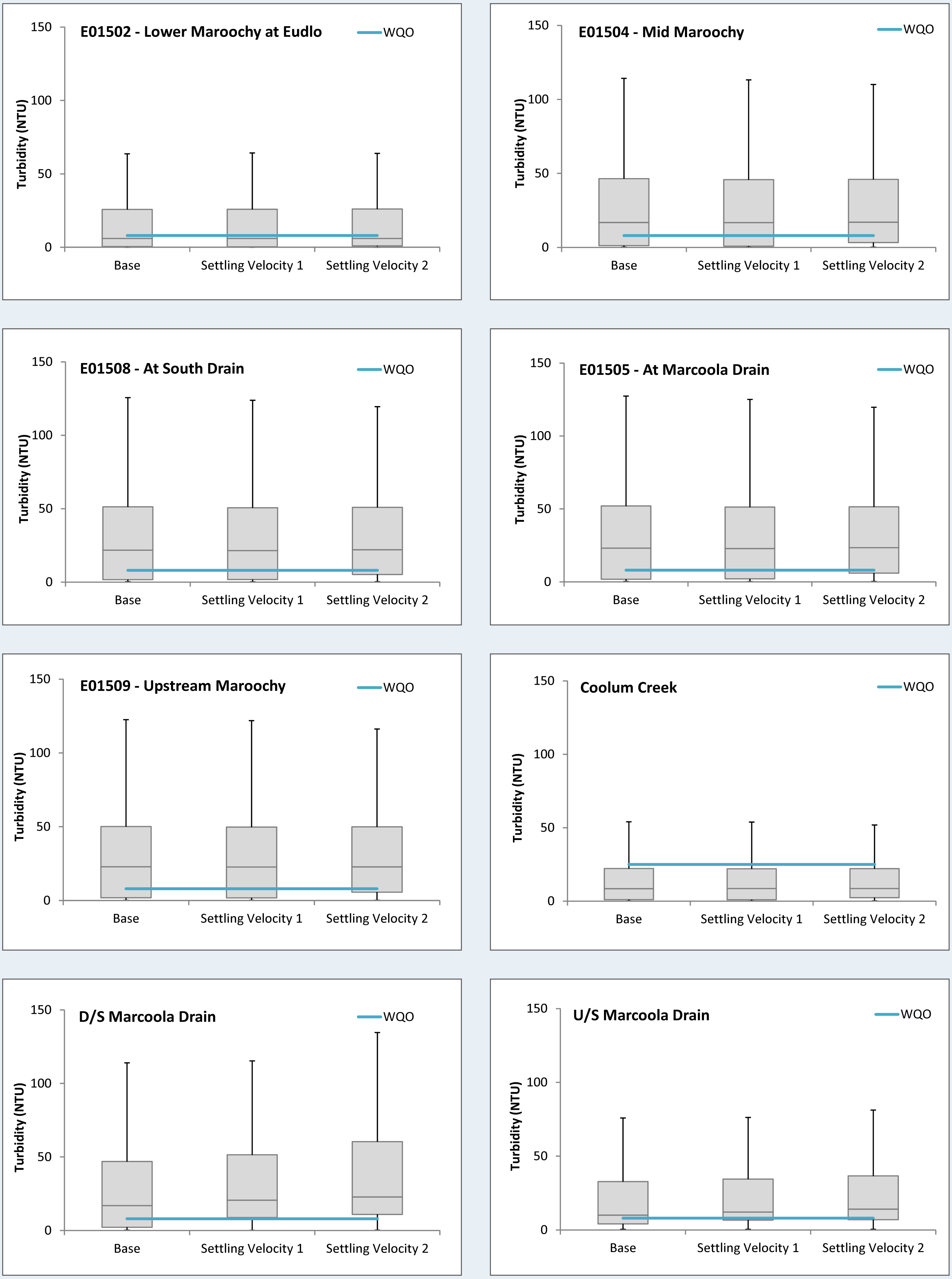


Figure 6.5k: Box and Whisker plots – TSS impacts during construction

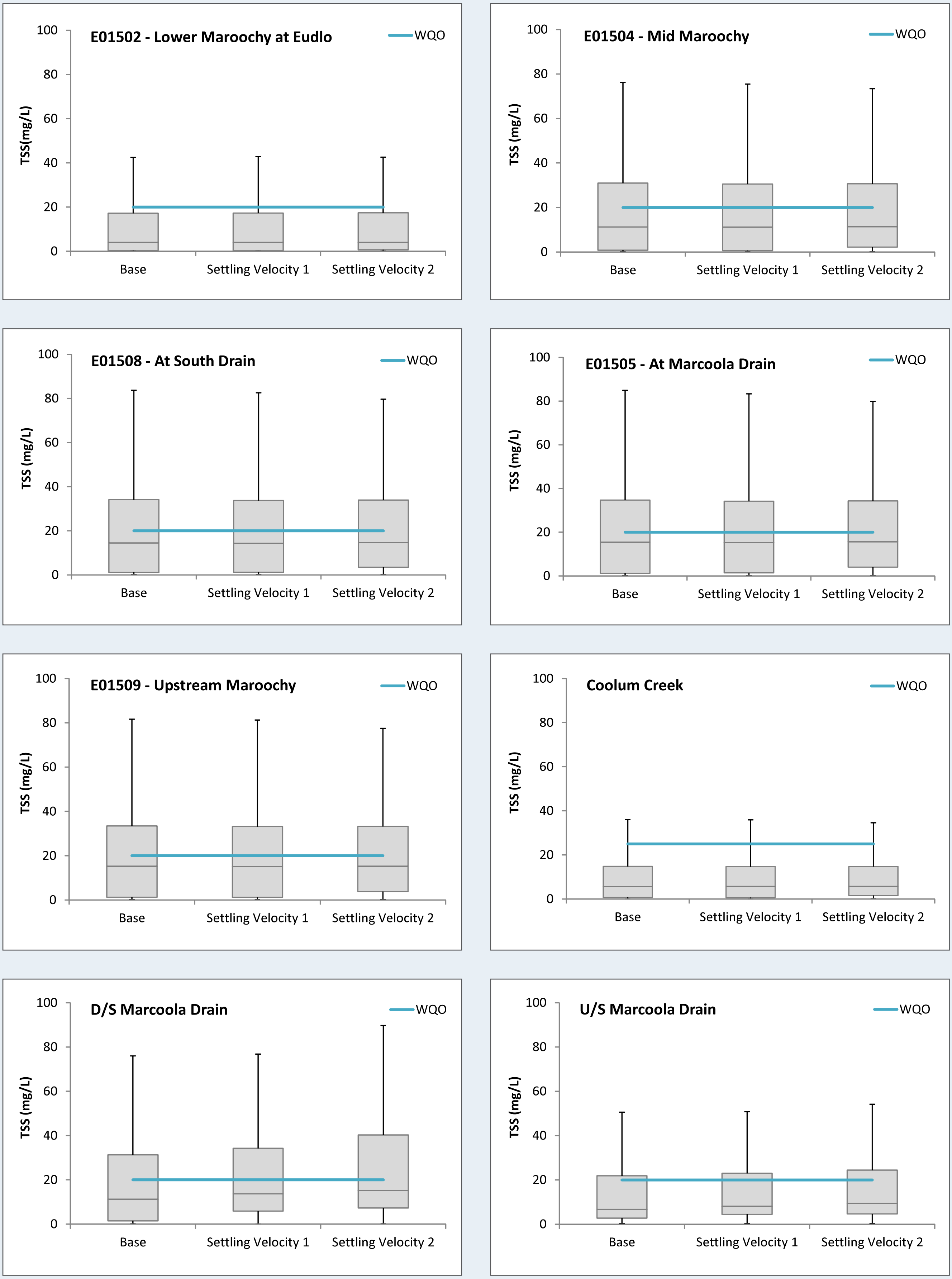


Figure 6.5l: Box and Whisker plots – salinity impacts during construction

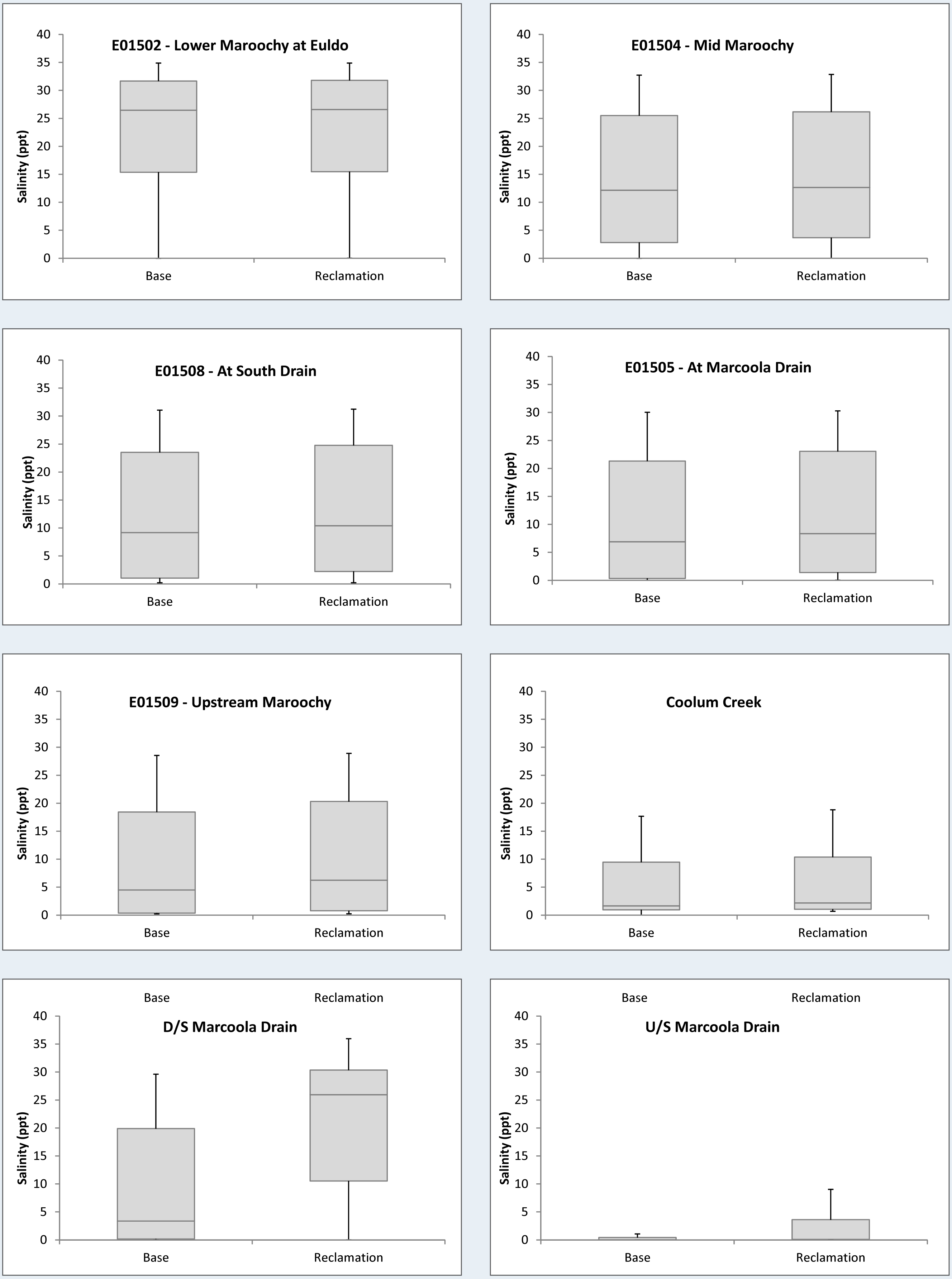
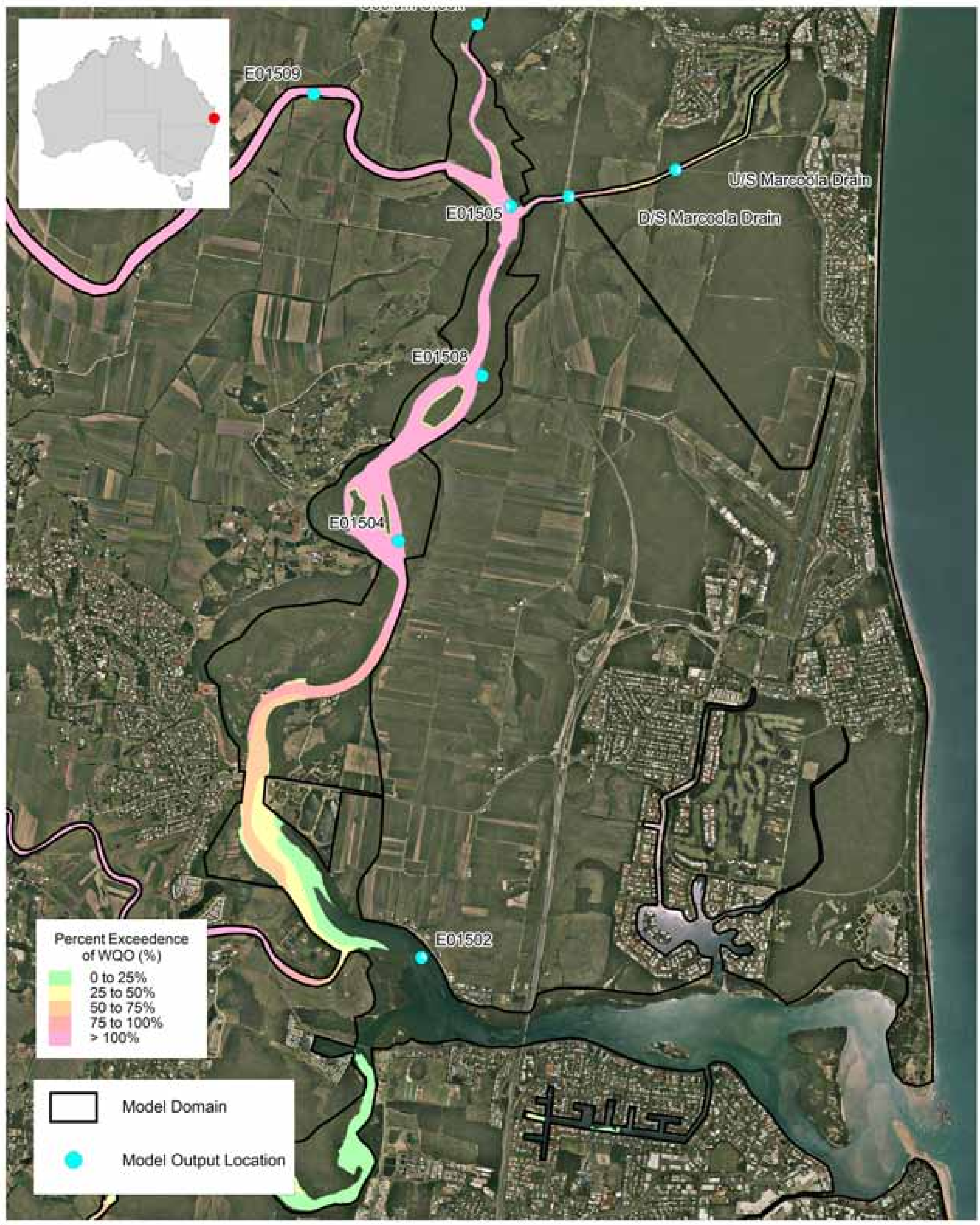


Figure 6.5m: Turbidity: water quality objective exceedances – base case (no development)



