Assessing the impact of sewage overflows on oyster harvest areas: Merimbula Lake estuary technical summary

WRL TR 2023/26, May 2025

By Y Doherty, M Mason, A J Harrison and B M Miller

UNSW Water Research Laboratory

UNSW SYDNEY

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1 Introduction

1.1 Project overview

The Water Research Laboratory (WRL) of the School of Civil and Environmental Engineering at UNSW Sydney was engaged to undertake an extensive study titled “Assessing the impact of sewage overflows on oyster harvest areas in NSW”. This study was funded through a Department of Regional NSW Storm and Flood Industry Recovery Program (SFIRP) – Sector Recovery and Resilience grant with support from local councils and wastewater authorities.

The study seeks to understand the fate of contaminants and the potential exposure of oyster leases following overflow events under different environmental conditions including tides, wind and catchment runoff. The results of this study provide decision makers with quantitative data to assess exposure risk to specific harvest areas on an individual sewer overflow event basis. These outcomes allow for increased confidence in ensuring consumer safety, and more targeted harvest area closures to reduce the economic impact of widespread closures on local industry.

Sewage overflows into estuaries occur under a range of conditions, often due to malfunctioning or overwhelmed infrastructure. As a result, the environmental conditions in the estuary at the time of an overflow can vary. While experimental data (such as large scale dye release experiments) can be useful to understand contaminant transport in a single set of conditions (or a small number of conditions), it is impractical to collect such data for the broad range of conditions possible across multiple sewage overflow locations. Therefore, the approach of this study is to combine desktop numerical modelling and site-specific field investigations as a cost-effective means to gain sufficient understanding of contaminant transport.

For a detailed background to the study, refer to the User Guide (WRL TR2024/26).

1.2 Report context

This report is focussed on the Merimbula Lake estuary. It provides technical details of the available data, data collection undertaken, model development and the capabilities of the predictive model.

This report provides specific details for Merimbula Lake and should be read in parallel with User Guide WRL TR2024/26 and Technical Summary Report WRL TR2023/32 (Table 1-1). The other reports for each specific estuary are listed in Table 1-2.

Table 1-1 Summary of project reference documents

Report number	Intention
WRL TR2024/26	Project overview and user guide
WRL TR2023/32	Technical summary of fieldwork and modelling methods

Table 1-2 Summary of estuary specific reports

Estuary	Technical summary
Tweed River	WRL TR2023/18
Nambucca River	WRL TR2023/19
Hastings River	WRL TR2025/05
Camden Haven River	WRL TR2023/20
Wallis Lake	WRL TR2023/21
Port Stephens	WRL TR2023/22
Clyde River	WRL TR2023/24
Shoalhaven/Crookhaven Rivers	WRL TR2023/23
Wagonga Inlet	WRL TR2023/25
Merimbula Lake	WRL TR2023/26 (this report)
Pambula Lake	WRL TR2023/27

1.3 Merimbula Lake site description

Merimbula Lake is a coastal estuary on the far south coast of NSW, Australia, located 350 km south of Sydney and 20 km north of Eden. Towns in the area include Merimbula and Bald Head. The Merimbula Lake estuary system is comprised of a deep lake (up to 9 m) connected to the ocean via a 3.5 km inlet channel and an untrained entrance. The estuary catchment is 26 km^2 with two primary inflows: Boggy Creek and Bald Hills Creek.

The waterway area is 4.5 km^2 and the tidal prism was approximately 2.3 x 10^6 m^3 on a spring tide in 2003 (MHL, 2003). The lake entrance has no history of closure, however the entrance bar is a dynamic feature with cyclical variation in entrance channel depth and sand bar morphology (Doherty et al., 2023). The estuary has two oyster harvest areas: Entrance and Top Lake. These are shown in Figure 1-1.

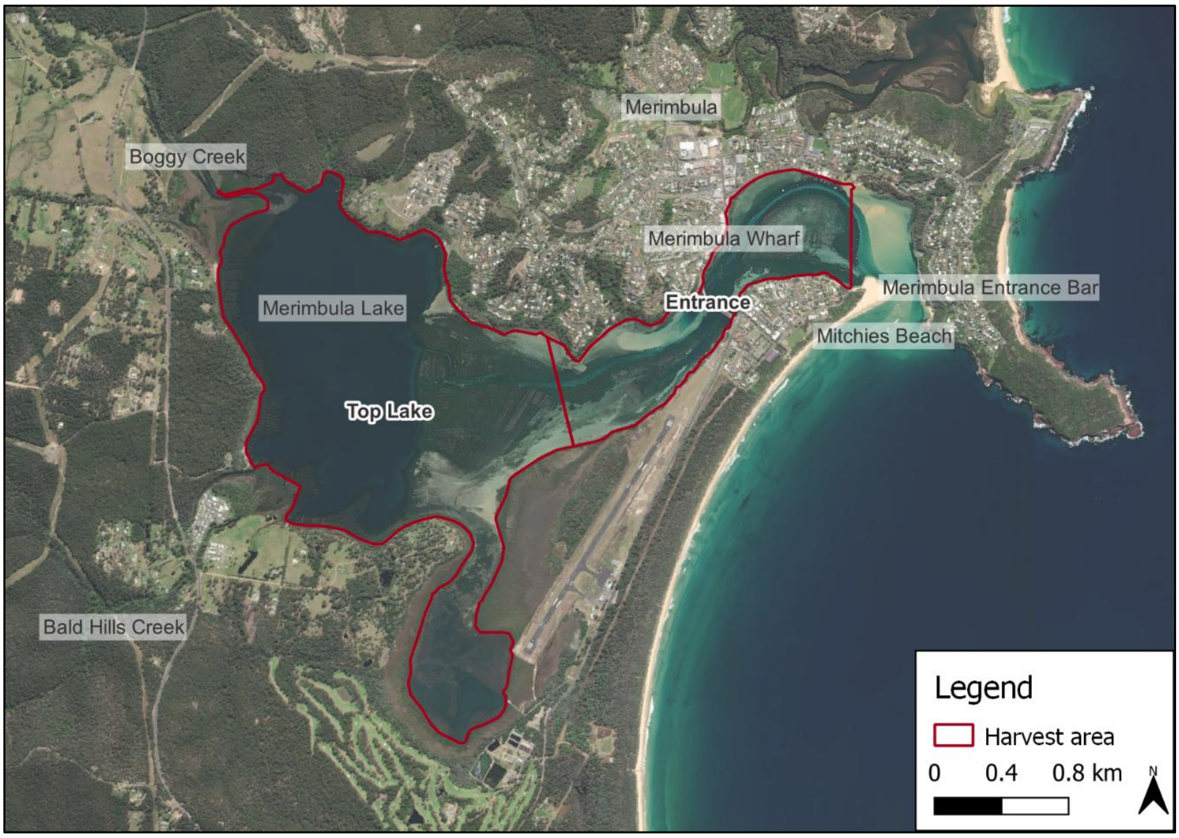

Figure 1-1 Oyster harvest areas in Merimbula Lake estuary

1.4 About this report

This report includes the following sections:

- **Section 2: Data collation** – summarising the relevant existing data available to assist in calibration of the numerical model, including information on historical sewage overflow locations.
- **Section 3: Field data collection** – summarising the outcomes of a field data collection campaign on the estuary.
- **Section 4: Model development** – outlining the development of the numerical model of the Merimbula Lake estuary.
- **Section 5: Scenario modelling** – describing the suite of scenarios run for the estuary.

The following appendices are included which provide additional detail:

- **Appendix A: Field data collection**
- **Appendix B: Model calibration**

2 Data collation

2.1 Preamble

Table 2-1 summarises the preexisting available data relevant for development of the numerical hydrodynamic and water quality model.

Table 2-1 Summary of data collated for this project

Data type	Primary sources	Comments	Report section
Long term water level data	MHL (2023a) MHL (2023b)	Long term water level data available at two locations in Merimbula Lake and at one nearby ocean tide gauge.	2.2
Water level data	NSW Food Authority (2023)	Single water level sensor in lower Merimbula Lake.	2.2
Tidal flow and water level	MHL (2003)	Tidal flow gauging at one location and temporary water level gauging at four locations in September and November 2003.	2.2
Catchment discharge	WaterNSW (2023)	One nearby long term catchment flow monitoring location.	2.3
Sewage overflows	NSW Food Authority	Data provided on overflows reported to EPA and NSW Food Authority including closure action pursued, spill duration and volume.	2.4
Bathymetry	DPIE (2018) OEH (2003) NSW Spatial Services (2013) NAVONICS (2023) NearMap (2024)	Bathymetry primarily sourced from 2018 marine LiDAR survey with supplementary data from 2003 single beam survey, 2012 Digital Elevation Model (DEM), NAVONICS SonarChart and NearMap aerials.	2.5

2.2 Water level and tidal flow gauging

Manly Hydraulics Laboratory (MHL) maintain two permanent water level gauges on Merimbula Lake, and one nearby ocean tide gauge at Eden. Further water level and flow gauging has occurred during two MHL short-term data collection campaigns in 1978 and 2003 (MHL, 1979; MHL, 2003). Due to potential hydrodynamic changes to the system arising from the construction of a new bridge in 1984, only the 2003 study was considered for model calibration purposes in this study. NSW Food Authority maintain an additional water level sensor in lower Honeymoon Bay which is used by the oyster growers. These gauging and water level sensor locations are shown in Figure 2-1 and tabulated in Table 2-2 and Table 2-3. Water level and flow gauging locations from the 2023 field campaign (refer to Section 3) are also included in these.

Table 2-2 Summary of water level gauges in Merimbula Lake and relevant ocean tide gauge

Water level gauge	Location label	Station number	Provider	Date range	MHL report number
Eden	-	220470	MHL	1970 – present	–
Merimbula Lake Mitchies Beach	1	-	MHL	22/09/2003 – 28/11/2003	MHL1290
Merimbula Wharf	2	220410	MHL	1991 – present	–
Merimbula Lake Bridge	3	-	MHL	22/09/2003 – 28/11/2003	MHL1290
Merimbula Lake Centre	4	-	MHL	22/09/2003 – 28/11/2003	MHL1290
Merimbula Lake (MHL)	5	220405	MHL	1991 – present	–
Merimbula Lake South	6	-	MHL	22/09/2003 – 28/11/2003	MHL1290
Merimbula Lake (ICT)	7	-	NSW Food Authority *	2022 – present	–

* This sensor was initially deployed as part of the 2017-2020 Food Agility CRC project: Oyster industry transformation – Building sustainability and profitability in the Australian Oyster Industry.

Table 2-3 Summary of tidal flow gauging locations in Merimbula Lake estuary

Tidal flow gauge	Location label	Date	Study
Merimbula Lake Bridge	A	25/10/2003	MHL1299

Figure 2-1 Water level and tidal flow gauging locations

2.3 Catchment inflows

Gauged catchment inflows were available from WaterNSW. When these were not at the tidal limit (the model boundary), the flows were scaled up proportional to the additional catchment area using the method in WRL TR2023/32 Section 2.4. There are two model boundary inflows into the Merimbula estuary. No catchment inflow gauges within the Merimbula catchment were available, thus, to estimate catchment inflows, flows were scaled from the closest WaterNSW station: Pambula River at Lochiel (6 km to the southwest), operational from 1966 to the present. Table 2-4 lists the model boundaries, the gauges used and the relevant scaling factor applied. Figure 2-2 shows the locations along with the catchment area flowing into each tidal boundary (solid line polygon) along with the associated portion of that catchment that is upstream of the gauge (hatched).

Note that the lack of gauged catchment inflows within the Merimbula Lake catchment means that catchment inflows are highly uncertain in this area. However, senstivity tests completed in the modelling stage of this project demonstrate that the results are not sensitive to catchment inflows, so this is not regarded as a significant limitation for this project. This is discussed further in Section 5.3.2.

Table 2-4 Summary of scaling factors for model catchment boundaries

Model boundary	Base WaterNSW gauge	Scaling factor
Boggy Creek*	220003	0.18
Bald Hills Creek*	220003	0.08

*This catchment was ungauged, so the gauge in the nearby Pambula River catchment was scaled and used.

Flowrates exceeded at various percentiles for each WaterNSW gauge are shown in Table 2-5.

Table 2-5 WaterNSW gauge flow percentiles

Percentile	Pambula River at Lochiel (220003) ML/d *(m^3/s)*
5th	0.0 *(0.0)*
20th	0.69 *(0.008)*
50th (median)	6.8 *(0.079)*
80th	29 *(0.34)*
95th	332 *(3.8)*

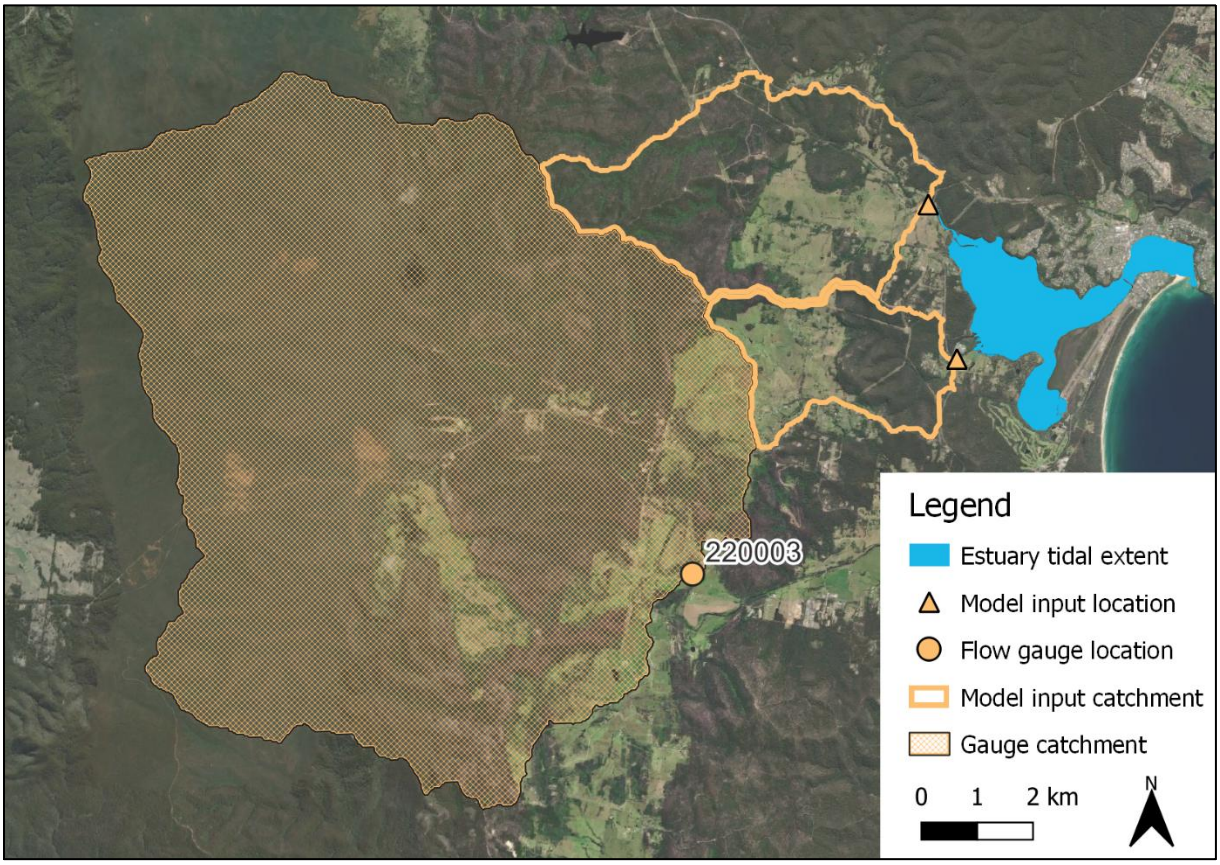

Figure 2-2 Catchment flow gauging stations*

*Hatched areas correspond to upstream catchments of WaterNSW gauges. Outline areas correspond to model input catchment areas.

2.4 Sewage overflow data

Bega Valley Shire Council (BVSC) is the agency responsible for wastewater treatment and sewage management in the catchment surrounding the Merimbula estuary. The sewerage system is comprised of a reticulation network of pipes and sewage pumping stations (SPS), in addition to the Merimbula wastewater treatment plant (WWTP). When sewage overflows occur, BVSC is required to notify NSW Food Authority so that appropriate decisions can be made on whether harvest area closures are necessary. Information on sewage overflows between 2016 and 2023 has been provided by the NSW Food Authority and reported overflow locations are shown in Figure 2-3. More information on sewage overflows and why they occur is provided in WRL TR2023/32 Section 2.5.

Figure 2-3 Locations of reported sewage overflows in Merimbula Lake estuary

2.5 Bathymetry

Two existing bathymetry datasets were sourced for this project:

- Coastal marine LiDAR collected by the former NSW Department of Planning, Industry and Environment (now DCCEEW) in 2018. In the Merimbula Lake estuary region, this survey covers areas within 1 km of the coast and corresponds to the estuary entrance and most of the inlet channel (shown in Figure 2-5) at a resolution of 5 m. This is the most recent and detailed survey and was used as the preferred bathymetry source for all regions of the mesh covered by the survey extent.
- Single beam bathymetry data collected in 2003. This dataset was collated and provided by the NSW Office of Environment and Heritage (OEH, now DCCEEW) and is available on the Australian Ocean Data Network (AODN) portal. This data was collected as a series of transects which cover the estuary with 25 to 50 m spacing (refer to Figure 2-6). This dataset was used in regions not covered by the marine LiDAR.

For areas where the 2003 single beam survey overlapped with the 2018 marine LiDAR extent, the difference in depth was investigated (refer to Figure 2-7). Approximately 85% of the sampled readings had a difference < 50 cm, while the remaining 15% varied by 0.5 to 2.5 m. A deepening of 2.5 m in the scour region immediately south of Merimbula Lake Bridge was observed over the 15 year period. Significant changes to entrance bar morphology were observed, with changes to the dune area, dune profile, and channel width. Based on aerial imagery, and research by Doherty et al. (2023), it is apparent that the sand bars and shoals at the entrance are mobile but appear to be in a state of dynamic equilibrium with no obvious long-term trends. Variation in sand bar position can be seen in Figure 2-4.

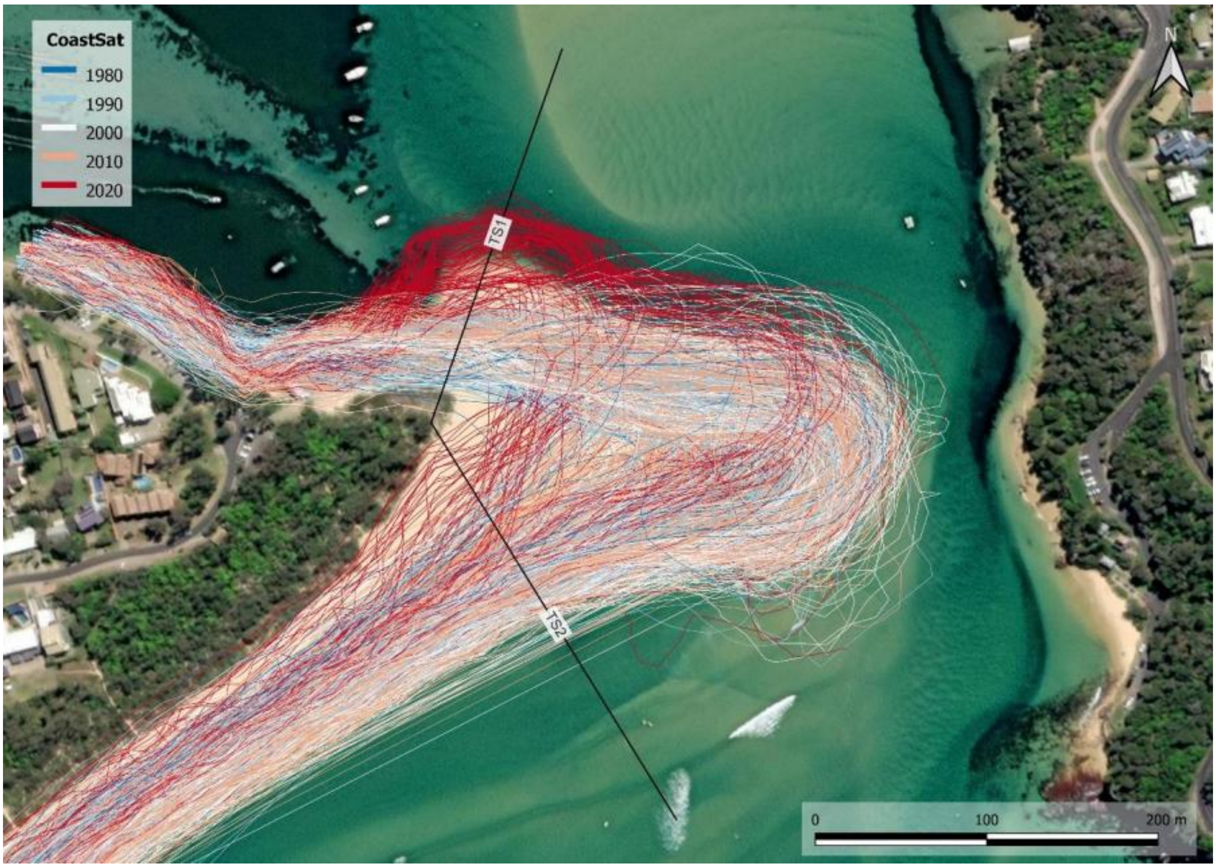

Figure 2-4 Long term position of Merimbula entrance bar sand spit from Doherty et al. (2023)

Additional bathymetric, topographic, and aerial data utilised include:

- 1 x 1 m DEM LiDAR data, collected in 2013 and available from NSW Spatial Services, was used for shallow areas inland of the extent of the 2018 LiDAR survey, provided they were above water level during the 2012 survey.
- NAVONICS SonarChart^{TM} was utilised for qualitative verification of model bathymetry. This was primarily used to assess whether model bathymetry was capturing the location and geometry of complex features not fully captured by single depth soundings such as shallow reefs, abrupt drop-offs, and river confluences.
- High resolution NearMap imagery was used to qualitatively provide information on important bathymetric features such as changes to shoal geometry over time.

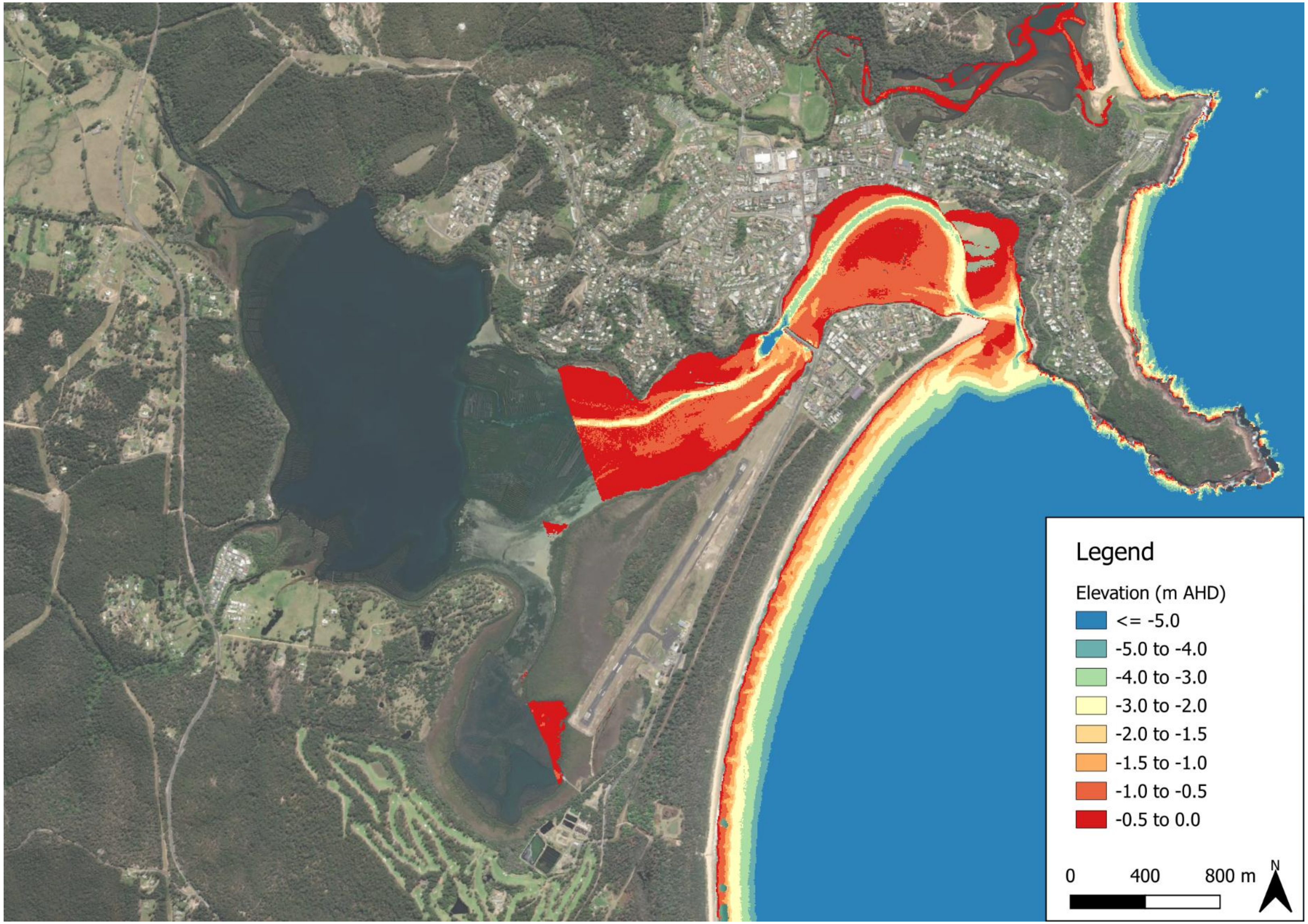

Figure 2-5 Coverage of 2018 LiDAR survey

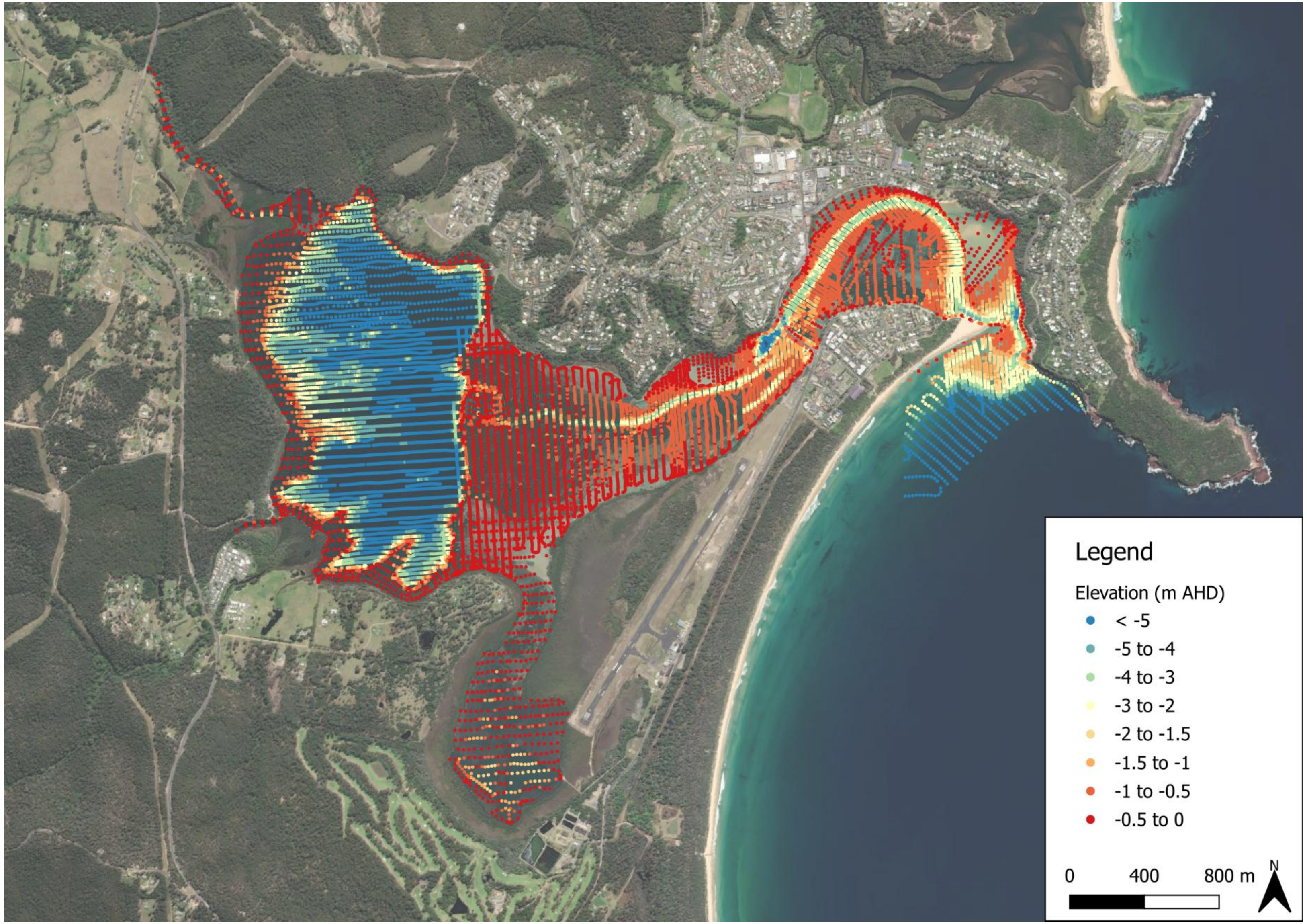

Figure 2-6 Coverage of 2003 single beam survey

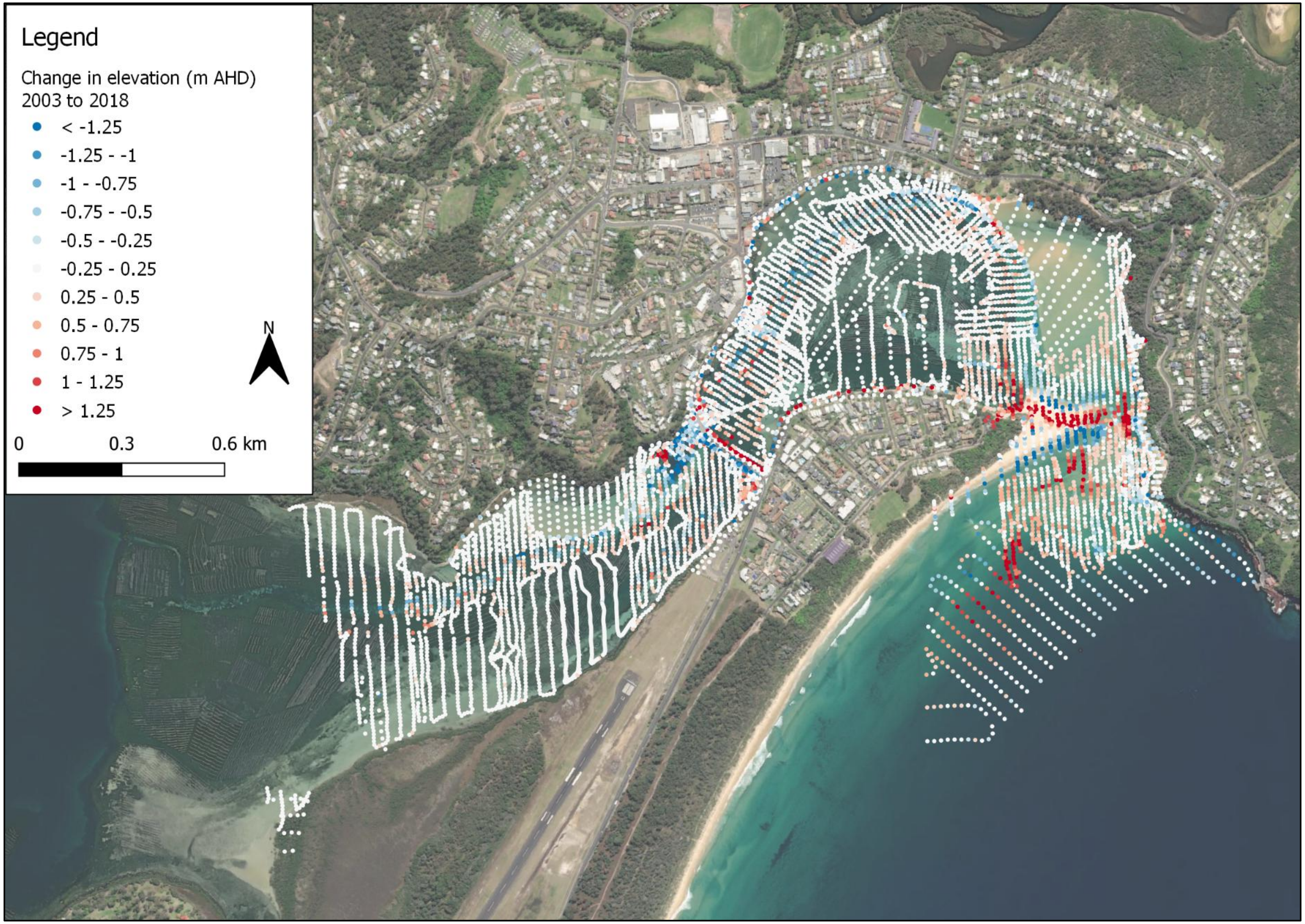

Figure 2-7 Bathymetry difference between 2003 survey and 2018 marine LiDAR. Red corresponds to accretion and blue to erosion

3 Field data collection

3.1 Preamble

A data collection campaign was completed on 4 July 2023. Field data collection included:

- Monitoring of current velocities and volumetric flow using an ADCP
- Monitoring of dispersion and advection using Rhodamine WT dye
- Monitoring of surface current speed and flow paths using GPS drifter drogues
- Monitoring of water level data and collation of data from MHL water level monitoring sites
- Conductivity measurements

3.2 Weather and tides

Data collection on Merimbula Lake was undertaken on both ebb and flood tides. Tides during field investigations were relatively small, ranging between approximately -0.44 to 0.18 m AHD recorded at Eden. The observed water levels at Eden, alongside the timing of key fieldwork components is shown in Figure 3-1. Predicted and observed tides at the Eden ocean tide station are shown in Figure 3-2. The residual between observed and predicted tides was near zero for this period.