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Turbidity: Water Quality Objective Exceedences Base Case (No Development)

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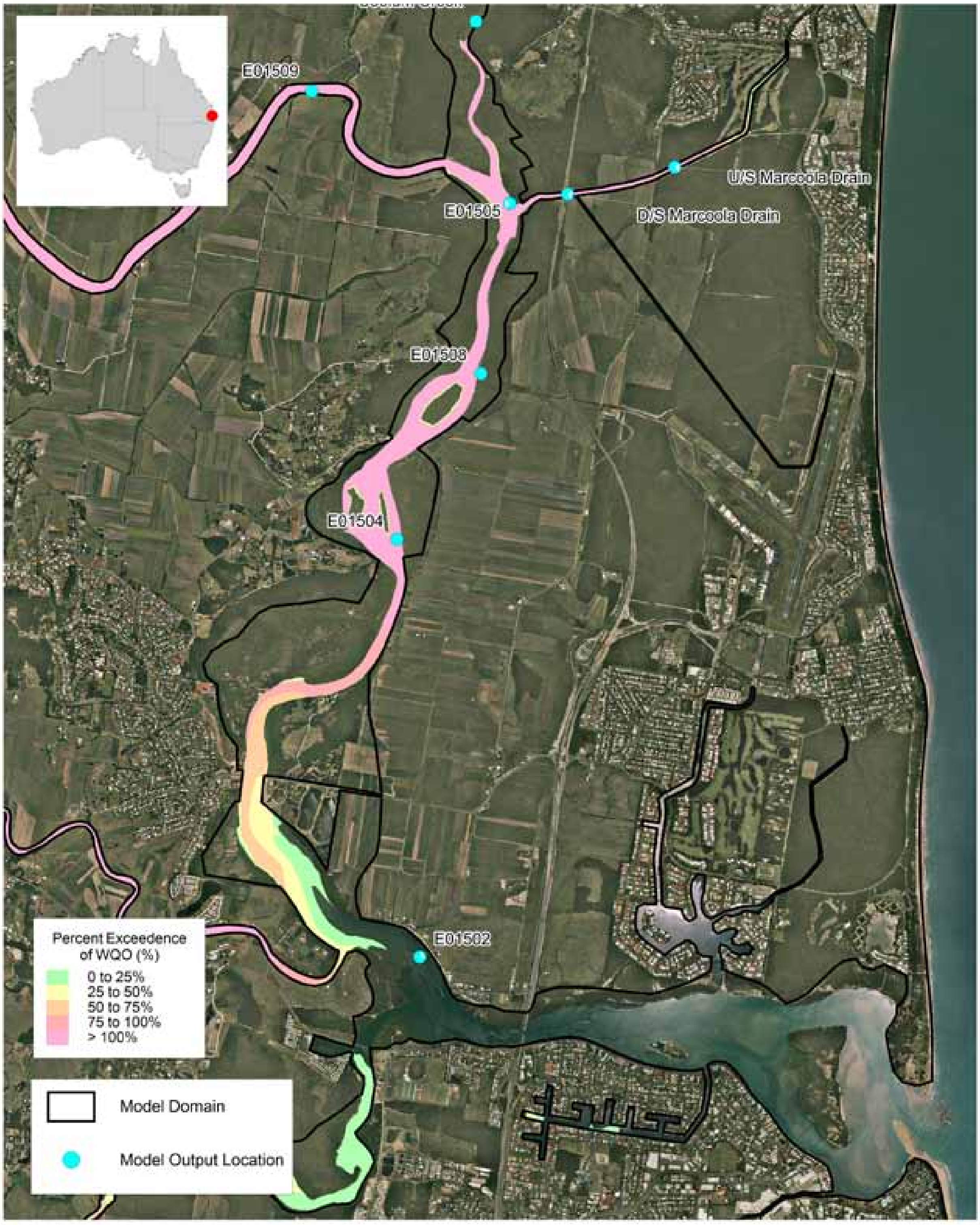
Table 6.5b: Statistics of turbidity, TSS and salinity tailwater impacts (during construction) over basecase (coloured cells are WQO exceedances)

Model Location	Statistic	Turbidity (NTU)			
		Existing Conditions	Settling Velocity 1	Settling Velocity 2	WQO
E01502	5th %-ile	0.1	0.1	0.2	-
E01502	25th %-ile	0.5	0.3	0.9	-
E01502	Median	5.7	5.7	5.7	8.0
E01502	75th %-ile	25.3	25.3	25.5	-
E01502	95th %-ile	83.3	83.3	83.4	-
E01504	5th %-ile	0.3	0.2	0.4	-
E01504	25th %-ile	1.3	0.9	3.4	-
E01504	Median	17.4	17.4	17.8	8.0
E01504	75th %-ile	47.4	46.7	47.0	-
E01504	95th %-ile	121.8	121.0	121.4	-
E01508	5th %-ile	0.2	0.1	0.2	-
E01508	25th %-ile	0.8	0.9	2.5	-
E01508	Median	10.8	10.7	10.9	8.0
E01508	75th %-ile	35.4	34.9	35.3	-
E01508	95th %-ile	110.7	109.8	110.1	-
E01505	5th %-ile	0.5	0.3	0.5	-
E01505	25th %-ile	1.8	1.9	5.9	-
E01505	Median	23.1	22.7	23.4	8.0
E01505	75th %-ile	51.8	51.2	51.4	-
E01505	95th %-ile	134.8	133.7	134.1	-
E01509	5th %-ile	0.5	0.3	0.6	-
E01509	25th %-ile	1.8	1.7	5.6	-
E01509	Median	22.7	22.5	22.7	8.0
E01509	75th %-ile	49.7	49.3	49.4	-
E01509	95th %-ile	142.0	141.1	141.2	-
Coolum Creek	5th %-ile	0.4	0.3	0.5	-
Coolum Creek	25th %-ile	1.9	1.7	4.6	-
Coolum Creek	Median	17.1	17.2	17.3	25.0
Coolum Creek	75th %-ile	43.8	43.4	43.6	-
Coolum Creek	95th %-ile	155.1	155.1	155.1	-
Marcoola drain D/S	5th %-ile	0.4	0.3	0.5	-
Marcoola drain D/S	25th %-ile	2.1	8.8	10.8	-
Marcoola drain D/S	Median	16.5	20.6	22.7	8.0
Marcoola drain D/S	75th %-ile	45.6	50.4	59.2	-
Marcoola drain D/S	95th %-ile	109.1	98.2	112.4	-
Marcoola drain U/S	5th %-ile	3.0	4.4	4.7	-
Marcoola drain U/S	25th %-ile	8.1	9.3	9.5	-
Marcoola drain U/S	Median	13.4	19.1	21.8	-
Marcoola drain U/S	75th %-ile	48.5	52.0	57.2	-
Marcoola drain U/S	95th %-ile	125.7	125.5	125.7	-

TSS (mg/L)				Salinity (ppt)		
Existing Conditions	Settling Velocity 1	Settling Velocity 2	WQO	Existing Conditions	Reclamation	WQO
0.1	0.1	0.1	-	3.9	4.2	-
0.3	0.2	0.6	-	15.6	15.7	-
3.8	3.8	3.8	20.0	26.7	26.8	-
16.9	16.9	17.0	-	31.7	31.8	-
55.5	55.5	55.6	-	34.1	34.2	-
0.2	0.2	0.3	-	0.1	0.5	-
0.9	0.6	2.3	-	2.9	3.8	-
11.6	11.6	11.9	20.0	13.4	14.1	-
31.6	31.2	31.3	-	26.5	27.2	-
81.2	80.7	80.9	-	30.3	30.6	-
0.1	0.1	0.2	-	0.0	0.1	-
0.6	0.6	1.7	-	0.4	1.0	-
7.2	7.1	7.3	20.0	4.5	5.1	-
23.6	23.3	23.6	-	13.5	14.5	-
73.8	73.2	73.4	-	28.4	28.9	-
0.3	0.2	0.4	-	0.0	0.1	-
1.2	1.3	3.9	-	0.3	1.3	-
15.4	15.1	15.6	20.0	6.9	8.3	-
34.5	34.1	34.3	-	21.3	23.0	-
89.9	89.2	89.4	-	27.1	27.7	-
0.3	0.2	0.4	-	0.0	0.0	-
1.2	1.2	3.8	-	0.1	0.5	-
15.1	15.0	15.1	20.0	4.1	5.9	-
33.2	32.9	32.9	-	18.2	20.1	-
94.7	94.1	94.1	-	24.7	25.6	-
0.3	0.2	0.3	-	0.4	0.4	-
1.3	1.1	3.1	-	0.5	0.5	-
11.4	11.5	11.5	25.0	2.0	2.9	-
29.2	29.0	29.1	-	18.1	20.0	-
103.4	103.4	103.4	-	24.2	24.9	-
0.3	0.2	0.3	-	0.0	0.1	-
1.4	5.9	7.2	-	0.2	10.6	-
11.0	13.7	15.2	20.0	3.5	25.5	-
30.4	33.6	39.5	-	20.1	29.7	-
72.7	65.5	74.9	-	27.2	35.6	-
2.0	3.0	3.1	-	0.00	0.00	-
5.4	6.2	6.3	-	0.00	0.00	-
8.9	12.7	14.5	-	0.01	0.07	-
32.3	34.7	38.2	-	0.69	3.50	-
83.8	83.7	83.8	-	14.0	26.1	-

Figure 6.5n: Turbidity: water quality objective exceedances – settling velocity 1 (impact case)



Title:
Turbidity: Water Quality Objective Exceedences Settling Velocity 1 (Impact Case)

Rev: **A**

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Approx. Scale

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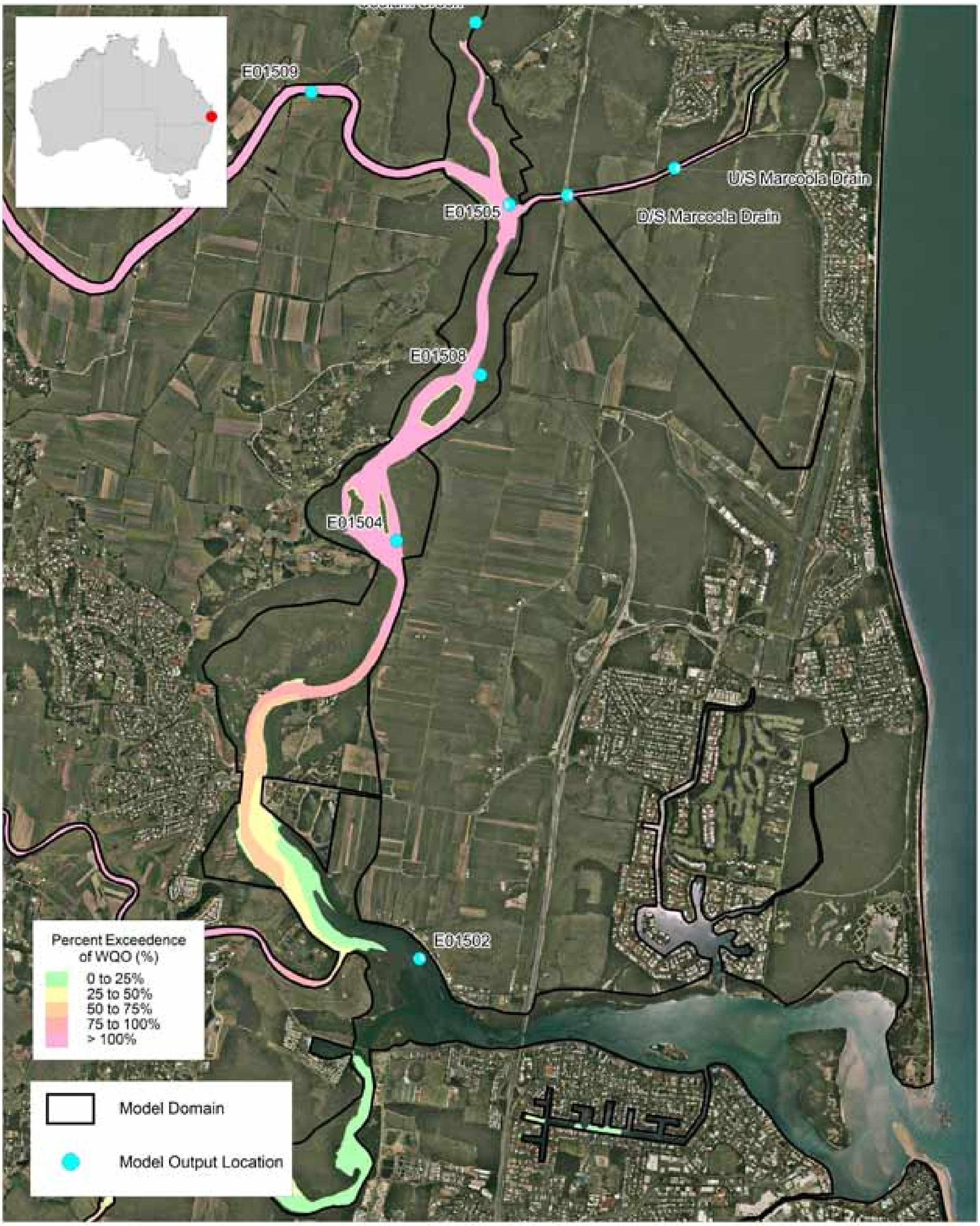
Figure 6.5o: Turbidity: water quality objective exceedances – settling velocity 2 (impact case)