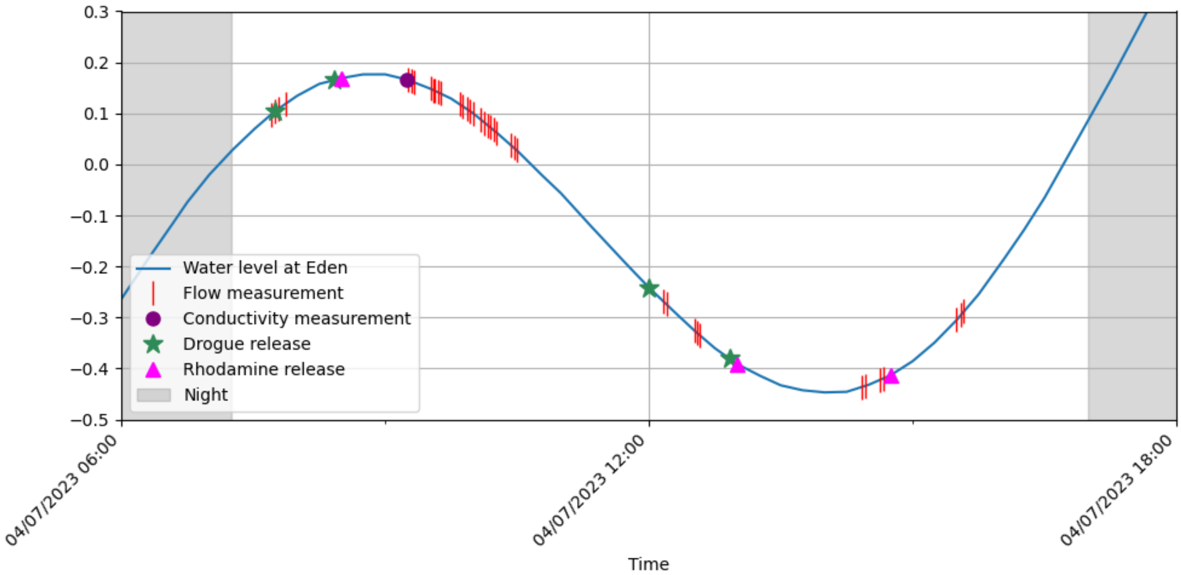

Figure 3-1 Ocean tide at Eden with timing of key data collection events

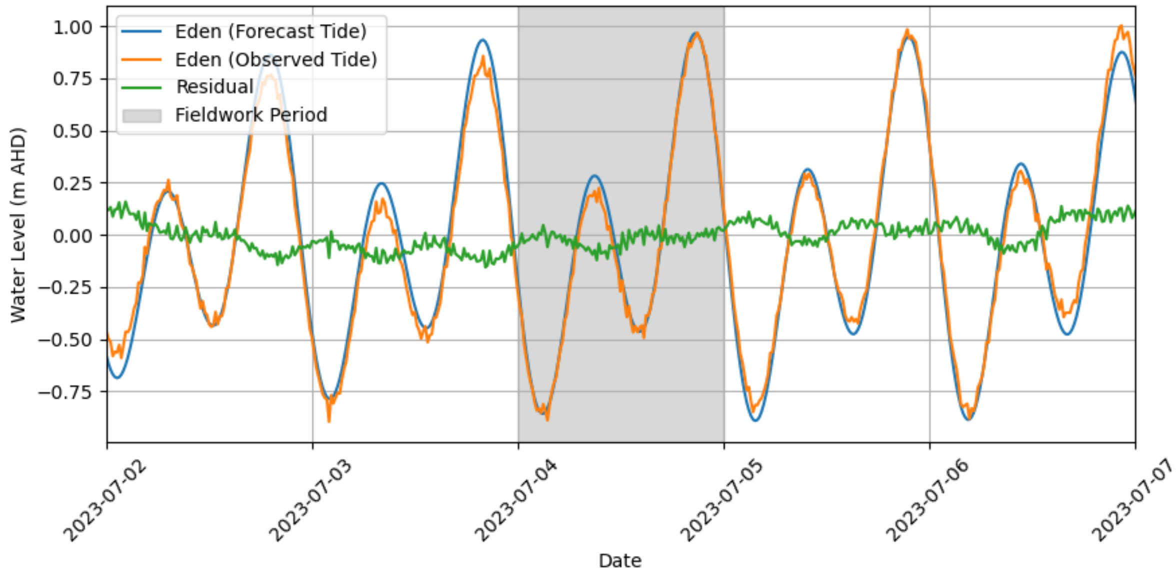

Figure 3-2 Forecasted and observed tides at Eden

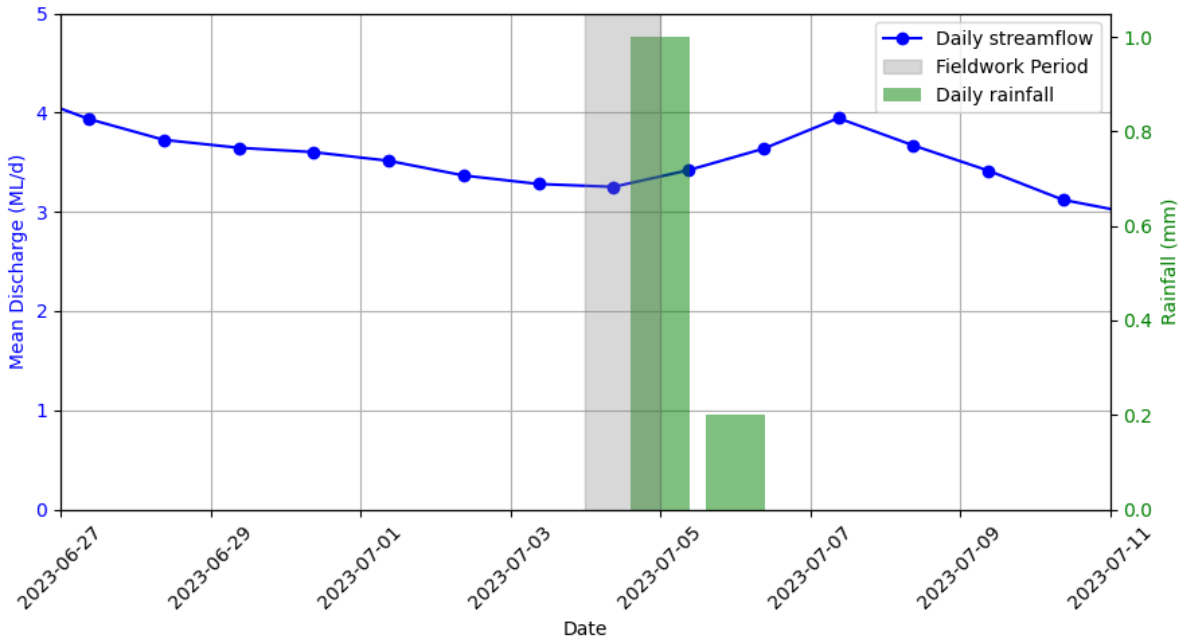

Figure 3-3 Rainfall recorded at Merimbula Airport and streamflow recorded at Pambula River at Lochiel for the period surrounding fieldwork

Light rain was observed in the field, however rainfall was negligible at Merimbula Airport (BoM station number 069147), as can be seen in Figure 3-3, (BoM, 2023). As can also be seen in Figure 3-3, freshwater inflows from the upstream catchments were low. Flows were below median flows at the nearby WaterNSW gauges on Pambula River, discussed in Section 2.3. Negligible wind was observed at Merimbula Airport.

3.3 Tidal flow gauging

Flow was measured using a boat mounted SonTek RiverSurveyor M9 ADCP at four targeted locations across a range of ebb and flood tidal stages. More information on methods used for tidal gauging can be found in WRL TR2023/32 Section 4.2. Flow measurements in Merimbula Lake are summarised in Table 3-1, with locations shown in Figure 3-4. For a table of tidal gauging measurements refer to Appendix A2, and for plots of tidal flows refer to Appendix B1.3. Particular attention was given to measuring flow under Merimbula Lake Bridge to understand the volume of flow entering the lake system. Additional measurements were taken adjacent to the entrance bar.

Table 3-1 Summary of 2023 fieldwork tidal flow gauging locations

Location	Number of transects
Merimbula Lake Bridge	38
Merimbula Entrance Channel	2

Figure 3-4 Tidal flow gauging locations from 2023 fieldwork

In addition to measuring total flow, ADCP data collected along each transect was used to understand flow and velocity distributions across the channel. Refer to Appendix A3 for figures of ebb and flood channel velocity distribution for all gauging transects.

Vertical velocity distribution for incoming and outgoing flows was also assessed for each gauging transect, which is useful for assessing the validity of assumptions associated with using a two-dimensional depth averaged model. For all locations and transects, observations approximated depth averaged flow. Velocity depth profiles for each gauging location are presented in Appendix A4.

3.4 Bathymetry and elevation surveys

During the ADCP data collection campaign, an RTK-GPS unit collected vertical position data to an accuracy of 10 cm. By pairing depth soundings and elevation data, bathymetry was captured for all flow gauging locations (refer to WRL TR2023/32 Section 4.3 for details on methods used for bathymetric surveys). In addition to gauging sites, additional bathymetry was collected along the main inlet channel from the entrance to the lakes edge. Bathymetry data for all locations is shown in Figure 3-5, and change between the 2018 LiDAR data and field captured bathymetry is shown in Figure 3-6.

Compared with the 2018 marine LiDAR survey, the 2023 field survey bathymetry results show minor to moderate changes over the last 5 years. The median of the observed bathymetric change is zero, with a standard deviation of 0.65 m. With no clear evidence for net sediment gain or loss, the bathymetric changes likely correspond to a state of dynamic equilibrium between channel scour and sand bar deposition. Key regions of bathymetric change correspond to:

- Deposition and shallowing of the scour channel immediately to the north and south of Merimbula Lake Bridge of up to 1.5 m (note that water depth in this region is 5 to 10 m).
- 100 m south of the Merimbula Lake Bridge at the southern extent of the bridge scour region, deepening of the channel was observed of up to 1.5 m.
- Minor (up to 0.5 m) deposition of the northern extent of the inlet channel U-bend was observed, with corresponding erosion on the southern edge of the channel.
- Significant deepening of the entrance bar up to 3 m due to channel alignment and sand bank migration.

Figure 3-5 Bathymetry collected during 2023 fieldwork

Figure 3-6 Difference between 2018 LiDAR and 2023 fieldwork bathymetry. Red corresponds to accretion and blue to erosion

3.5 Rhodamine WT dye releases

To simulate pollutant advection and dispersion in the Merimbula Lake estuary, three Rhodamine WT dye releases were performed on during the field campaign (refer to WRL TR2023/32 Section 4.4 for methods). These are summarised in Table 3-2, with locations shown in Figure 3-7. The initial release concentration was 200,000,000 ppb in all instances.

Table 3-2 Summary of dye releases

No.	Date	Time released	Tracked until	Volume of dye released (mL)	Location	Tide
1	04/07/2023	8.33am	10.14am	250	Merimbula inlet channel	Flood
2	04/07/2023	12.58pm	1.45pm	500	Merimbula Lake Bridge	Ebb
3	04/07/2023	2.46pm	3.26pm	250	Merimbula Lake Bridge	Ebb

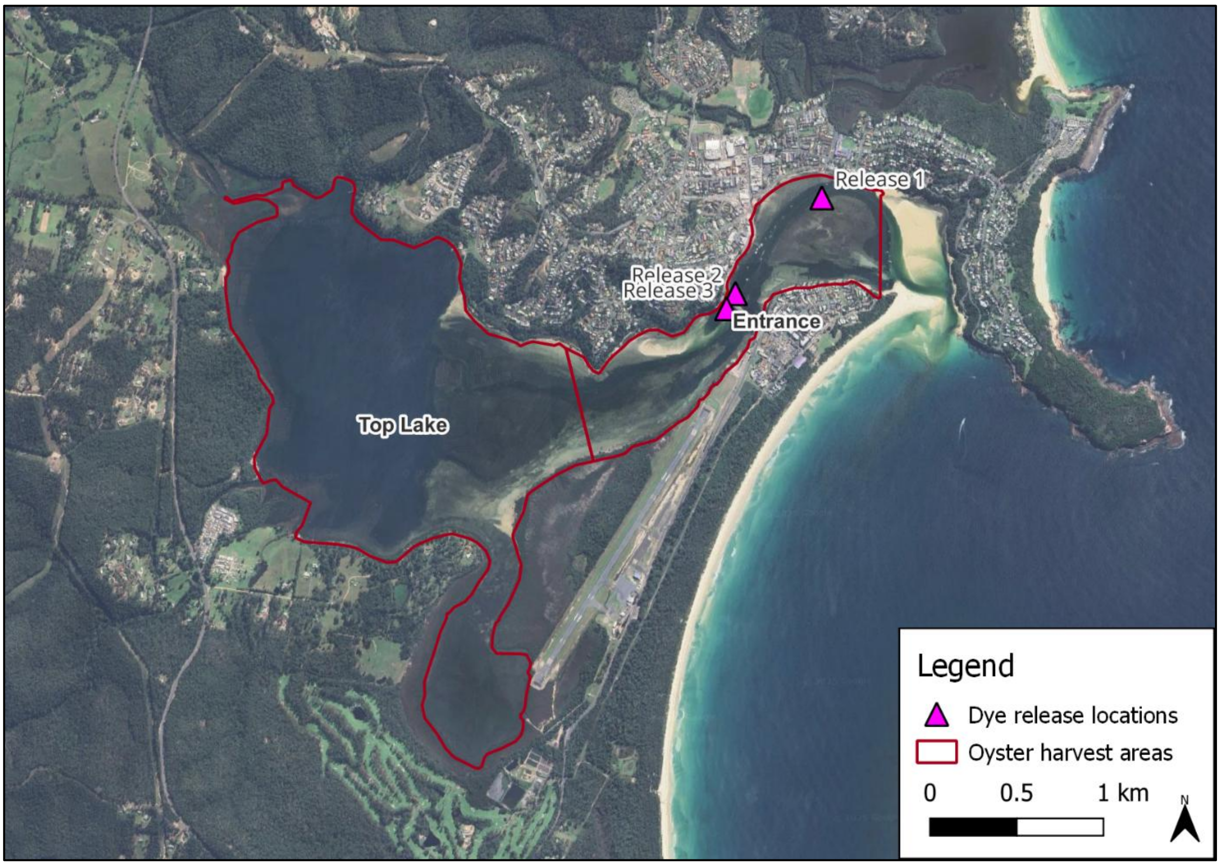

Figure 3-7 Rhodamine WT dye release locations

3.5.1 Release 1 – Merimbula Inlet Channel

Dye release 1 was started mid-channel at the northern extent of the inlet channel U-bend (Figure 3-8). This release was completed to understand transport rates from the inlet channel east of Merimbula Lake Bridge towards Merimbula Lake and to determine pollutant dispersion rates. The release occurred on an incoming tide, approximately 30 minutes before peak inflow at Merimbula Lake Bridge. For this release, 250 ml of dye was released instead of the usual 500 ml as the release was in a public area. Dye was released around 8.30am and tracked for 1 hour 45 minutes. Figure 3-9 shows the observed dye concentrations over the period of monitoring, with the maximum plume concentration along select transects highlighted.

Figure 3-8 Merimbula inlet channel flood release 5 minutes after dye drop

Steady mixing and dispersion were observed immediately after the dye release, and by 15 minutes a depth profile indicated the plume was vertically well mixed. The plume continued spreading with decreasing peak concentrations as it moved upstream towards Merimbula Wharf. The plume hugged the inside bank of the main channel, however, no obvious dye excursion was observed into the oyster leases. The dye was tracked spreading and travelling south-west in the main channel for another 15 minutes until the plume was artificially dispersed by a speed boat's propellers.

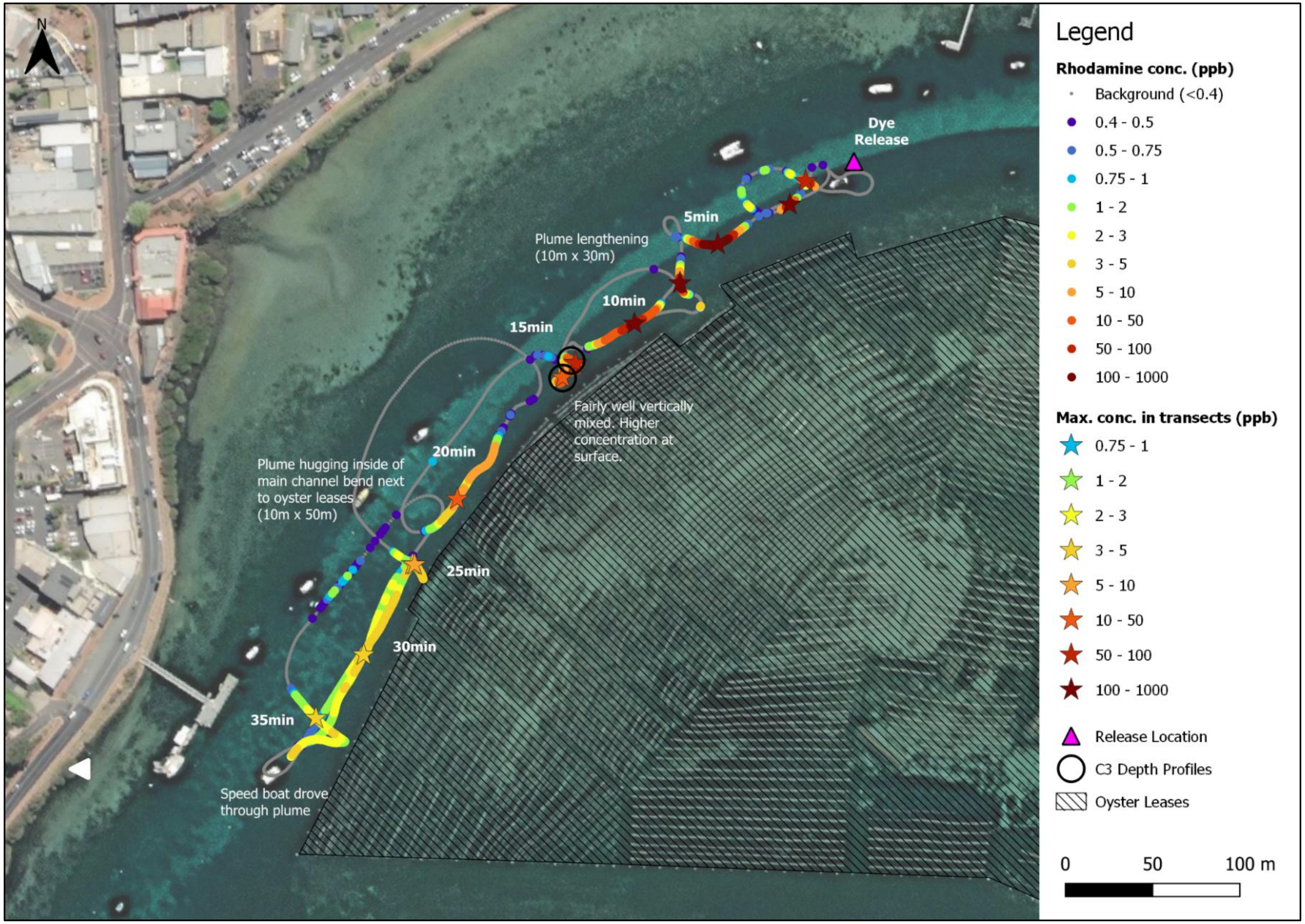

Figure 3-9 Dye release 1 at Merimbula Inlet Channel. All observed concentrations (circles) and maximum concentration observed in select transects (stars)

3.5.2 Release 2 – Merimbula Bridge

Dye release 2 was conducted mid-channel approximately 50 m north-east of Merimbula Lake Bridge (Figure 3-10). The aim of this release was to observe plume velocity and dispersion in the main inlet channel east of Merimbula Lake Bridge on an outgoing tide. For this release, 500 ml of dye was released and a fixed rhodamine sensor was placed adjacent the oyster harvest area to observe any dye incursion into the oyster leases. The release was approximately 30 minutes after peak tidal inflow at Merimbula Lake Bridge and was tracked for 45 minutes from 1.00pm. Figure 3-11 shows the observed dye concentrations over the period of monitoring, with the maximum plume concentration along select transects highlighted.