Title:

Turbidity: Water Quality Objective Exceedences Settling Velocity 2 (Impact Case)

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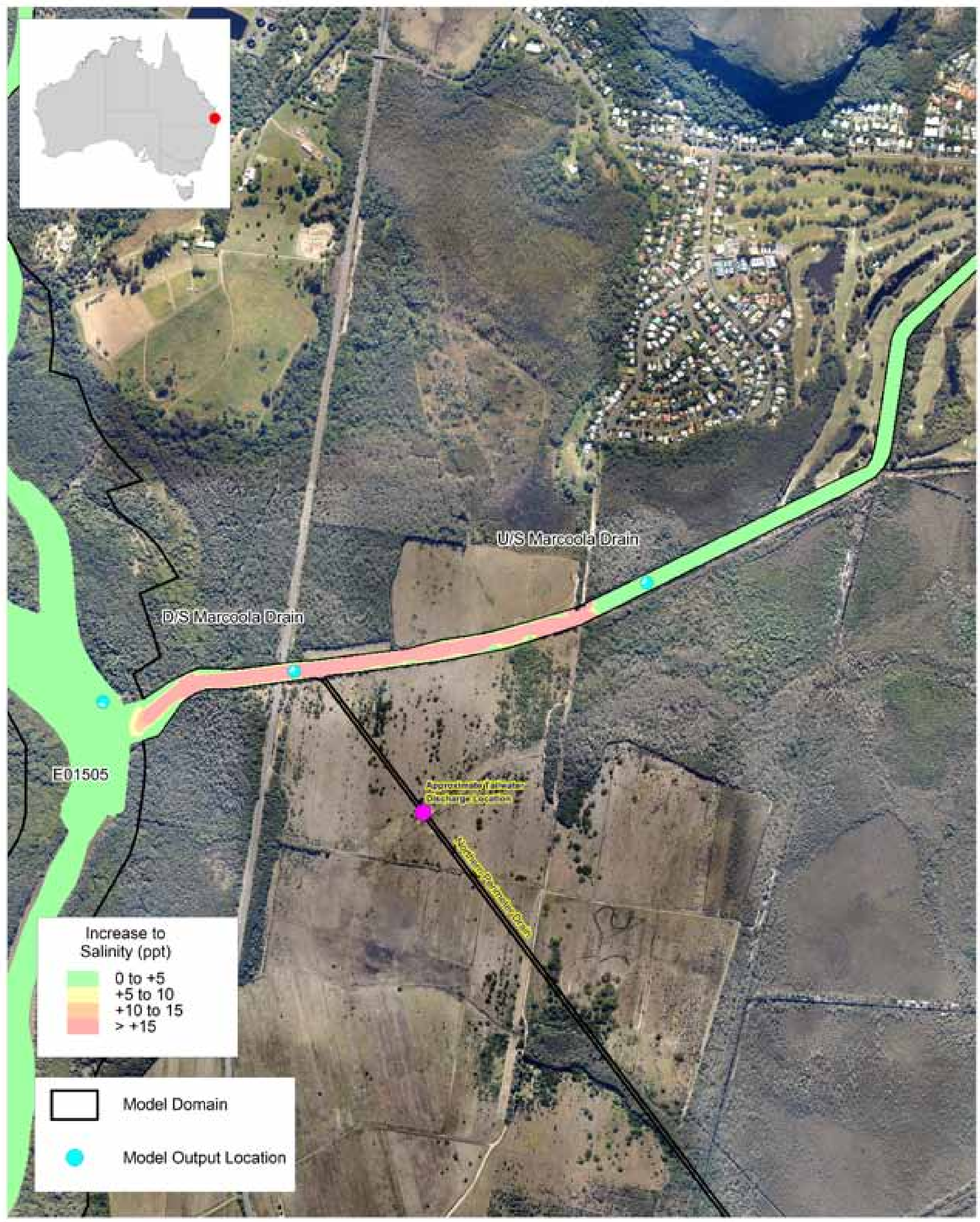
Figure 6.5p: Salinity: increases from reclamation above background (background) – median salinity levels



Title:
Salinity: Increases from Reclamation Above Background - Median Salinity Levels

Rev:
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Figure 6.5q: Salinity: increases from reclamation above background (basecase) – 95th percentile salinity levels