Figure 3-10 Dye release 2 after 5 minutes

Upon release, the plume elongated, spread laterally, and moved rapidly downstream with the fast moving currents under the bridge. At 5 minutes, two speed boats drove through the plume which artificially dispersed the dye. At 10 minutes, the plume passed the fixed rhodamine sensor. No dye was visually observed heading into the oyster leases, and no rhodamine was detected by the fixed sensor. The plume continued downstream along the main inlet channel and after 25 minutes covered the width of the channel. Around the northern extent of the inlet channel U-bend, some dye was observed entering the shallow areas adjacent to the private jetties. A depth profile at 40 minutes indicated the plume was vertically well mixed. As the plume continued towards the entrance, the dye continued dispersing as the plume elongated and became difficult to visually track.

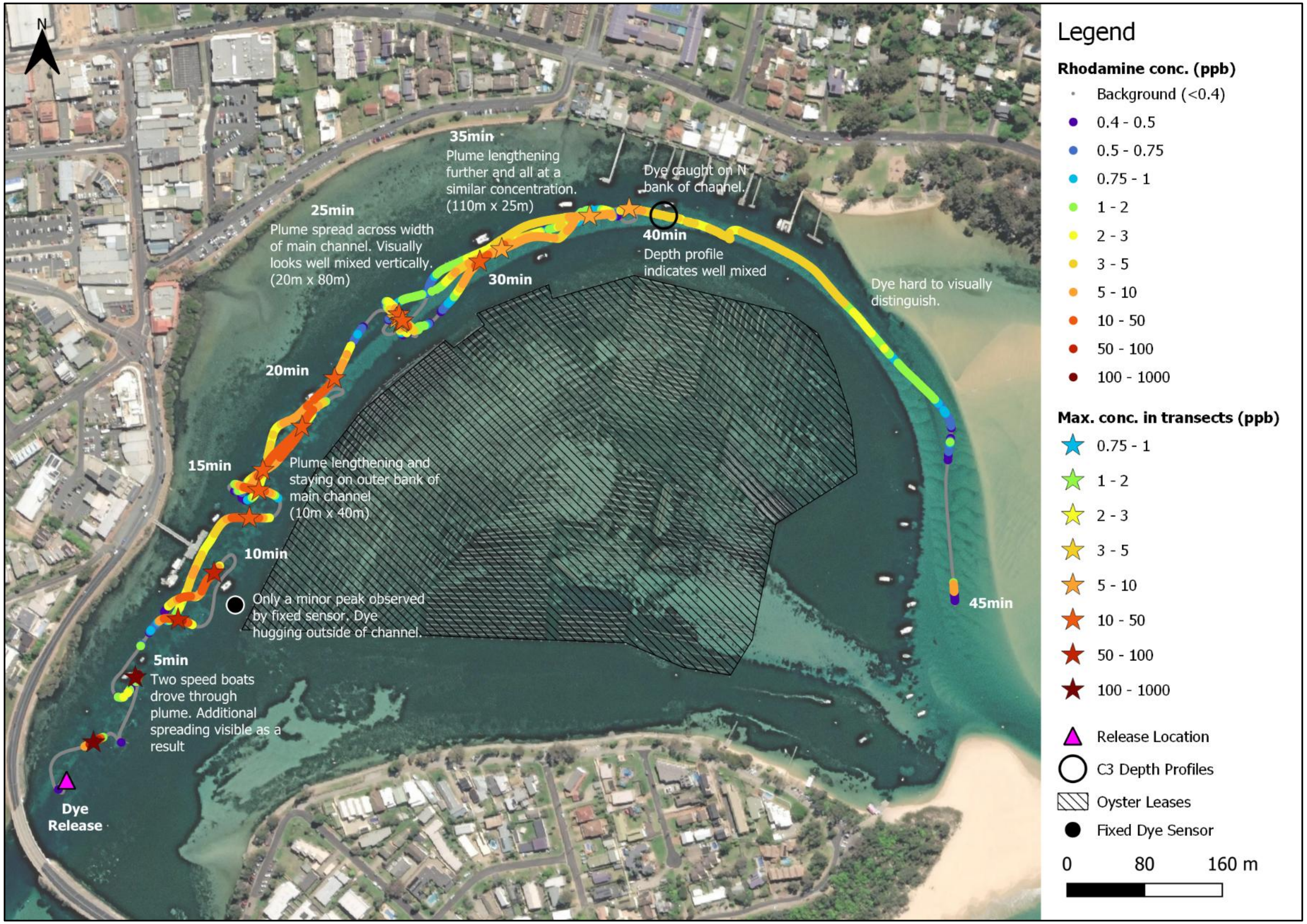

Figure 3-11 Dye release 2 at Merimbula Bridge. All observed concentrations (circles) and maximum concentration observed in select transects (stars)

3.5.3 Release 3 – Merimbula Bridge

Dye release 3 was completed mid-channel approximately 100 m southwest of Merimbula Lake Bridge (Figure 3-12). This release was completed to help understand plume mixing under Merimbula Lake Bridge, and to repeat release 2. Again, 250 ml of dye was released instead of the usual 500 ml as the release was in a public area. The release occurred on an outgoing tide, approximately 2 hours after peak outflow at Merimbula Lake Bridge. Dye was released around 2.45pm and was tracked for 45 minutes. Figure 3-13 shows the observed dye concentrations over the period of monitoring, with the maximum plume concentration along select transects highlighted.

Figure 3-12 Dye release 3 passing under the bridge after 3 minutes

Under the bridge, rapid mixing was observed due to the high velocities and turbulent flow around the pylons. The plume was further dispersed by a boat driving through the plume immediately after the bridge. Similar to release 1 and 2, longitudinal spreading was greater than lateral spreading as the plume headed downstream, and after 10 minutes the plume was approximately 20 x 50 m. At 15 minutes, a vertical profile indicated dye was present over the entire water column. As per release 2, the plume remained in the primary channel and no dye excursion into the oyster leases was evident. Past Merimbula Wharf, some dye was visually observed entering the shallow sand bank area on the northern end of the inlet channel U-bend. The plume was tracked for another 10 minutes before it became difficult to visually track the plume. The boat was then driven ahead of the plume, and consecutive transects made across the width of the channel to capture the plume width and peak as it flowed past.

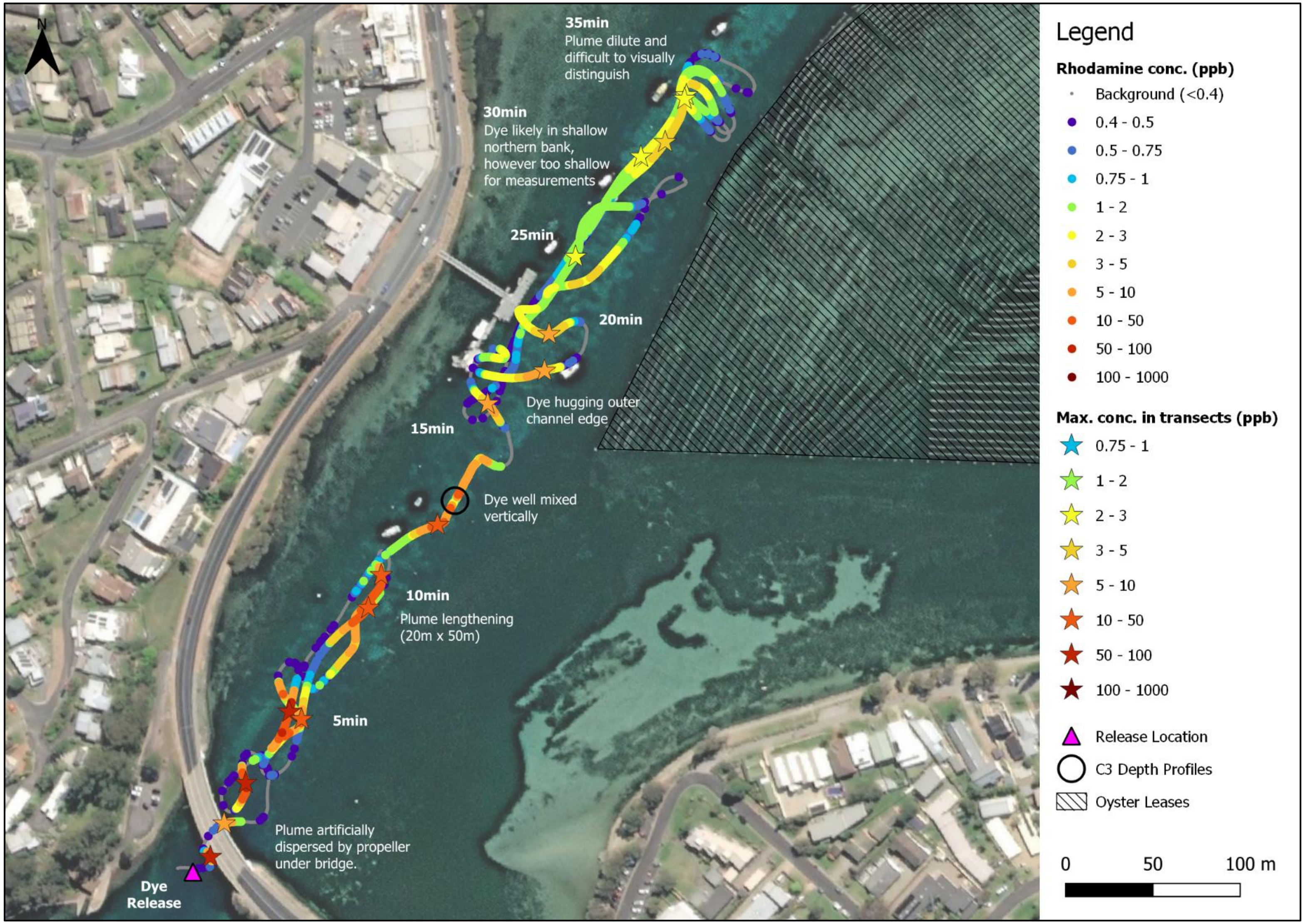

Figure 3-13 Dye release 3 at Merimbula Bridge. All observed concentrations (circles) and maximum concentration observed in select transects (stars)

3.5.4 Field derived dispersion values

Field dye experiments were used to obtain estimates of plume spreading dispersion rates in the Merimbula Lake estuary, using the methods described in WRL TR2023/32 Section 7.3. During each dye release, transects were taken across the plume to capture the plume width and peak concentration at a point in time. From the set of all transects, a subset of representative peak concentrations was compared to theoretical estimates of maximum plume concentrations over time. This is shown in Figure 3-14. To allow easy comparison, concentrations for all dye releases were scaled to match an initial release volume of 500 mL before plotting.

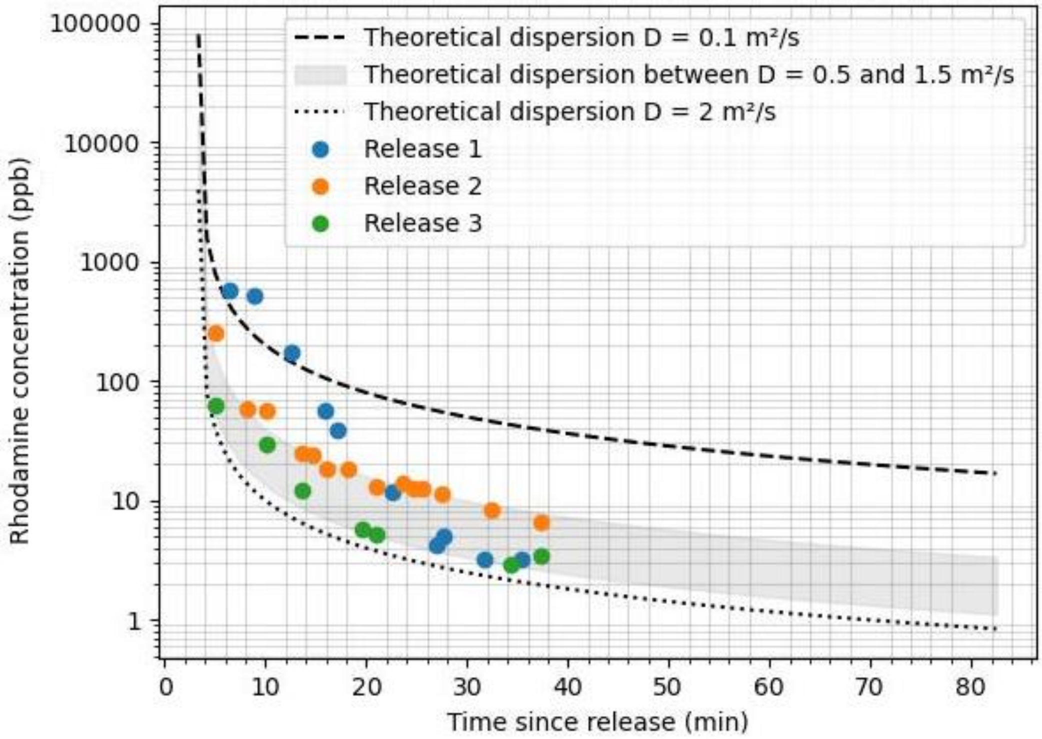

Figure 3-14 Peak concentration of transects plotted against theoretical dispersion

Measurements of field dispersion across the state for this project showed dispersion was spatially and temporally variable typically between D = 0.1 and 2 m^2/s, with the most common range being 0.5 to 1.5 m^2/s, which was consistent in Merimbula. When comparing the observed peak observations to theoretical dispersion, most field dispersion values fall within D = 0.5 to 1.5 m^2/s. The start of release 1 had a lower diffusion, possibly as it was released slightly to the side of the channel, however, diffusion increased about 30 minutes into the experiment in line with other observations.

3.6 GPS drifter drogue releases

To monitor surface current speeds and flow paths in the Merimbula estuary, GPS drifter drogues were deployed at strategic locations throughout the field campaign (refer to WRL TR2023/32 Section 4.5 for further information on drifter drogues). Drogues were released during dye releases 1 and 3 to aid plume tracking, with two additional drogue releases completed at various stages of the tide cycle (refer to Table 3-3). The GPS tracks for the drogue releases are shown in Appendix A1. A brief discussion of the observations is provided in this section.

Table 3-3 Summary of drogue releases

No.	Date	Time	Tide	Duration (h)	Location	Comments
1	04/07/2023	7.50am	Flood	3:30	Merimbula Bridge	
2	04/07/2023	8.34am	Flood	2:10	Merimbula inlet channel	Released with dye drop 1
3	04/07/2023	12.01pm	Ebb	0:45	SW of Merimbula Bridge	
4	04/07/2023	1.00pm	Ebb	1:00	Merimbula Bridge	Released with dye drop 3

Drogue releases 2 and 4 coincided with dye experiments outlined in Section 3.5. During the releases it was noted that the drogues were a reasonable proxy for the advection and longitudinal dispersion of dye in the river. Where drogues were released as a group, the drogues spread longitudinally along the river with the distance between the leading and trailing drogue a similar distance to the length of the dye plume at the corresponding location. For all drogue releases, it was noted that the drogues remained in the primary inlet channel and did not stray into slower moving sand banks and oyster harvest areas.

3.7 Conductivity measurements

Two conductivity profiles were recorded at Merimbula Lake Bridge near high and low tide with a Sontek EXO3, as detailed in WRL TR2023/32 Section 4.7. During both measurements, salinity measured was comparable to ocean water.

4 Model development

4.1 Preamble

The model used for this project consists of both a hydrodynamic and a water quality model. Initially, a hydrodynamic pilot model was developed which identified data gaps to be targeted during field data collection. After incorporating new data from the field, the hydrodynamic model was iteratively refined through calibration based on the MHL data collection campaign in 2003 and field data collected for this project in 2023. The hydrodynamic model was then used as an input for the water quality model. This model was informed by dye release experiments and was then used to run sewage overflow scenarios. A schematic of this process can be seen in Figure 4-1. For a detailed overview of the model development used for the broader project, refer to WRL TR2023/32 Sections 6 and 7.

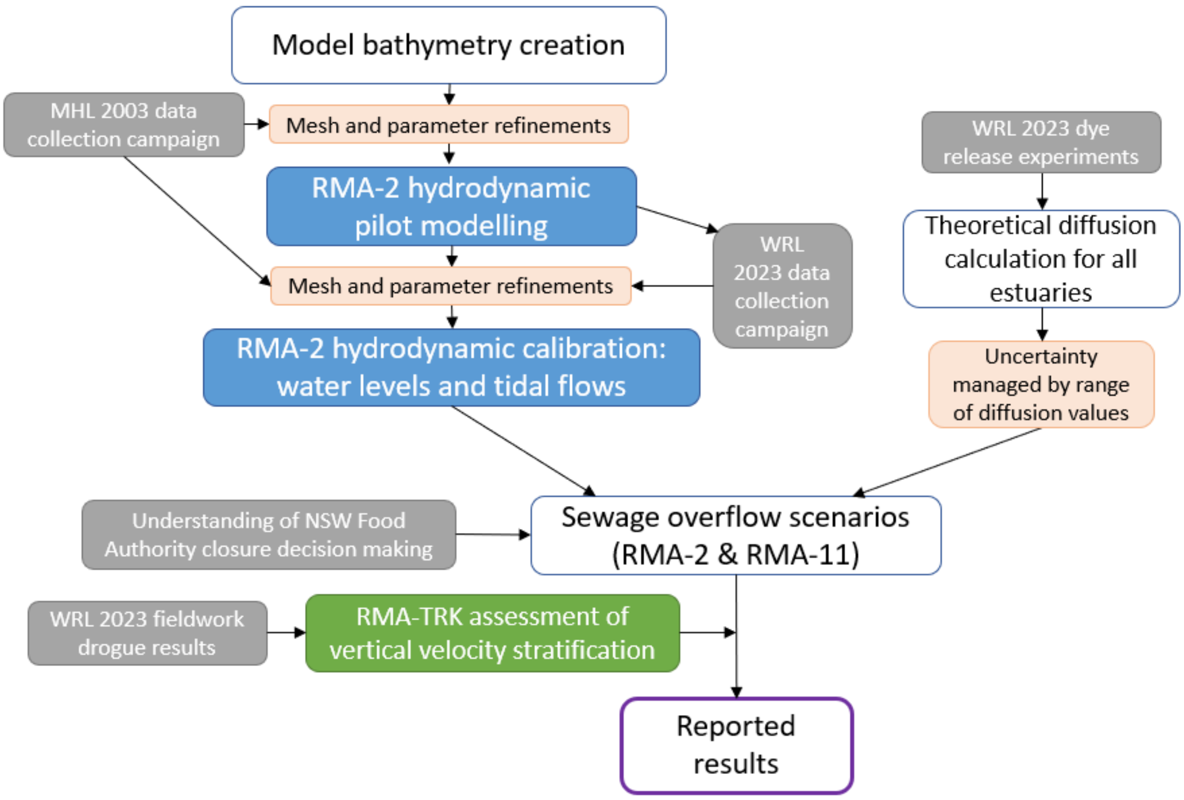

Figure 4-1 Overview of modelling approach

4.2 Model mesh development

The model domain extends from approximately 500 m offshore of the ocean entrance of Merimbula Lake estuary, to the tidal limits of the estuary and its major tributaries (refer to Figure 4-2). The model mesh consists of over 15,000 nodes and 6,800 elements varying in size from 10 m^2 to over 8,500 m^2. Mesh resolution is highest in the main inlet channel and under Merimbula Lake Bridge, with lower resolution in the upper lake system. A two-dimensional, depth averaged model mesh was chosen for Merimbula, where advective transport in the areas of interest (the channels) is largely driven by tidal and riverine flow (not wind). Wind would contribute to transport in the lake itself, which has been accounted for with an increased diffusion coefficient (see Section 4.7.1). This region is upstream of both the oyster harvest areas and the sewage overflows, which is the focus of this current study. A discussion on the impact of model dimensionality is provided in WRL TR2023/32 Section 6.2.2.