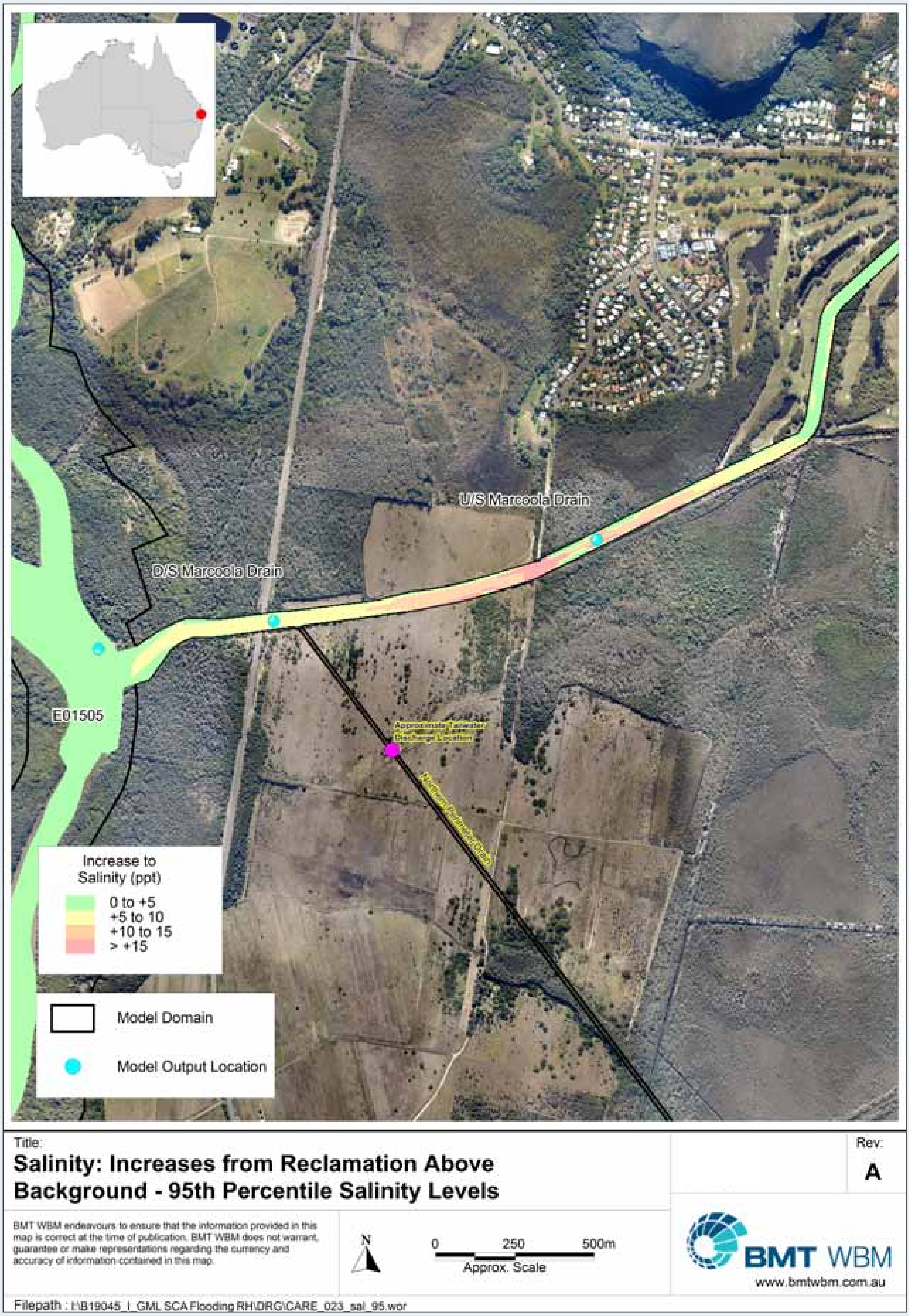
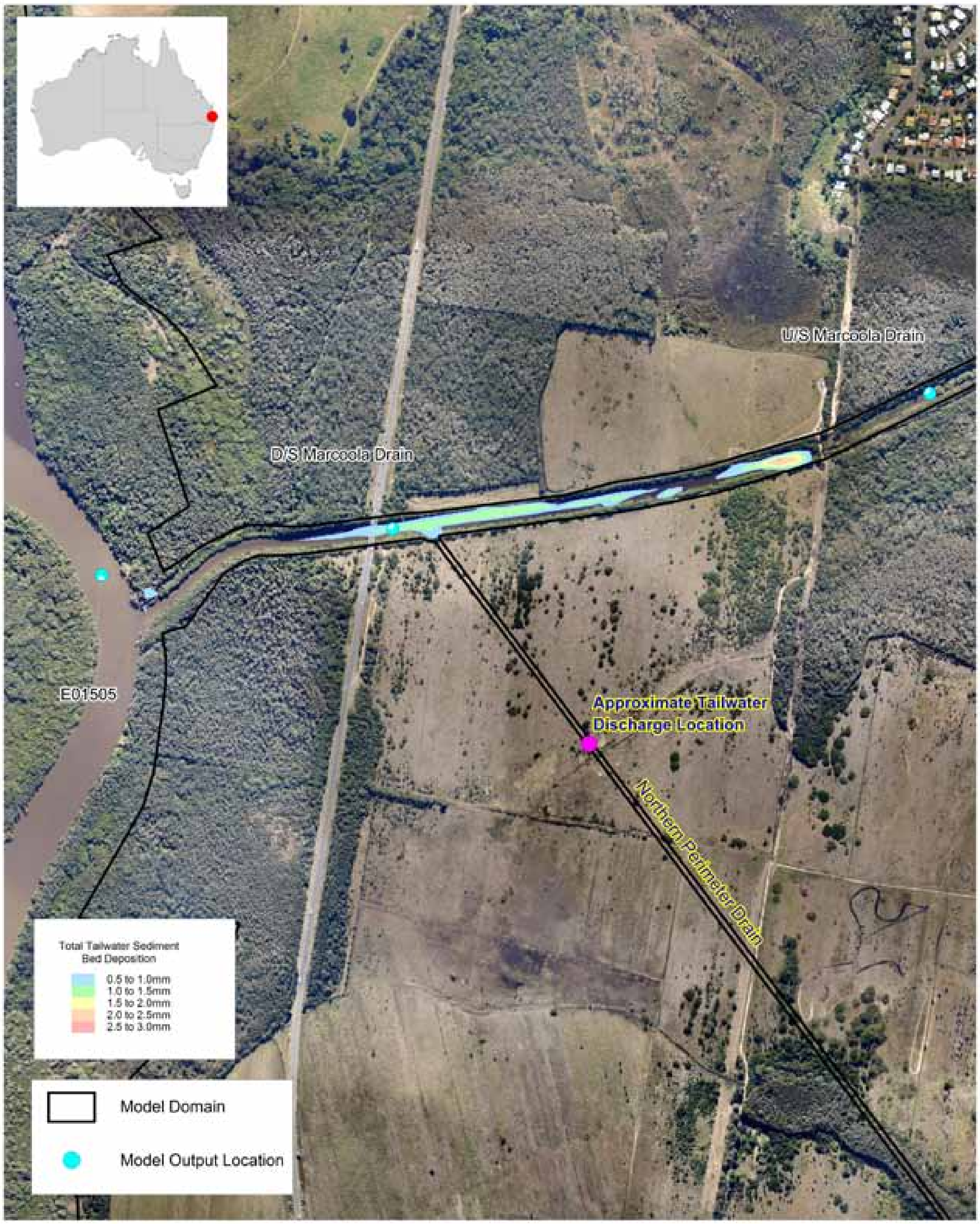


Figure 6.5r: Total tailwater sediment bed deposition – settling velocity 1



Title:
Total Tailwater Sediment Bed Deposition Settling Velocity 1

Rev: **A**

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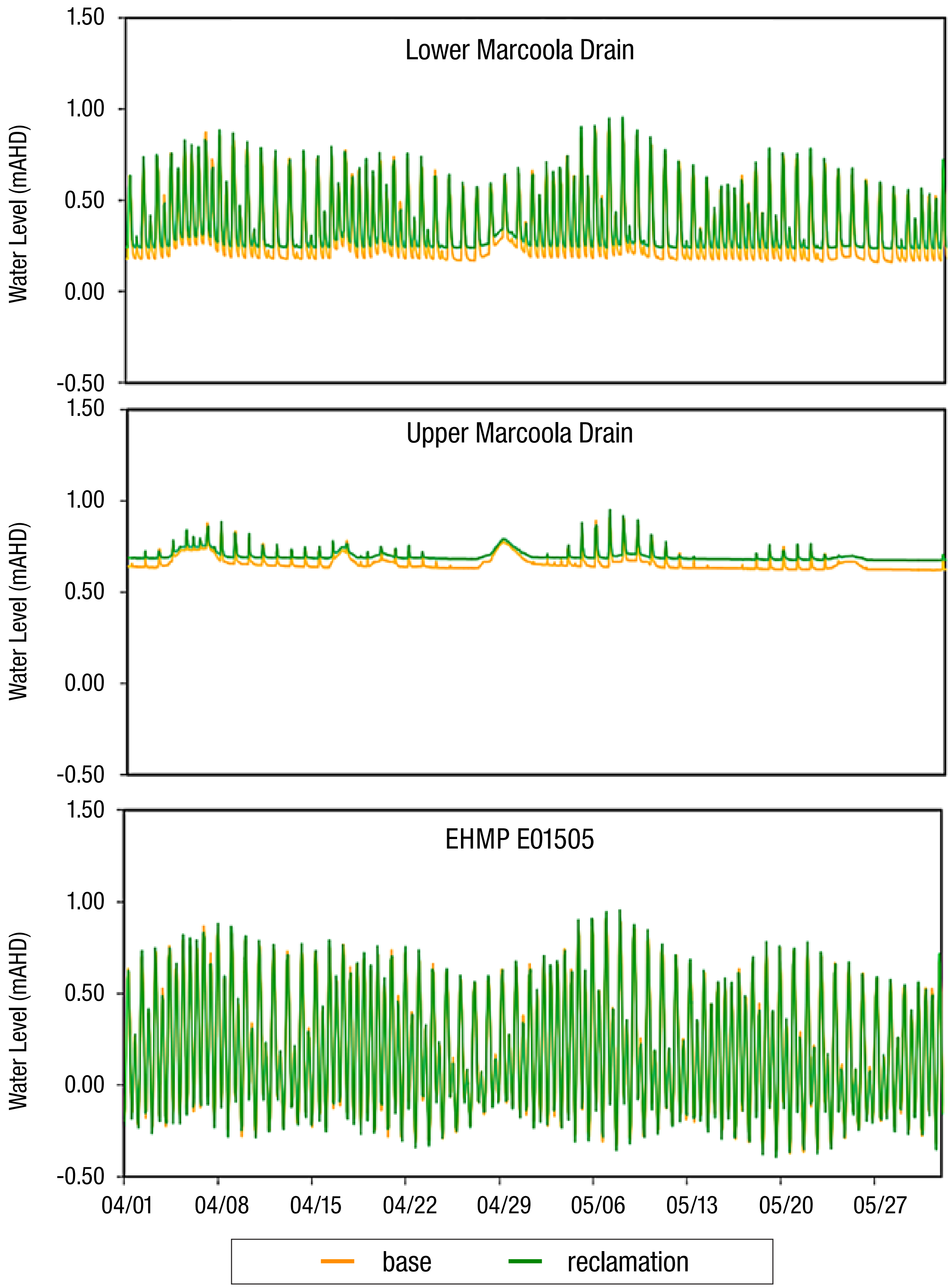
Figure 6.5s: Hydraulic impacts within Marcoola drain and at E01505; top – D/S Marcoola drain; middle – U/S Marcoola drain; bottom – Maroochy River at E01505



6.5.2.5 Tailwater discharge discussion

The following is a summary of the key findings as predicted by the modelling suite:

- Overall, the modelling demonstrates that as expected the greatest impacts of the tailwater occur within the Marcoola drain between the culverts at Finland Road and the Marcoola drain entrance to the Maroochy River (designated as the Lower Marcoola drain in the previous figures). The following points regarding impacts of the tailwater discharge in the Marcoola drain are as follows:
  - The downstream Marcoola drain site demonstrates the greatest percentage increase in turbidity and TSS. Annual median TSS concentrations and turbidity levels are increased by approximately 25 per cent and 38 per cent for the first and second settling rates, respectively
  - In terms of compliance with water quality objectives assuming the baseline water quality is that of the nearest EHMP site, turbidity exceeds the WQO for existing conditions as well as the developed cases. No exceedances of the suspended sediment WQOs were observed in the Marcoola drain
  - Median salinity in the lower Marcoola drain is increased by a factor of 7 for the reclamation overall. The median salinity increases from 3.5 ppt to 26 ppt over the course of the year
  - Water level changes are observed at the lower Marcoola drain site, however these changes are predominantly to the low water levels (low tide). Changes to water levels over the 5th-percentile (low) water level is approximately 10 mm, whilst the change to the 95th is on the order of 3 mm (see **Figure 6.5s**)
  - Impacts to the upper Marcoola drain upstream of the culverts at Finland Road are minor, in that changes to the overall salinity and sediment regime are within the range of natural variability observed in the existing conditions.
- Within the Maroochy River, impacts are generally minor:
  - Both settling rates result in negligible changes in median turbidity and TSS levels. In some instances the faster settling velocity demonstrated a decrease in sediment concentrations and turbidity in the Maroochy River, likely because of the changes in sediment loads (see **Appendix B6:A**) as the land use changes from green space to airport runway
  - The tailwater discharge results in minor increases in salinity over existing conditions, and negligible increases in the lower estuary. These changes, however, are within the natural variations observed at each site
  - There are no observable changes in water levels within the Maroochy River including at E01505, at the entrance of Marcoola drain
  - In terms of compliance with water quality objectives, turbidity exceeds the WQO for existing conditions as well as the developed cases. No exceedances of the suspended sediment WQOs were observed in the Maroochy River for existing and developed conditions with the exception of a small region upstream of E01509
  - There are no observed impacts at the entrance of the Maroochy River or in the open coastal region into which the Maroochy River drains.

The overall significance of these impacts is therefore deemed minor due to:

- The short-term period over which they are likely to occur (less than 1 year)
- There will be no permanent or long-term changes to water quality
  - The WQOs that are currently being met will continue to be met during and after construction
  - Those WQOs that are not currently being met are not changed or are only increased marginally.
- The resulting short-term changes in water quality are within the observed background ranges of the constituents of concern in the existing conditions
- The modelling performed for this EIS is conservative with conservative assumptions applied when there was any uncertainty or undefined project specifications
- Impacts are generally confined to Marcoola drain, which is a manmade channel with limited environmental value.

6.5.2.6 Mitigation measures

As outlined in the impacts section, the Project sand delivery period will likely result in some temporary increases in water quality constituents, namely turbidity and TSS. Measures that seek to minimise or avoid these impacts include:

- Use of the Marcoola drain as a mixing zone for tailwater prior to discharge into the Maroochy River
- Implementation of a reactive monitoring program to ensure compliance with proposed turbidity trigger values and WQOs (Refer to Chapter E4 – Environmental Management Plan) during construction works. Continuous monitoring data would be downloaded from a real time system during construction and assessed against threshold trigger values, with appropriate management actions implemented if those trigger values are exceeded, including warning, corrective action and stopping discharge. Specific measures under this program that can be implemented to control discharge include:
  - Increasing tailwater residence time where practical elsewhere on the site prior to the tailwater entering the final polishing pond

- Installation of silt curtains in the polishing pond, ensuring routine inspections (every 7 days) and required maintenance are undertaken to ensure the curtains remain effective.

- Development of an overall sediment spill budget and assessment of the discharge of cumulative sediment loads throughout the duration of the Project. This will include frequent sampling of TSS to monitor and account for sediment discharged to Marcoola drain.

6.5.2.7 Performance criteria

The information presented in **Table 6.5b** provides a contextual description of the model predictions, and it uses percentiles and WQOs to do so. These are not related to trigger 'performance' values that require management intervention, and these trigger values, and their operation, are provided below.

There are two specific performance criteria:

1. Response criteria (warning) which triggers one level of corrective action to reduce turbidity in the tailwater discharge:
   - Where the background levels (E01505) are less than 45 NTU (80th percentile of background), tailwater must not exceed 50 NTU (80th percentile of tailwater)
   - Where the background levels are greater than 45 NTU (80th percentile of background), tailwater must not exceed 120 per cent of the background.
2. Absolute discharge criteria (stop discharge) which triggers a second level of corrective action, including ceasing discharge, in order to reduce turbidity in the discharge:
   - The tailwater discharged must not exceed 150 NTU.

These criteria were established based on:

- For the performance criterion when background conditions are less than 45 NTU, the criterion is based on existing water quality in the Maroochy River and the Marcoola drain. The 75th percentile value of background turbidity values in the Marcoola drain is 45 NTU (E01505 is 50NTU). The living organisms present in the receiving environments are known to be resilient to large fluctuations in turbidity (see Chapter B10 – Marine Ecology)
- Background turbidity in Coolum Creek is known to be highly modified by and exceeds that in the Maroochy River and Marcoola drain
- A discharge turbidity value of 45 NTU is achievable by the contractor (BMT WBM 2010b)
- The performance criterion for when background is greater than 45 NTU, is based on an overall increase in turbidity anticipated to be 20 per cent
- The maximum discharge turbidity of 150 NTU in the tailwater is based on a maximum expected discharge TSS concentration 100 mg/L and the conversion factor used in this report to derive turbidity from in-stream suspended sediment concentrations.
- A project-based TSS-turbidity relationship should be developed upon commencement of this Project to better define these performance criteria
- The project-based TSS-turbidity relationship may be used to address actual turbidity values resulting from the TSS in the tailwater discharge.

6.5.3 Changes to airport stormwater water quality during operation

The nutrient, sediment and other contaminants were monitored for in the BAC New Parallel Runway Project (used as a surrogate for this Project). These pollutants were shown to be at low levels and within the range of typical concentrations used in quantifying runoff related loads. For example, stormwater event mean concentrations (EMC) observed in the BAC sampling are at the low end range of regionally observed values (Chiew and Scanlon 2002; BMT WBM 2010a). Comparison of the BAC stormwater concentrations and the regional values is presented in **Table 6.5c**. It should be noted that the regionally typical TSS concentrations presented in **Table 6.5c** were used in the catchment modelling. These values have been used due to the adoption of a stormwater strategy for the BAC project that is comparable to that to be used for the SCA Project, and as a conservative estimate demonstrating impacts will be manageable for the SCA Project given the smaller scale.

These values were input into the Source model (see **Appendix B6:A**) to determine the overall change in sediment and nutrient loads generated from the overall airport site as a result of the development. **Table 6.5d** presents the comparative load inputs per annum for the total catchment containing the airport for existing conditions and with the Project. These results represent modelled flows and loads from 1/01/1980 to 31/10/2011. Based on these results, stormwater generated by the operation of the airport is likely to have negligible impacts to water quality in the Maroochy River and surrounds.

The mitigation for this impact incorporated into the design of the Project is to implement flow control through vegetated (grass) pathways, aimed at reducing or minimising pollutant runoff from the new runway and taxiway system. Runoff from the airfield pavements will flow across the grassed runway strip which has been shown to significantly reduce pollutant loads at other airports. Based on studies at Brisbane Airport, it is anticipated that the treatment afforded by these grassed areas will be more than adequate to address stormwater quality.

Pollutant runoff from storm events during construction will be mitigated through erosion and sediment control (see Chapter B3 – Geology, Soils and Groundwater).

Table 6.5c: Comparison of TSS EMC runoff rates between BAC stormwater values and regional values

Constituent	Observed BAC (mg/L)	Typical Rural Values (mg/L)
TSS	25.0	20 – 550
TN	0.71	1.5 – 5.2
TP	0.09	0.06 – 0.45

Table 6.5d: Comparison of sediment and nutrient mean annual loads from airport and surrounds catchment

Parameter	Baseline	Operational
TSS (t/yr)	395	391
TN (t/yr)	8.31	8.30
TP (t/yr)	0.800	0.799

6.5.4 Scour and the potential to mobilise Marcoola drain bed sediments

The potential for scour was assessed in terms of critical bed shear stress, or the amount of force created by the movement of water at the channel bed. This assessment was based on a threshold stress beyond which bed material may begin to become suspended in the water column. For this assessment, the shear stress is based on the particle size of the bed material.

Within the Marcoola drain, particle sizes are typically small, comprising primarily fine materials (silts). An appropriate critical shear stress for silts is approximately 0.2 newtons per square metre (N/m^2; e.g. Whitehouse et al., 2000), noting that this threshold is likely to vary spatially due to, for example, differences in bed consolidation. Shear stresses were extracted from the TUFLOW FV model for baseline conditions and for the reclamation and compared to determine the change in potential for scour within the Marcoola drain.