Mesh resolution is highest in the main entrance channel, around the bridge and around overflows, with lower resolution in the lake system. Refer to WRL TR2023/32 Section 6.2.3 for a discussion of model resolution.

4.3 Model bathymetry

Model bathymetry was based on the sources discussed in Section 2.5 and primarily utilised the 2018 DPIE (now DCCEEW) coastal marine LiDAR topo-bathy survey for the lower estuary. For regions outside of the LiDAR extent, the OEH 2003 single beam survey was used. NAVONICS (2023) SonarChart™ and NearMap imagery were used to inform sand bar bathymetry and channel edge locations in areas where no additional data was available. The NSW Spatial Services 1 m resolution DEM (2012) was used for shallow intertidal regions. The scour region south of Merimbula Lake Bridge reaches depths greater than -10 m AHD, however the majority of estuary channels are around -4 to -2 m AHD, with the lake around -8 to -4 m AHD. The model bathymetry and nodal bed elevations are shown in Figure 4-3.

Estuaries are dynamic systems and bathymetric changes through time will alter water levels, velocities, and tidal flows for the same set of boundary conditions. Depending on entrance conditions, friction losses across the entrance bar can reduce the tidal range within the lake by 25 to 40% compared with the ocean tide (Doherty et al., 2023). For the mean Eden tidal range of approximately 1.1 m, changes to entrance morphology may alter the lake water level range by up to 15 cm. This may have significant impacts on the water volume movement and velocity within the lake.

Because a deeper entrance condition is the predominant entrance state, and appears to be the state during both the MHL 2003 and 2023 fieldwork periods, this model was used for the hydrodynamic calibration and validation. A different entrance state would change the hydrodynamic behaviour of the estuary, however, as scenario results showed large impacts from all scenarios with a deep entrance state, it was not deemed necessary to simulate multiple entrance conditions.

4.4 Model boundaries

The model includes two upstream catchment flow boundaries, shown in Figure 4-2 and discussed in Section 2.3. A tidal elevation boundary was included in the model offshore of the Merimbula Inlet entrance (refer to Figure 4-2). This modelled water level boundary was based on observed tidal elevation data collected by MHL at Eden (station number 220470). This data was then smoothed to remove signal noise to increase model stability. For modelling water quality scenarios, all boundaries (upstream and ocean) were set to a constant constituent concentration of zero (e.g. no pollutant inflows from these boundaries).

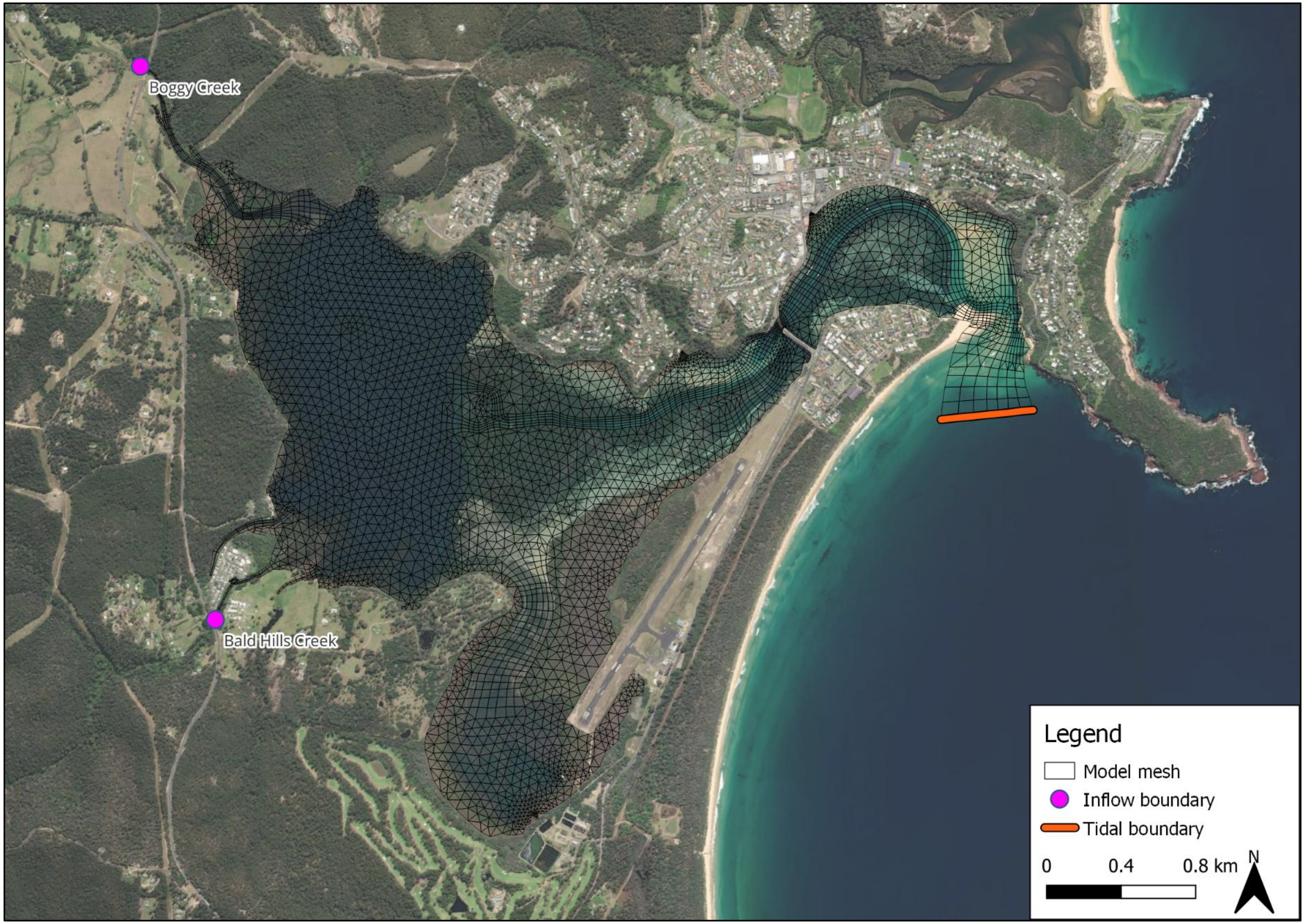

Figure 4-2 RMA model mesh showing boundary condition locations

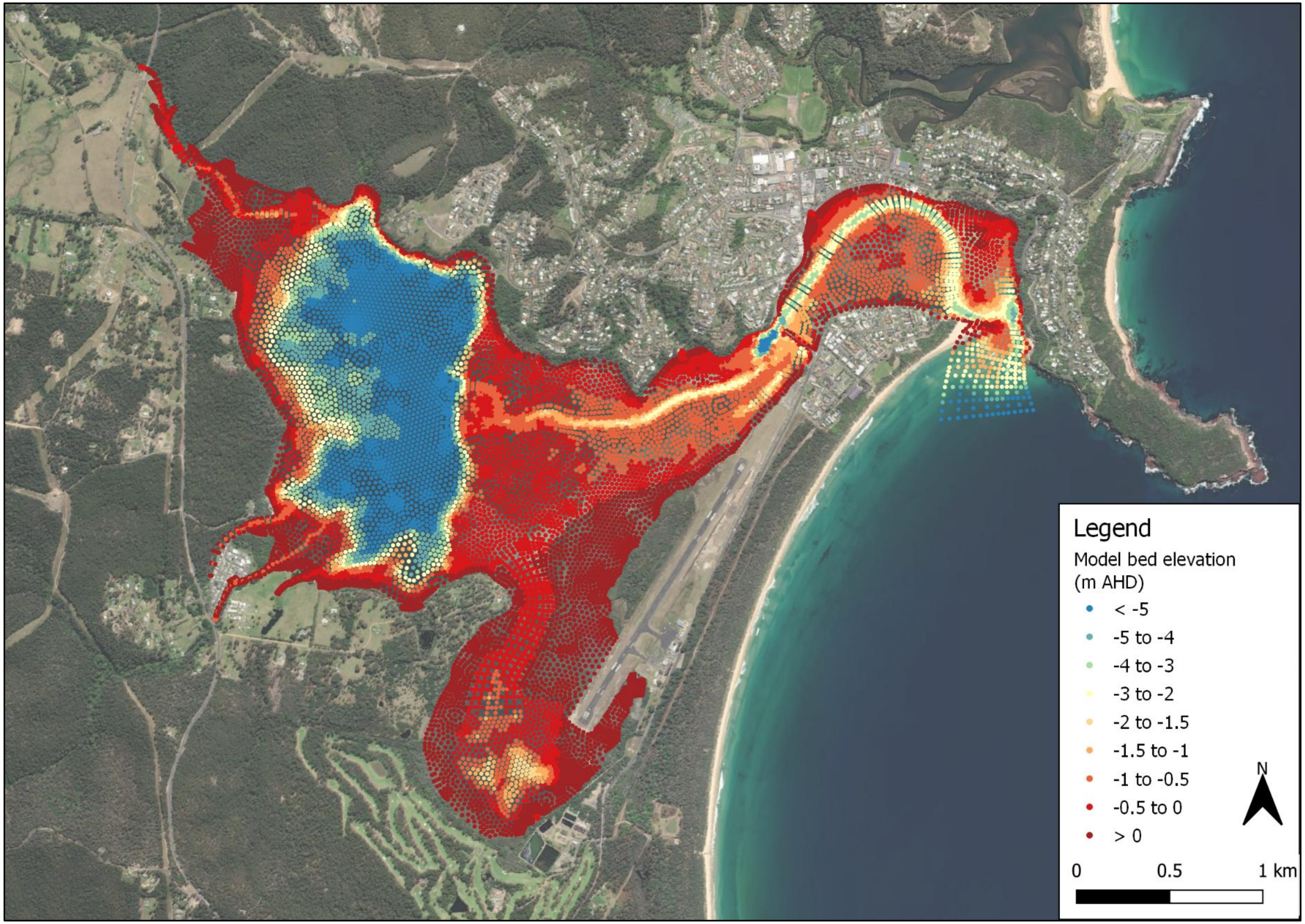

Figure 4-3 RMA model bathymetry

4.5 Pilot model

Initially, a hydrodynamic pilot model was developed using the existing data described in Section 2. For more details on pilot modelling and its purpose refer to WRL TR2023/32 Section 3. This initial modelling was used to identify data gaps to be targeted during fieldwork. The primary gaps identified were modern flow data and channel bathymetry data.

4.6 Hydrodynamic calibration

It is important for a hydrodynamic model to be able to replicate water levels, velocities and flow throughout the model domain. One appropriate preexisting set of hydrodynamic data was available, collected by MHL in 2003 and described in Section 2.2. This was supplemented by data from the 2023 fieldwork period, which targeted key stages of the tide but was not a full tidal flow gauging (refer to Section 3). Additional water level data was available from a long-term water level gauge managed by MHL, and a recently installed water level logger managed by NSW Food Authority (see Section 2.2). For each period, a minimum 3 day model warmup period was run.

4.6.1 September 2003 calibration period

During the 2003 MHL data collection campaign in Merimbula Lake estuary, tidal flow data was collected at one transect and water level data at six locations (refer to Section 2.2). The pilot model was calibrated to flow and water level for this period. Measured tide levels were applied at the ocean boundary and scaled catchment inflows were applied at the two upstream model inflow boundaries. Plots of all observed water level and flow compared with model results are shown in Appendix B1.1 and B1.2, while select results are shown below.

A reasonable model flow match was achieved for the gauging site at Merimbula Lake Bridge (Figure 4-4). Peak inflow, outflow and slack timing were matched, however, the peak magnitude of outgoing flow was below measured flow. The magnitude of inflow was well matched and the shape of the flow curve matched the observed data.

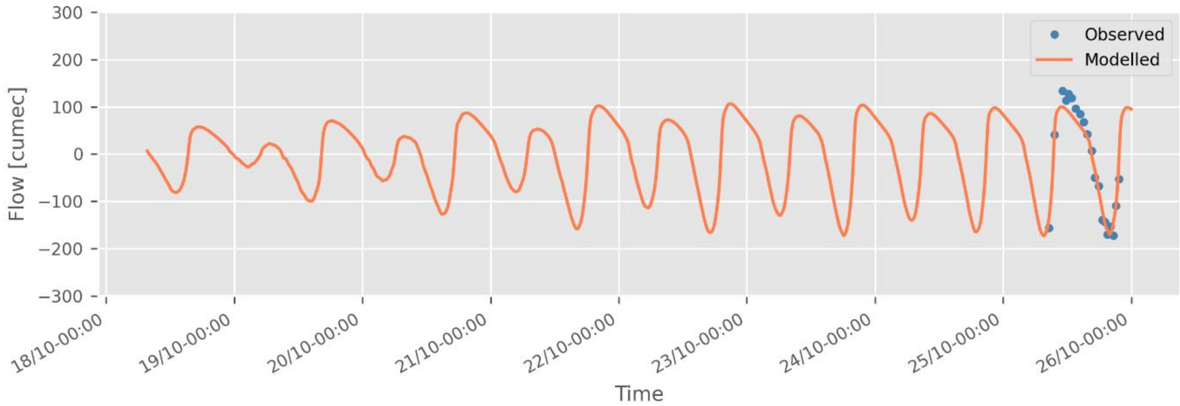

Figure 4-4 2003 tidal flow calibration – Location A – Merimbula Lake Bridge

A good model match was achieved for water levels at and downstream of Merimbula Lake Bridge. Model low tide water levels in the lake however were approximately 10 cm lower than measured water levels (see Figure 4-5 for example), indicating the model channel may be too efficient compared with the 2003 system. This may be due to the scouring which has occurred since 2003 at the bridge, discussed in Section 2.5. However, as scenario results showed large impacts from all scenarios with a deep entrance state, it was not deemed necessary to calibrate to different bathymetries or simulate multiple entrance states.

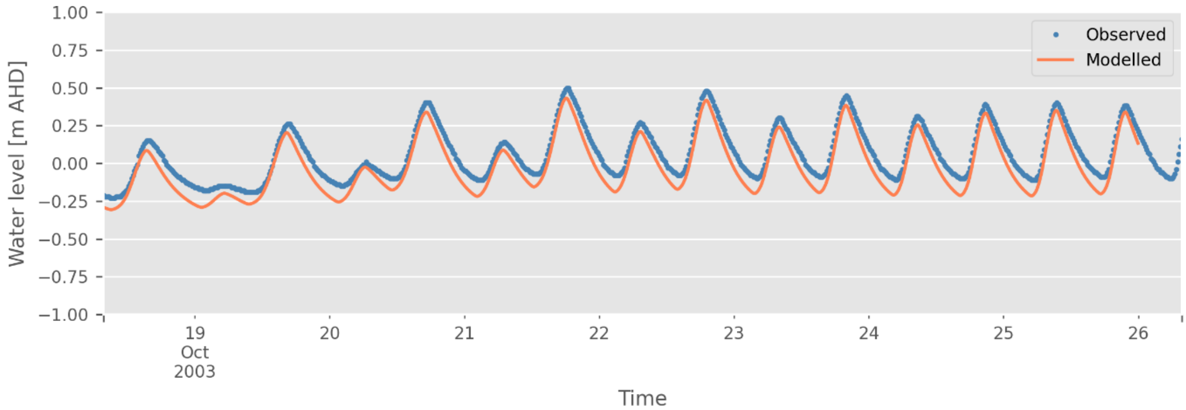

Figure 4-5 2003 water level calibration – Location 4 – Merimbula Lake Centre

4.6.2 July 2023 field data calibration period

The 2023 field campaign involved the collection of tidal flow gauging at two transects, and water level data at three locations (refer to Section 3). Measured tide levels were applied at the ocean boundary and scaled measured catchment inflows were applied at the two upstream model inflow boundaries. Model results were then compared with the observed data, using the same model parameters used for the 2003 model run. Plots of all observed water level and flow compared with model results are shown in Appendix B1.3 and B1.4, while select results are shown below. Note that the transect at the entrance sand bar was not used for calibration purposes.

Water level and flow results from the 2023 calibration show improved fit compared to the results from the 2003 calibration periods for all locations (see Figure 4-6 and Figure 4-7 for examples). This provides confidence that the model is fit for purpose and best suited for running present day overflow simulations.