Figure 6.5t presents the 95th percentile values of shear stress observed throughout the modelling period (2004) as exceedances of the 0.2 N/m^2 critical stress. Similarly, **Table 6.5e** presents the 95th percentile shear stresses at four locations within the Marcoola drain:

- The entrance with the Maroochy River
- Sediment sampling location CD1
- The entrance of the northern perimeter drain
- Sediment sampling location CD2.

Finally, **Figure 6.5u** provides example time series of bed shear stresses at the four previously mentioned locations from 28/07/2004 to 3/08/2004. This time period was selected because maximum shear stresses during this time were the greatest of the overall modelled period. Also provided in the figure is the critical shear stress and water levels at E01505.

Figure 6.5t shows that the highest shear stresses are near the entrance of the Marcoola drain and that these are not increased or decreased significantly over the modelled time period. **Table 6.5e** presents similar information, suggesting that the tailwater discharge from the reclamation may reduce high critical shear stresses. Examination of **Figure 6.5u** indicates that peaks in bed shear stress occurs during peak flood and ebb tidal conditions when channel velocities are greatest.

It is likely the minor decreases in shear stress in the Marcoola drain from the reclamation are due to increased water levels (see **Figure 6.5s**) as a result of the increased volume from the tailwater discharge. These higher water levels correspond to decreased velocities because the cross sectional area of flow is increased. For this reason also, this decrease in bed shear stress is likely to be accentuated with a higher tailwater discharge flow rate (e.g. 0.7 m^3/s), further reducing scour potential within the system.

Overall, there are no significant changes in bed shear stress to the existing conditions as a result of the tailwater discharge, and the risk of enhanced mobilisation of bed sediment is low. Additionally, the generally low nature of contaminants within the analysed sediment samples (refer **Section 6.3.2.2**) suggests any increase in sediment transport potential would be of minor significance, resulting in a low overall risk rating.

Operational impacts are likely to be significantly less than from construction due to lower flows during operation than those observed during tailwater discharge. Therefore, it was assumed the operation impacts from sediment transport would be of minor significance.

Table 6.5e: Shear stress, 95th percentile of basecase and reclamation

Location	Basecase	Reclamation
Marcoola drain Entrance	1.95	1.83
CD1	0.33	0.28
North Perimeter drain	0.09	0.09
CD2	0.12	0.17

Figure 6.5t: Shear stress – 95th percentile exceedances over critical shear stress

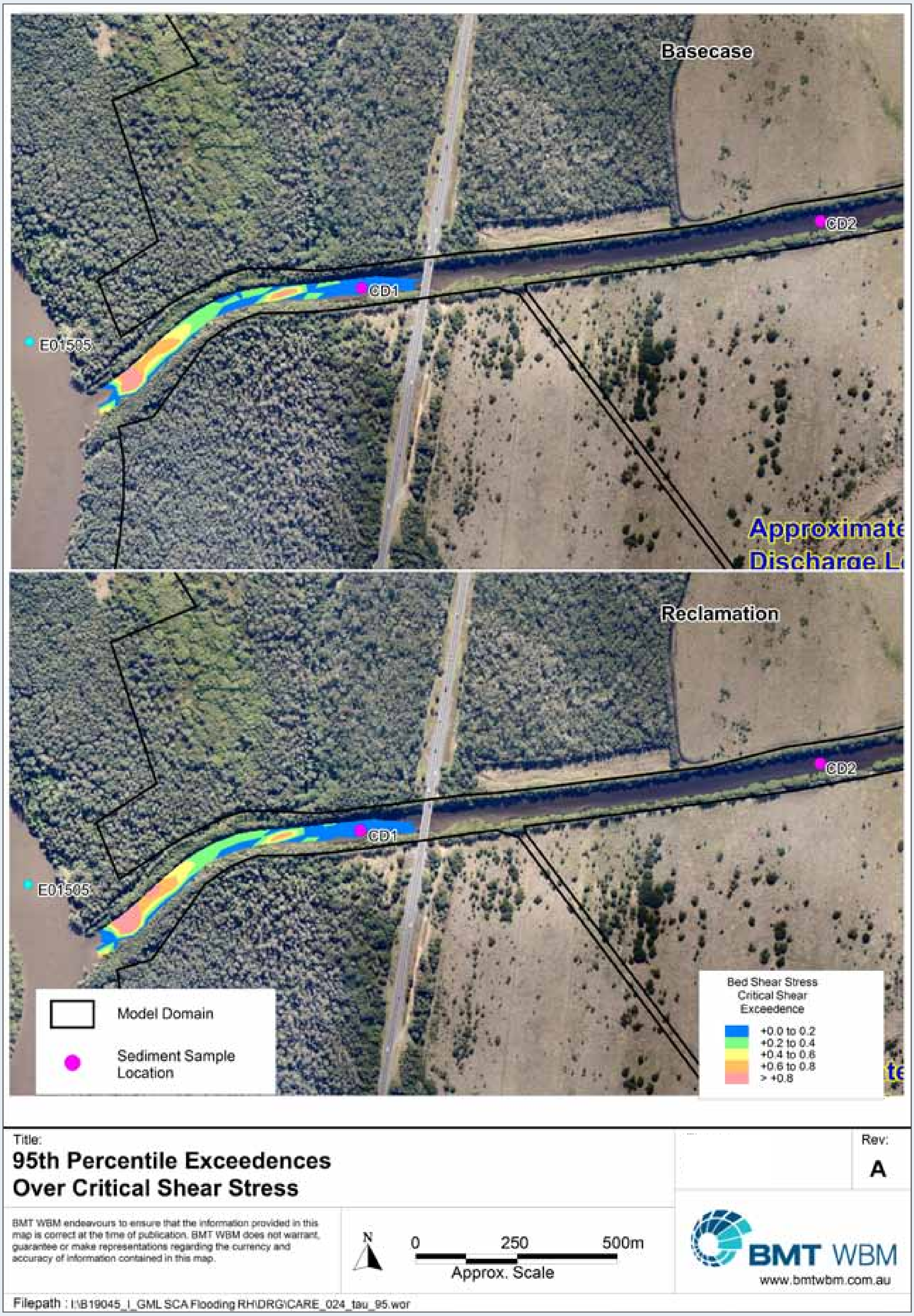
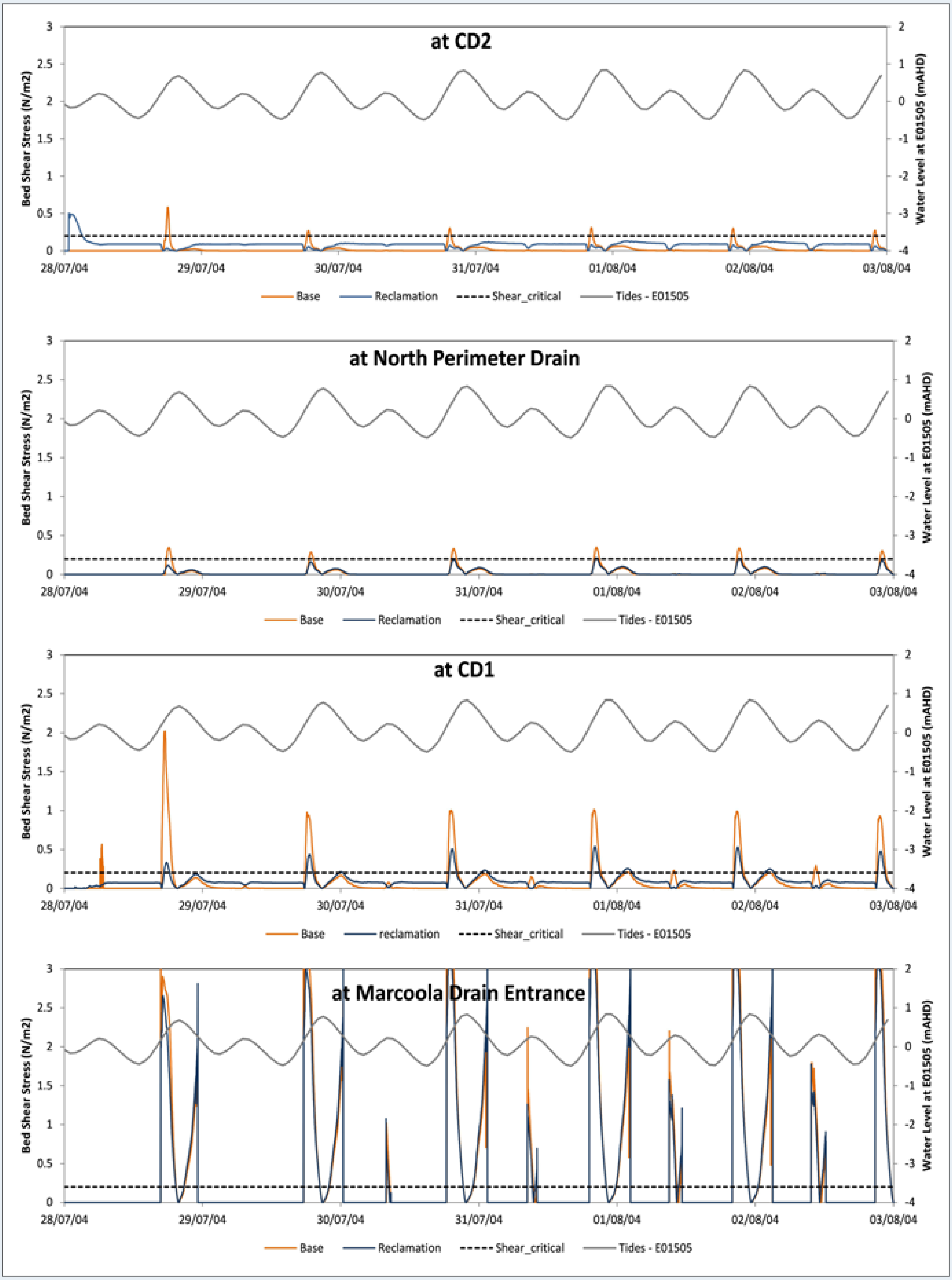