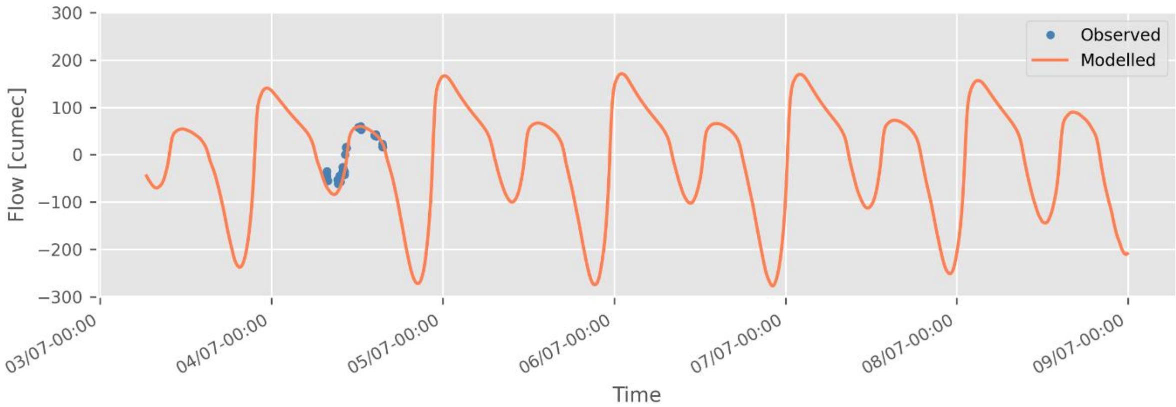

Figure 4-6 2023 tidal flow calibration – Location A – Merimbula Lake Bridge

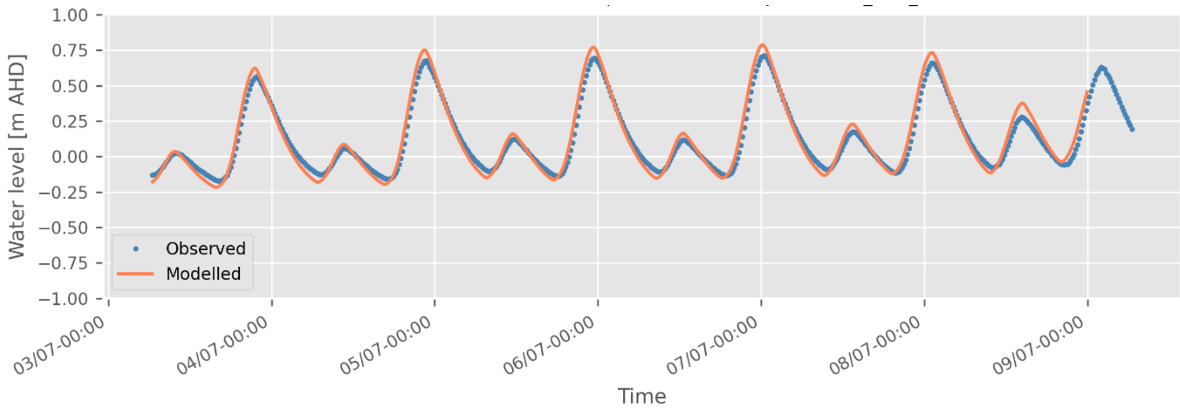

Figure 4-7 2003 water level calibration – Location 4 – Merimbula Lake Centre

4.6.3 Roughness coefficients

Table 4-1 lists the roughness coefficients (Manning's n) which control the frictional losses in the final calibrated model. Most areas have a coefficient between 0.02 and 0.03, which is typical for large sandy channels. The rip rap entrances to the lagoons have a higher frictional coefficient to account for the large amount of friction created by the rock.

Table 4-1 Mannings n roughness coefficients of the final model

Location	Manning's n roughness coefficient
Main channel from entrance to bridge	0.030
Main channel from bridge to lake	0.035
Lake	0.020
Seagrass beds and oyster leases	0.035
Intertidal areas	0.050
Channel to southern embayment	0.030
Sand shoals near the entrance	0.020
Tributaries	0.035

4.7 Water quality model

4.7.1 Modelling of dispersion in RMA-11

Dye dispersion experiments, discussed in Section 3.5, provided valuable information on dispersion and its simulation in modelling. In particular, they provided evidence for a sensible range of dispersion coefficients to use in the modelling. However, it was concluded that they could not be used to produce estuary specific values for dispersion. Hence, a range of dispersion values derived from the field experiments was used across all the estuaries. Models were run with two dispersion coefficients, 0.5 and 1.5 m^2/s in the channels, and the scenario results presented are a combination of the two to manage the uncertainty in dispersion. For further details on how these dispersion values were determined, sensitivity testing, and how model results were combined refer to WRL TR2023/32 Section 7.3, 7.4 and 8.2.3.

A single dispersion coefficient of 4 m^2/s was used in the lake to capture potential dispersion from wind driven mixing. The RMA-11 model utilised a 3 minute timestep, with results output every 30 minutes. For select scenarios, where greater temporal resolution was required, results were output every 6 minutes.

4.7.2 Tidal straining and vertical velocity distribution

As outlined in WRL TR2023/32 Section 7.5, tidal straining is a process leading to asymmetrical vertical velocity distributions in some estuaries. In instances of tidal straining, much higher velocities are observed at the surface than at the bed on the ebb tide, with much less velocity difference observed on the flood tide. Using the methods described in WRL TR2023/32 Section 7.5, RMA-TRK (Lagrangian model) was used to compare the travel times from field observations with drifter drogues (see Section 3.6) with modelled transport. Table 4-2 shows the difference in drogue velocity and velocity of particles released in the model at the same location and time, plus the ratio between the two.

In the Merimbula system, ratios were close to one, indicating that vertical velocity profiles in the system were close to depth averaged (consistent with observations from the tidal flow gauging). Hence no timing adjustments were required for this system.

Table 4-2 Summary of RMA-11 velocity factors calculated from GPS drifter drogues

Drogue release	Location	Tide	Average drogue velocity (km/h)	Average model particle velocity (km/h)	Average ratio (velocity factor)
1	Merimbula Bridge	Flood	1.36	0.99	1.37
2	Merimbula Inlet channel	Flood	0.74	0.79	0.94
3	SW of Merimbula Bridge	Ebb	0.92	0.77	1.19
4	Merimbula Bridge	Ebb	1.23	1.63	0.75

4.8 Limitations for future model uses

This model has been constructed and calibrated to be fit for the purpose of modelling sewage overflow transport from the modelled locations to oyster harvest areas. The model may be adapted for other uses, however, the limitations must be considered. A general discussion on the limitations of applying these models to other use cases can be found in WRL TR2023/32 Section 6.6.

Limitations specific to the Merimbula Lake model include:

- The lake transport processes are likely to be driven by wind, not captured in this model. Uncertainty about the lake transport processes for the Merimbula WWTP location (in the main lake) are dealt with by having a higher diffusion coefficient of 4 m^2/s in the lake. However, future modelling purposes may wish to simulate lake transport processes explicitly through the addition of wind as an input.
- This estuary has a dynamic, untrained entrance which can change the tidal prism drastically (Doherty et al., 2023). This was not deemed to be necessary to simulate for this project, as scenario results showed large impacts from all scenarios with a deep, open entrance state. Thus it was not deemed necessary to simulate multiple entrance conditions. This is unlikely to be true for other use cases.
- Due to the limited amount of preexisting hydrodynamic data for this estuary, the 2023 field data was used as further calibration data rather than separate verification (validation) data as it was on some other estuaries. Thus, this model is not validated. This was deemed acceptable for this purpose, however, may not be for other use cases. This is discussed further in WRL TR2023/32 Section 6.4.
- There is no catchment gauging in the Merimbula Lake catchment, and stream flow data from a nearby catchment has been used instead. This was deemed acceptable for this model, as the catchment was very small relative to the lake and results varied little with catchment inflows, however, may not be acceptable for other use cases.

5 Scenario modelling

5.1 Preamble

A detailed description for the methods of scenario modelling for this project can be found in WRL TR2023/32 Section 8. For Merimbula, a total of 51 model scenario simulations were completed, including permutations of:

- Three overflow locations
- Four stages of the tide
- Three catchment inflow conditions
- Three overflow volumes and duration

Reporting focused on the minimum dilution observed in each harvest area (during the 21 day scenario) and the time taken for the plume to reach each harvest area at 5,000,000 times dilution. Refer to WRL TR2023/32 Section 8.3 for more information. In situations where multiple scenarios gave very similar results, these scenarios were grouped for ease of use, and the worst case results (minimum dilution and shortest travel time) were reported, as detailed in WRL TR2023/32 Section 8.3.6.

The results of all modelled scenarios have been compiled into a user-friendly HTML tool. A description of the tool and its use can be found in the User Guide (WRL TR2024/26).

5.2 Overflow locations

Three locations were used to simulate overflow locations into the Merimbula estuary. These locations were based on historical overflow events (Section 2.4) and input from NSW Food Authority. These locations typically correspond to creek lines or infrastructure where sewage may be directed to following an overflow. The model only considers overflows from the moment they enter the estuary surface water system. Containment prior to reaching the estuary may still be effective. A judgement of whether the overflow reached the estuary should be made in consultation with local authorities to determine if the modelled scenarios need to be consulted. Moreover, in situations where there is a delay between the overflow occurrence and the time it reaches the estuary, this delay and related uncertainty needs to be considered when determining which stage of the tide scenario to use. If it is uncertain which scenario timing should be used, use the possible timing which results in the worst case scenario. Modelled overflow locations are shown in Figure 5-1.

At each overflow location, three different overflow conditions were considered:

1. 10 kL overflow over 1 hour (10 kL/hr)
2. 30 kL overflow over 3 hours (10 kL/hr)
3. 100 kL overflow over 10 hours (10 kL/hr)

The rate of discharge (10 kL/hr) was kept constant between each condition. This is equivalent to a rate of approximately 3 L/s. Intermediate results can be inferred for overflows of the same duration, but a different volume. See WRL TR2023/32 Section 8.3.3 for details on how to do this.

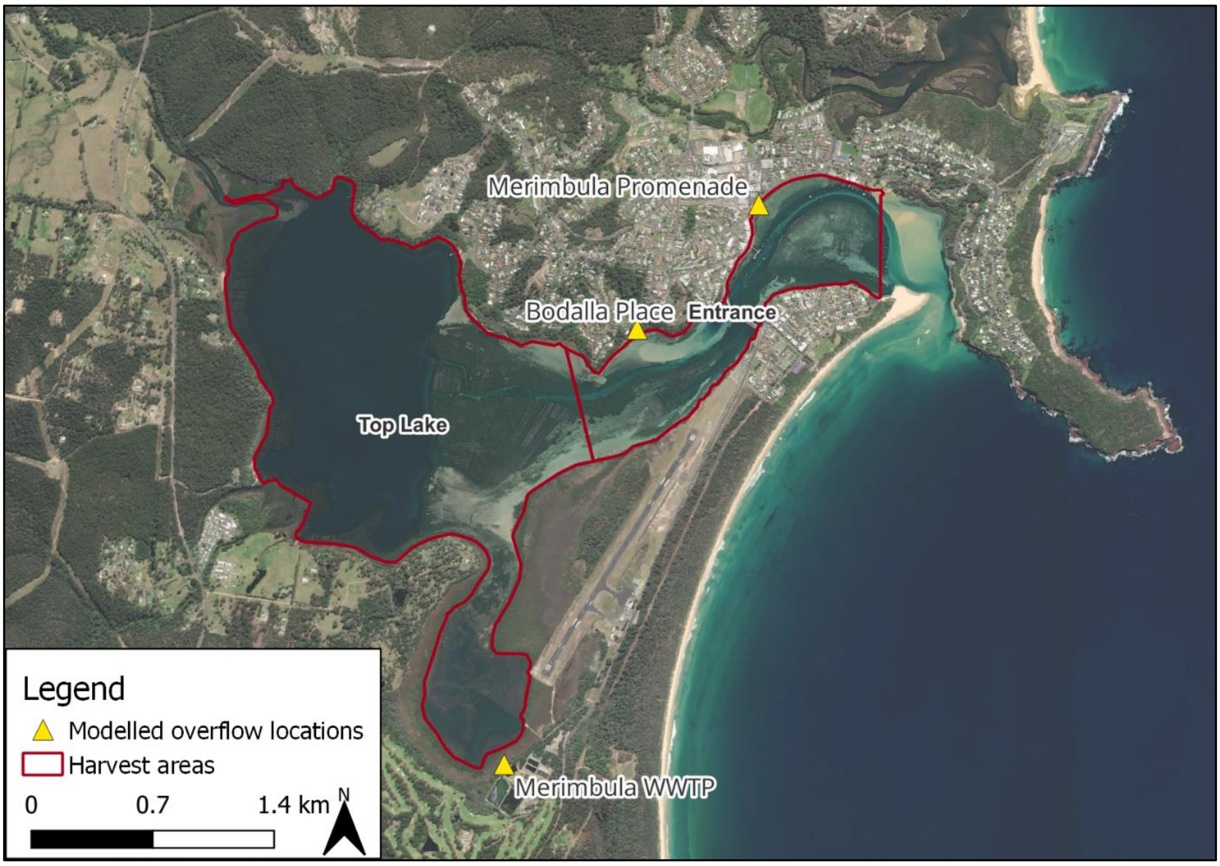

Figure 5-1 Modelled overflow locations in Merimbula Lake

5.3 Environmental variables

Two environmental variables were tested for Merimbula:

1. Stage of the tide (slack low tide, slack high tide, mid ebb tide and mid flood tide)
2. Magnitude of catchment inflows (median, 80th percentile and 95th percentile)

5.3.1 Stage of the tide

Stage of the tide for all locations is indexed to the MHL water level gauge at Merimbula Wharf, via the relationship described in Table 5-1.

Table 5-1: Model stage of tide timing relative to the MHL water level gauges

Overflow location	Results scenario	MHL water level gauge	Water level at start of spill
All locations	Slack low tide	Merimbula Wharf (220410)	Low tide
All locations	Mid flood tide	Merimbula Wharf (220410)	Half way between low and high tide
All locations	Slack high tide	Merimbula Wharf (220410)	High tide
All locations	Mid ebb tide	Merimbula Wharf (220410)	Half way between high and low tide

The stage of the tide affects plume transport for overflows from Merimbula Promenade and Bodalla Place, however, all overflows from this location of at least 1 kL affect all harvest areas at a high concentration. Figure 5-2 and Figure 5-3 show changes to the plume shape with overflows from Merimbula Promenade at both high and low tides. Because overflows from the Merimbula township flow onto a shallow, slow moving, 150 m wide intertidal area before reaching the channel, overflows are unable to be completely flushed out of the estuary, even when occulting at slack high tide. A more closed entrance condition would decrease flushing even further. Thus, impacts to this estuary are always severe.

For ease of use, results for overflows on different stages of the tide have been combined when management implications were the same. See WRL TR2023/32 Section 8.3.4 for more details on scenario grouping.

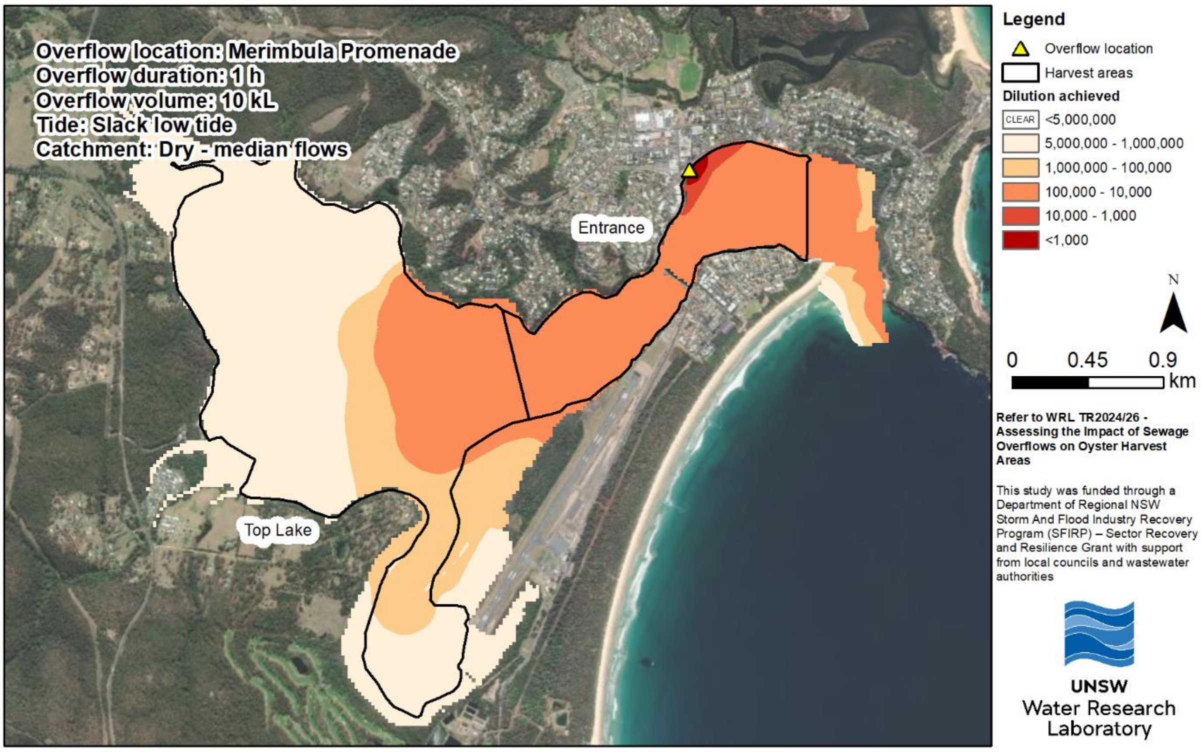

Figure 5-2 Example of a 1 hour overflow at Merimbula Promenade at slack low tide*

*Result figures present the minimum dilution (i.e. maximum concentration) observed at each point during the entire scenario period (21 days).

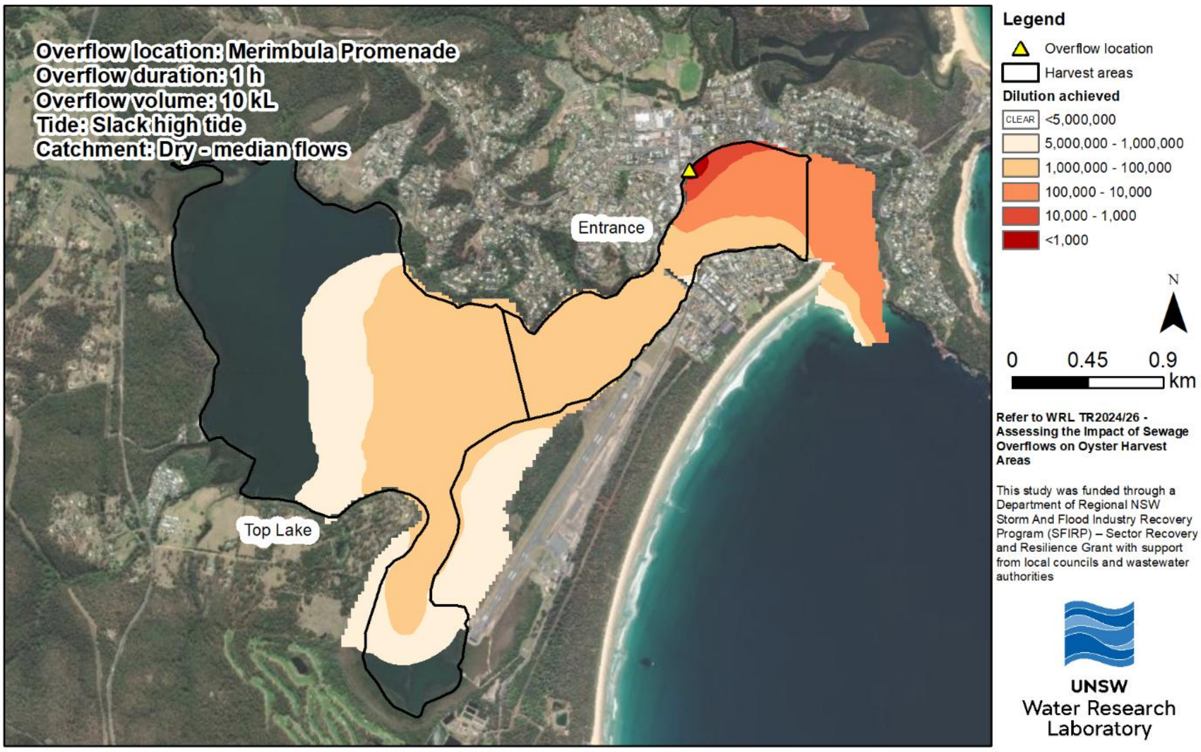

Figure 5-3 Example of a 1 hour overflow at Merimbula Promenade at slack high tide*

*Result figures present the minimum dilution (i.e. maximum concentration) observed at each point during the entire scenario period (21 days).

5.3.2 Catchment inflows

Catchment inflow had negligible effect on plume transport, thus a full suite of catchment inflow conditions was not simulated. Multiple catchment inflow scenarios were only run for 1 hour overflows. For context, due to the very small catchment, the total catchment inflows (from both upstream boundaries into the model, shown in Figure 4-2) for the 95th percentile flow is approximately 1 m^3/s. This is less than 0.5% of the peak tidal flows through the entrance, which highlights the relative importance of tidal flows in transport and dilution of overflows in this estuary. For ease of use, results for different catchment inflow have been combined when multiple catchment inflow scenarios were run, and in cases where only the median case was run, the scenario has been labelled to apply to all catchment inflow conditions (sub-runs are not available in this case). See WRL TR2023/32 Section 8.3.4 for more details on scenario grouping.

6 Conclusion

This report is focussed on the Merimbula Lake study and produced for the study "Assessing the impact of sewage overflows on oyster harvest areas in NSW". The purpose of this report was to provide technical and estuary specific information on the process and data sources used to create the Merimbula Lake model. Key information included in the report relates to the integration of existing data sources, the July 2023 field data collection campaign, data processing and model development.

This report should be read in conjunction with WRL TR2023/32 which provides details on the technical methods used across each of the 11 study estuaries (including Merimbula) and discussions on modelling limitations including model parameter sensitivity and pollutant dispersion. Results of the scenario modelling is available in the accompanying tool, which is documented in the User Guide (WRL TR2024/26).

7 References

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Appendix A Field data collection

A1 Drifter drogue experiments

The below figures summarise the behaviour of the four drifter drogue experiments. For more information on these deployments, refer to Section 3.5.4.

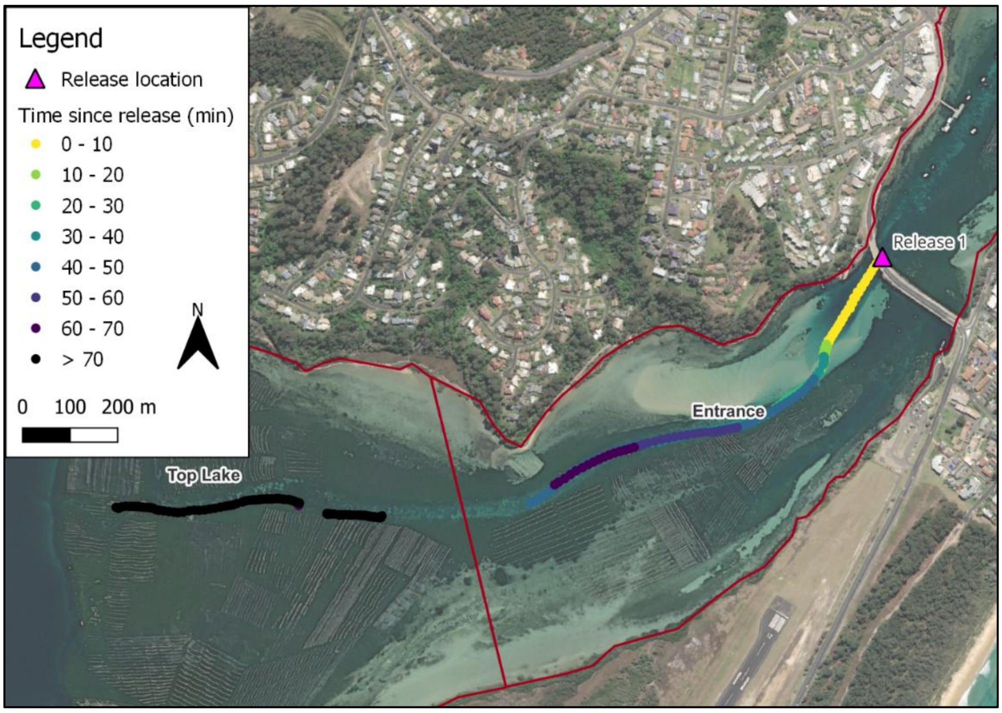

Figure A-1 GPS drifter drogue release 1 – Merimbula Lake Bridge – incoming tide

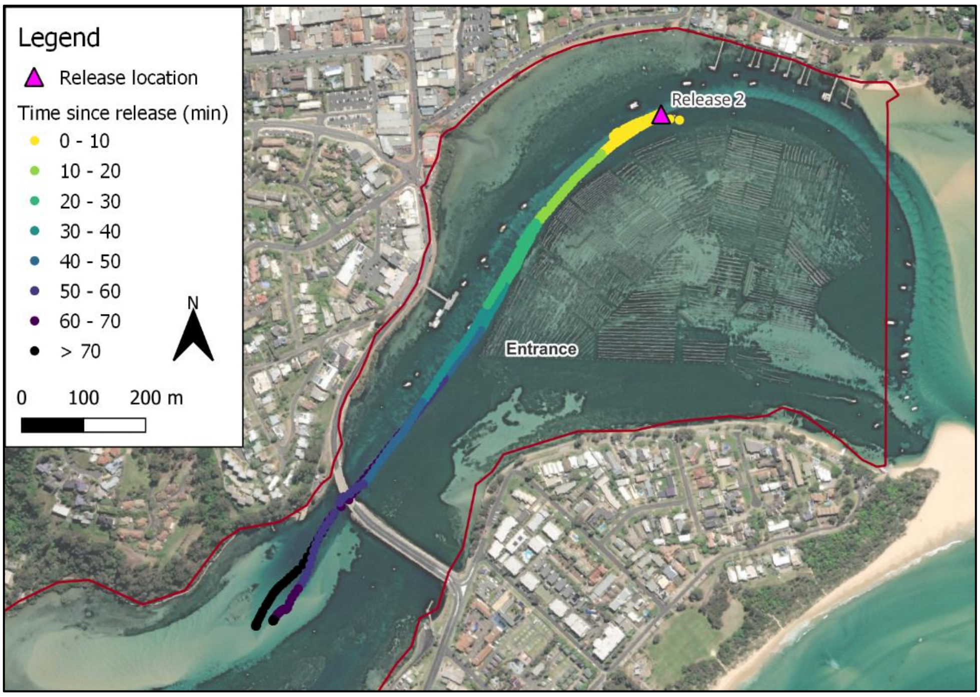

Figure A-2 GPS drifter drogue release 2 – northern edge of inlet channel – incoming tide

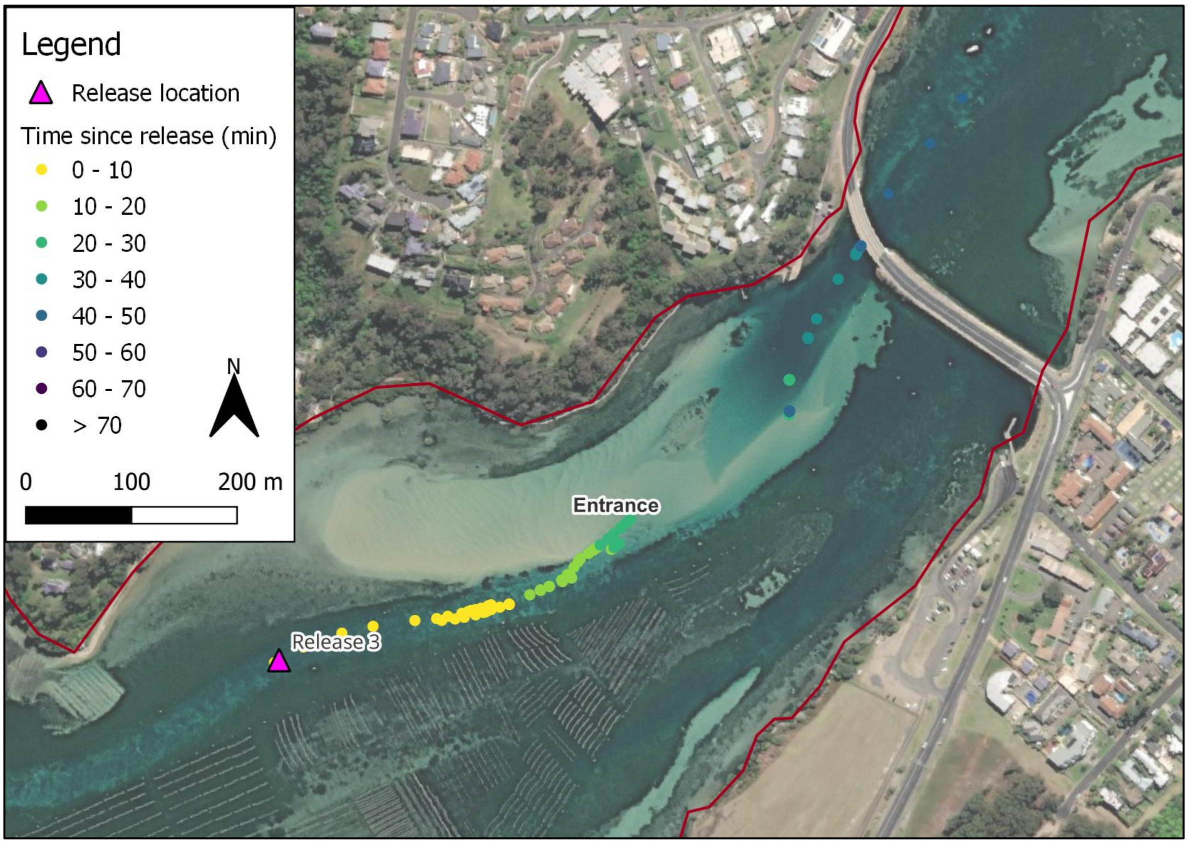

Figure A-3 GPS drifter drogue release 3 – Southwest of Merimbula Lake Bridge – outgoing tide

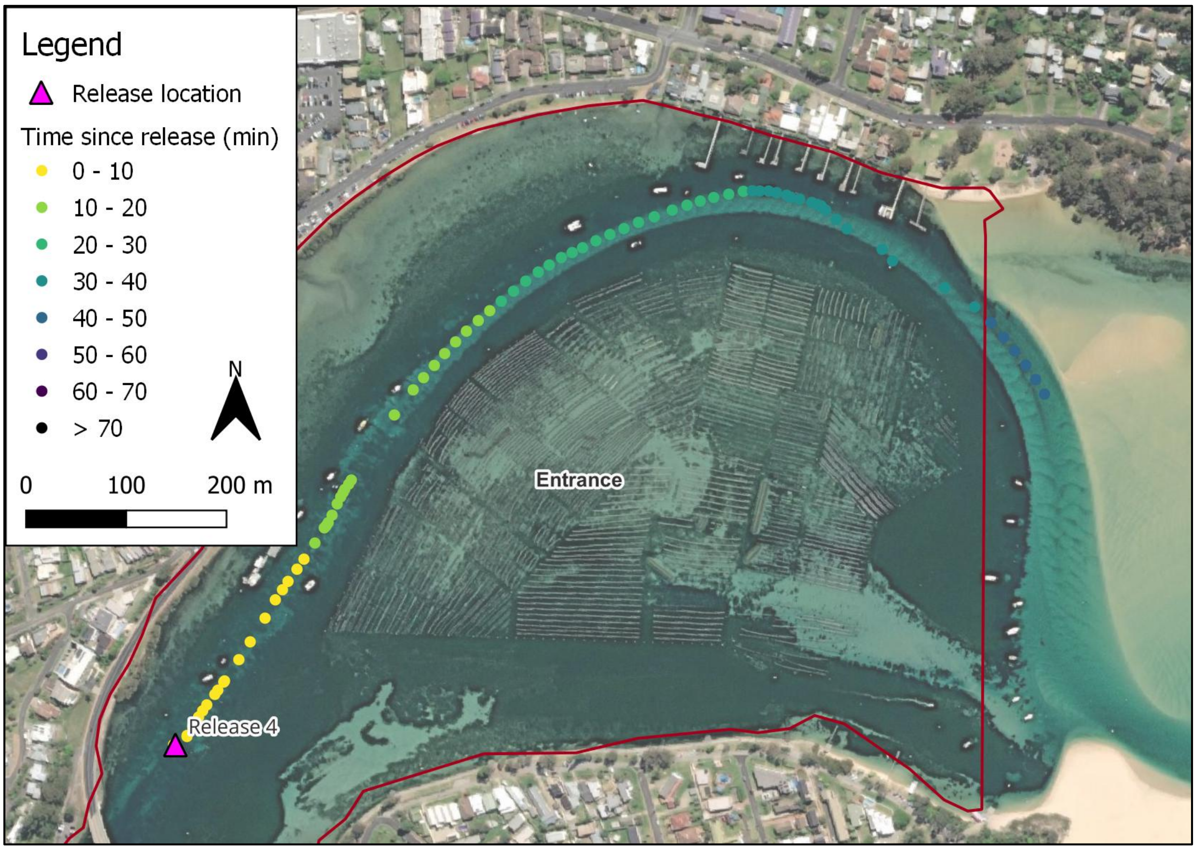

Figure A-4 GPS drifter drogue release 4 – Merimbula Lake Bridge – outgoing tide

A2 Tidal flow gauging

The below figures summarise tidal flow gauging results from the 2023 field campaign. For more information, refer to Section 3.3.

Table A-1 Merimbula Bridge 2023 tidal flow gauging

No.	Date	Time	Flow (m^3/s) *
1	04/07/2023	7:42:42	-41
2	04/07/2023	7:45:49	-46
3	04/07/2023	7:47:37	-35
4	04/07/2023	7:52:56	-55
5	04/07/2023	9:16:15	-53
6	04/07/2023	9:18:41	-61
7	04/07/2023	9:20:37	-52
8	04/07/2023	9:31:22	-44
9	04/07/2023	9:33:12	-48
10	04/07/2023	9:34:45	-52
11	04/07/2023	9:36:43	-53
12	04/07/2023	9:38:37	-57
13	04/07/2023	9:51:52	-39
14	04/07/2023	9:53:58	-40
15	04/07/2023	9:56:04	-36
16	04/07/2023	9:58:15	-26
17	04/07/2023	10:00:42	-27
18	04/07/2023	10:05:47	-42
19	04/07/2023	10:08:16	-39
20	04/07/2023	10:10:14	-40
21	04/07/2023	10:12:23	-42
22	04/07/2023	10:14:42	-36

No.	Date	Time	Flow (m^3/s) *
23	04/07/2023	10:16:31	0
24	04/07/2023	10:26:33	14
25	04/07/2023	10:28:42	16
26	04/07/2023	10:30:46	14
27	04/07/2023	12:10:14	58
28	04/07/2023	12:12:09	57
29	04/07/2023	12:31:19	60
30	04/07/2023	12:33:04	55
31	04/07/2023	12:35:32	53
32	04/07/2023	14:25:52	41
33	04/07/2023	14:28:00	40
34	04/07/2023	14:38:25	43
35	04/07/2023	14:40:32	39
36	04/07/2023	15:30:39	23
37	04/07/2023	15:33:39	16
38	04/07/2023	15:35:17	16

* Flow sign relative to upstream river flow direction. Outgoing ebb flows are positive, while incoming flood flows are negative.

Table A-2 Merimbula Entrance Channel 2023 tidal flow gauging

No.	Date	Time	Flow (m^3/s) *
1	04/07/2023	13:55:12	58
2	04/07/2023	13:53:48	65

* Flow sign relative to upstream river flow direction. Outgoing ebb flows are positive, while incoming flood flows are negative.

A3 Channel flow distribution

The below figures summarise velocity distribution results from the 2023 field campaign. For more information, refer to Section 3.3. Note that all measurements are at a different stage of the tidal cycle so the magnitude of flow will vary. The primary purpose is to illustrate flow distribution across the channel.