Figure 6.5u: Example time series of bed shear stresses at the 4 locations in July/August



6.5.5 Material spill at the offshore pump-out location

During sand pumping, it is anticipated that a quantity of marine sand may be spilled from the dredger. The amount of spilled material will depend on the vessel selected for the Project (see Chapter A5 – Project Construction). The pump-out site is expected to be at least 500 m offshore from Marcoola Beach, and approximately 850 m by 900 m as shown in **Figure 6.5v**. See Chapter A5 – Project Construction for more details.

The depth across the potential spill area ranges between approximately 13-22 m below AHD. Typically, there is very little morphological change at depths greater than 15 m below AHD. It is therefore anticipated that any spilt material will only become mobile under relatively extreme wave conditions and will eventually integrate into the local sediment budget. Resuspended sand is likely to have negligible impact on coastal water quality.

Total spillage at the pump-out site could temporarily decrease depths locally by 1-2 m during pumping. If the accumulated spill is excessive (e.g. causing a navigational hazard) it will be re-dredged. If required, this work is expected to have a negligible impact on water quality since the re-dredging works would occur infrequently for short periods (up to a few hours). Re-dredging of the accumulated spill at the pump-out site is likely to have negligible impacts.

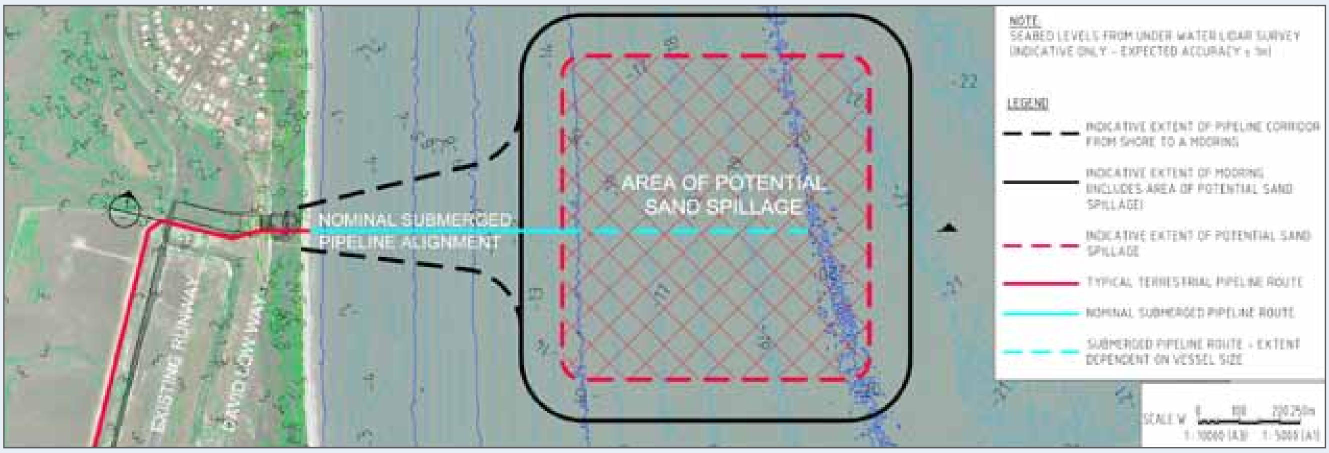
Potential impacts on water quality from normal operations of the dredge whilst at the pump-out locations, such as fuel leaks, release of liquid waste or other pollutant sources are addressed in Chapter E4 – Dredge Management Plan.

6.6 SUMMARY AND CONCLUSIONS

Overall, the impacts of the Project on the hydrology and water quality of the airport and surrounding area are likely to be minor to negligible. The tailwater discharge impacts on sediment, turbidity and salinity within the Marcoola drain and in the fish habitat areas of the Maroochy River are likely to be minor. The reclamation process is anticipated to be less than 1 year (as related to the WQOs), therefore, impacts are short-term and increases in water quality parameters are within the range of levels already observed within the Maroochy River. Specifically, the impact assessments, including the tailwater and catchment modelling, show that:

- Impacts are generally localised to the downstream reach of the Marcoola drain which is an artificial channel. When the tailwater discharge mixes with receiving water in the Maroochy River, there is fast and thorough dispersion of the tailwater and its constituents, and increases above background levels are minor. Within the upper Marcoola drain above the culverts at Finland Road, impacts are minor due to the limited hydraulic connection between the upper and lower Marcoola drain and the freshwater inflows observed from the upstream catchments
- Existing sediment concentrations are generally in compliance with WQO and the reclamation will not result in increases to sediment concentrations above the WQOs
- Existing turbidity levels within the Maroochy River already exceed WQOs, especially within the higher reaches of the estuary. Impacts to turbidity are demonstrated to be low, with minor (less than +5 per cent) increases above background levels. These impacts are likely to be short-term, for the duration of the reclamation stage of the Project

Figure 6.5v: Indicative pump-out location



- Salinity does not currently have WQOs set for the Maroochy River, however impacts to salinity are demonstrated to be within the range of natural background variation
- Changes to hydrology of the system, including the Marcoola drain are likely to be negligible. Some flows within the northern portion of the airport surrounds will be diverted into the Marcoola drain instead of to the Maroochy River directly. Nevertheless, overall water quality due to operational stormwater will not be impacted adversely
- Stormwater runoff from the airport facilities, such as the new runway, are likely to have minor water quality impacts, as values observed from a similar study at the Brisbane Airport demonstrate lower than typical concentrations observed within the region
- There is the potential for minor impacts as bed mobilisation from scour in the Marcoola drain associated the tailwater discharge. These impacts are minor and unlikely to occur due to no significant changes in the bed shear stresses from the tailwater
- Water quality impacts associated with spillage and the unlikely event of dredging at the pump-out site would be minor, not resulting in significant changes to water quality.

These impacts, significance, mitigation and residual impacts, where applicable are summarised in **Table 6.6a**.

6.7 REFERENCES

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Table 6.6a: Summary of impacts, significance, mitigation and residual impacts for the Project on airport and surrounds hydrology and water quality

Hydrology and Water Quality Parameter	Initial assessment with mitigation inherent in the Preliminary design in place				Residual Assessment with additional mitigation in place (i.e. those actions recommended as part of the impact assessment phase)			
Primary impacting process	**Mitigation inherent in the design**	**Signifi-cance of impact**	**Likeli-hood of impact**	**Risk rating**	**Additional mitigation measures proposed**	**Signifi-cance of impact**	**Likeli-hood of impact**	**Residual risk rating**
Changes to hydrology in the Marcoola drain during construction	NA	Negligible	Likely	Low	NA	Negligible	Likely	Low
Changes to turbidity levels in the Maroochy River at the confluence with the Marcoola drain during the construction phase; Impacts to fisheries areas	Settlement pond and liner	Minor	Likely	Medium	Ongoing monitoring during reclamation and ensure compliance with EMP. Cease discharge if turbidity compliance thresholds are exceeded	Minor	Unlikely	Low
Changes to TSS concentrations in the Maroochy River at the confluence with the Marcoola drain during the construction phase; Impacts to fisheries areas	Settlement pond and liner	Negligible	Likely	Negligible	NA	Negligible	Likely	Negligible
Changes to salinity in the upper reaches of the Marcoola drain during the construction phase	NA	Negligible	Likely	Negligible	NA	Negligible	Likely	Negligible
Changes to salinity in the Marcoola drain after construction and during operation	NA	Negligible	Likely	Negligible	NA	Negligible	Likely	Negligible
Changes to airport stormwater quantity and water quality regimes during the operational phase	Physical separation by approx. 150m of vegetated overland flow	Minor	Possible	Low	NA	Minor	Possible	Low
Scour and mobilisation of existing bed sediments in the Marcoola drain due to tailwater discharge from the North Perimeter drain	NA	Minor	Unlikely	Low	NA	Minor	Unlikely	Low
Changes to water quality from material spill and potential dredging at the offshore pump-out location	NA	Negligible	Unlikely	Negligible	NA	Negligible	Unlikely	Negligible