Figure A-5 Outgoing channel flow distribution at Merimbula Lake Bridge

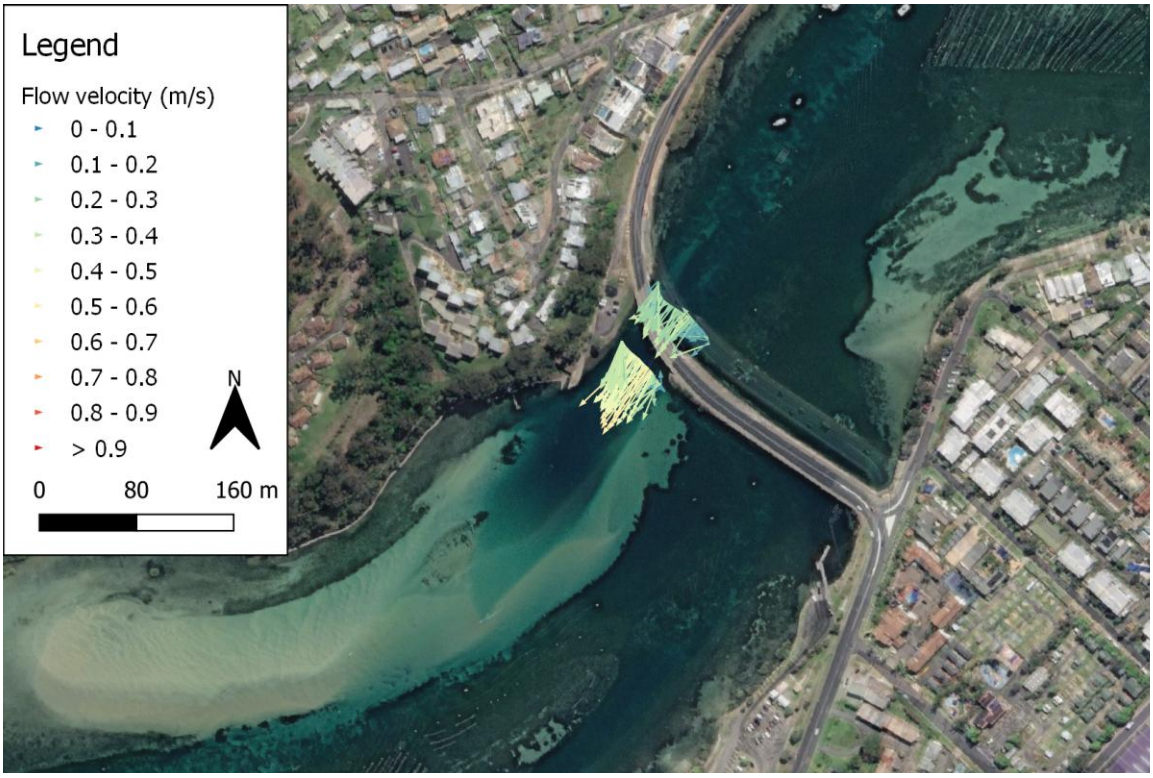

Figure A-6 Incoming channel flow distribution at Merimbula Lake Bridge

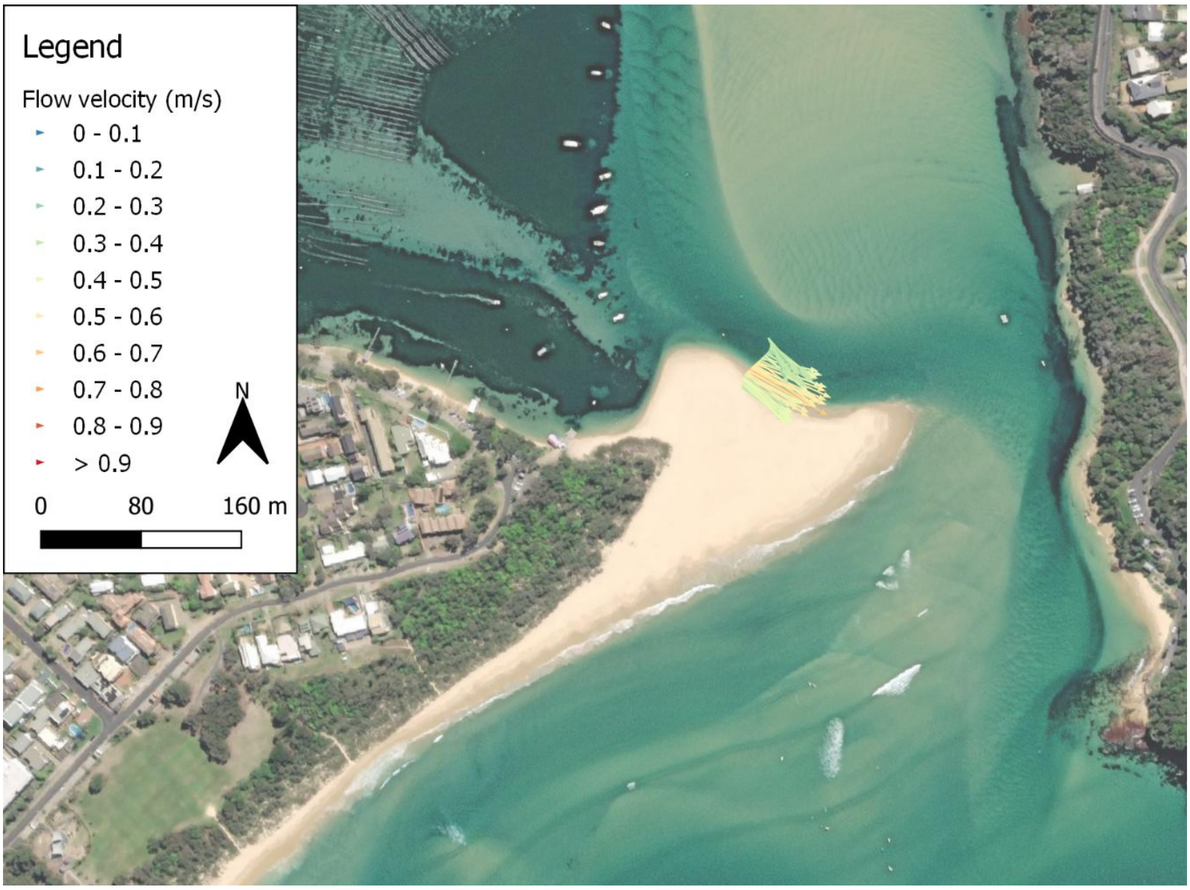

Figure A-7 Outgoing channel flow distribution at Merimbula entrance

A4 Vertical velocity distributions

The following figures show the vertical distribution of horizontal speed for select transects measured during the 2023 field campaign. This was used to help assess whether vertical velocity stratification was significant. For more information, refer to Section 3.3 and 4.7.2. Bathymetry sometimes varies between ebb and flood transects because transects were not always taken at the exact same location due to boat manoeuvrability limitations. Transects were usually taken within a 50 m reach in which flow would be equivalent.

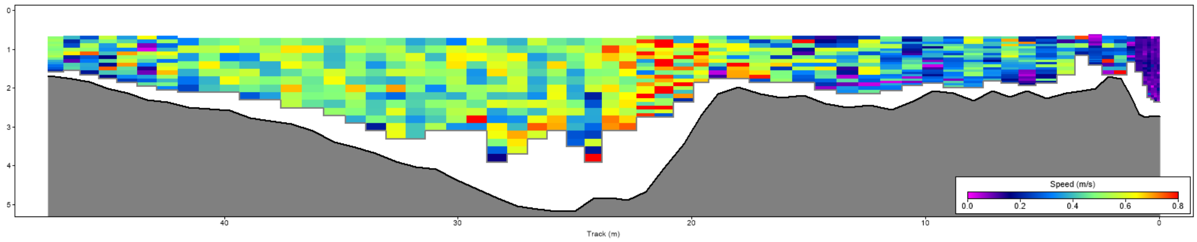

Figure A-8 Vertical velocity distribution – Merimbula Lake Bridge – South– Incoming flow – (2023/07/04 09:38:07)

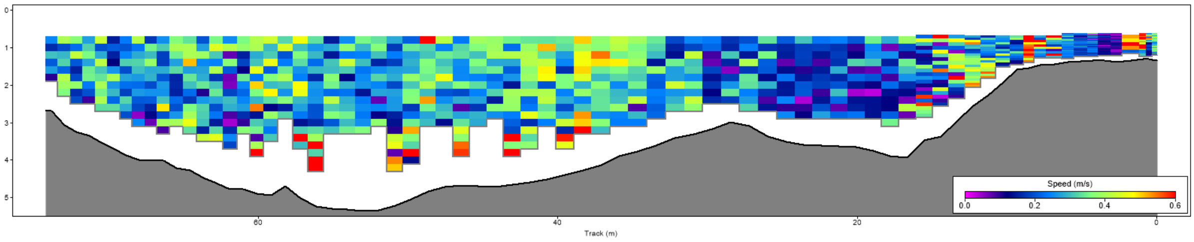

Figure A-9 Vertical velocity distribution – Merimbula Lake Bridge – North – Incoming flow – (2023/07/04 09:18:41)

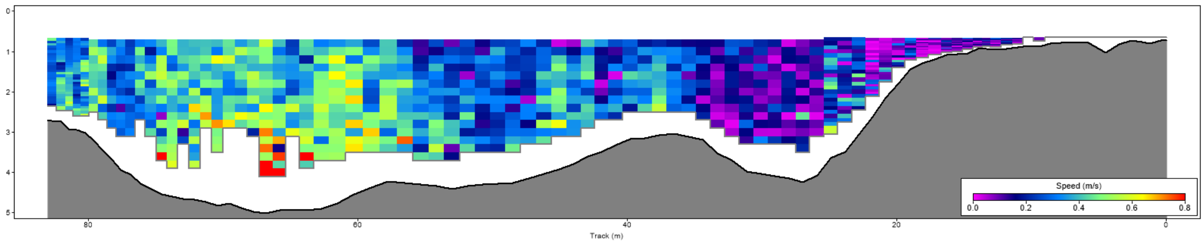

Figure A-10 Vertical velocity distribution – Merimbula Lake Bridge – North – Outgoing flow – (2023/07/04 12:35:32)

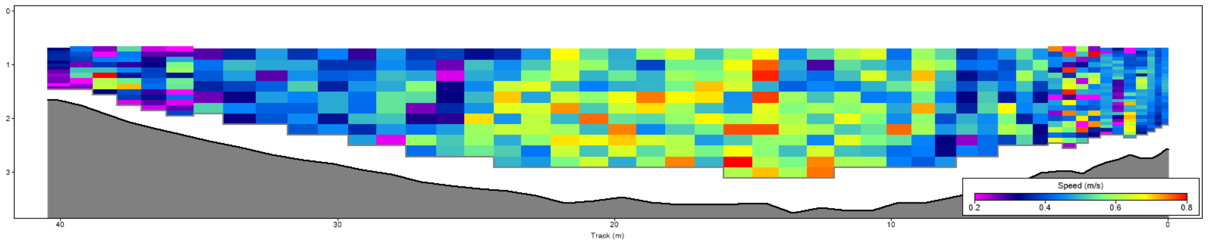

Figure A-11 Vertical velocity distribution – Merimbula Entrance Channel – Outgoing flow – (2023/07/04 09:18:41)

Appendix B Model calibration

B1 Hydrodynamic calibration results

The below figures summarise results from the Merimbula Lake estuary hydrodynamic calibration process. For more information, refer to Section 4.5.

Figure B-1 Water level and tidal flow gauging locations

B1.1 Tidal flow gauging calibration – 2003

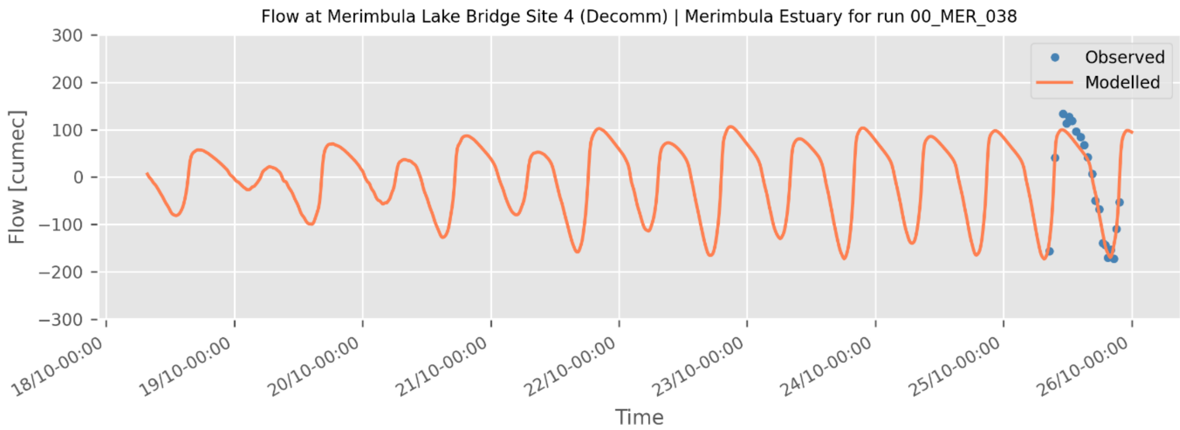

Figure B-2 2003 tidal flow calibration – Location A – Merimbula Lake Bridge

B1.2 Water level calibration – 2003

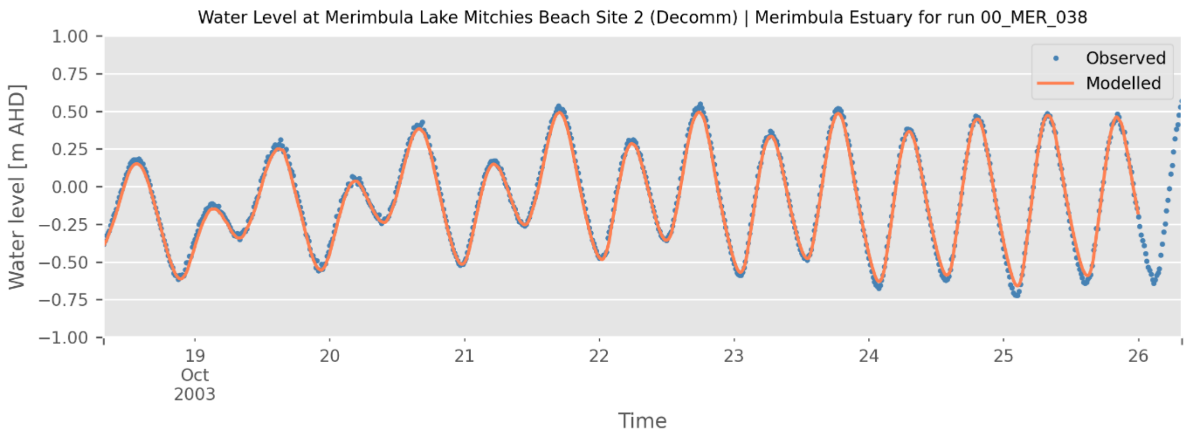

Figure B-3 2003 water level calibration – Location 1 – Merimbula Lake Mitchies Beach

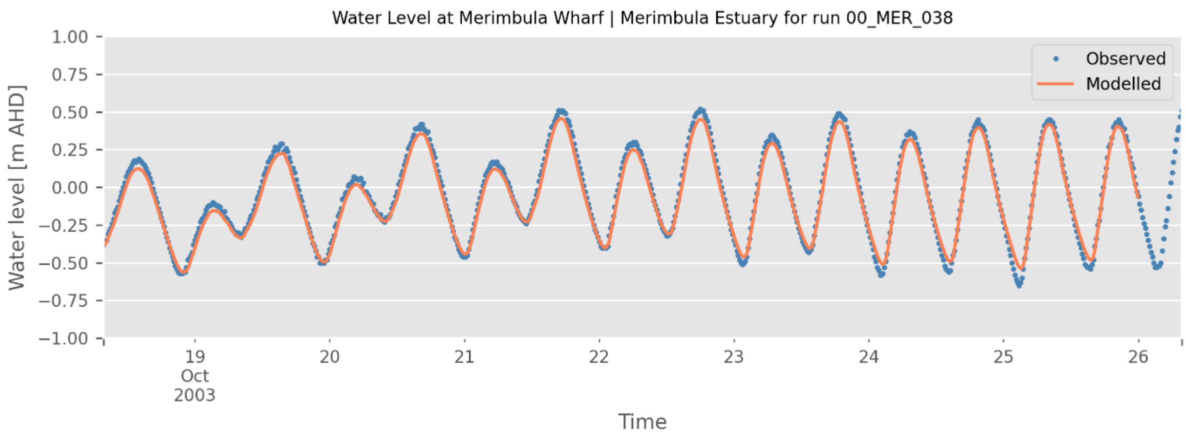

Figure B-4 2003 water level calibration – Location 2 – Merimbula Wharf

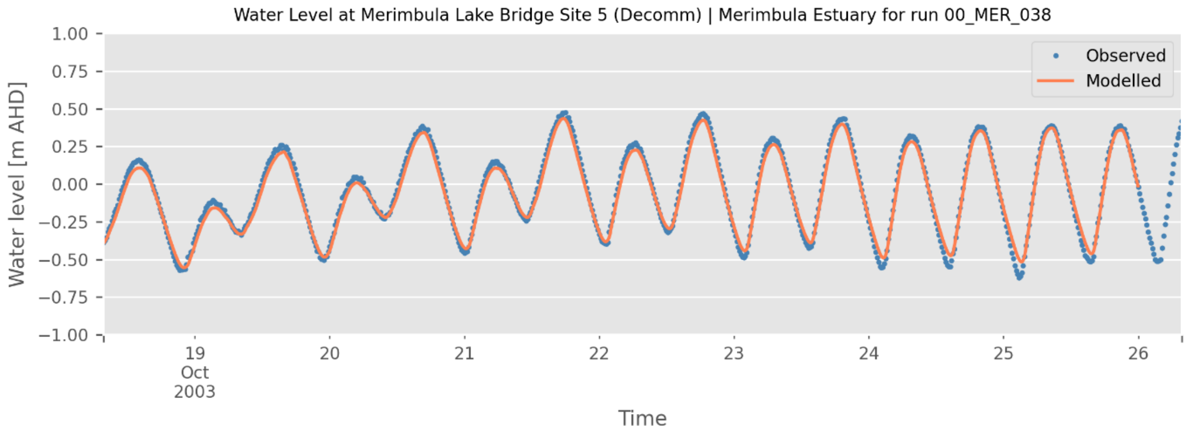

Figure B-5 2003 water level calibration – Location 3 – Merimbula Lake Bridge

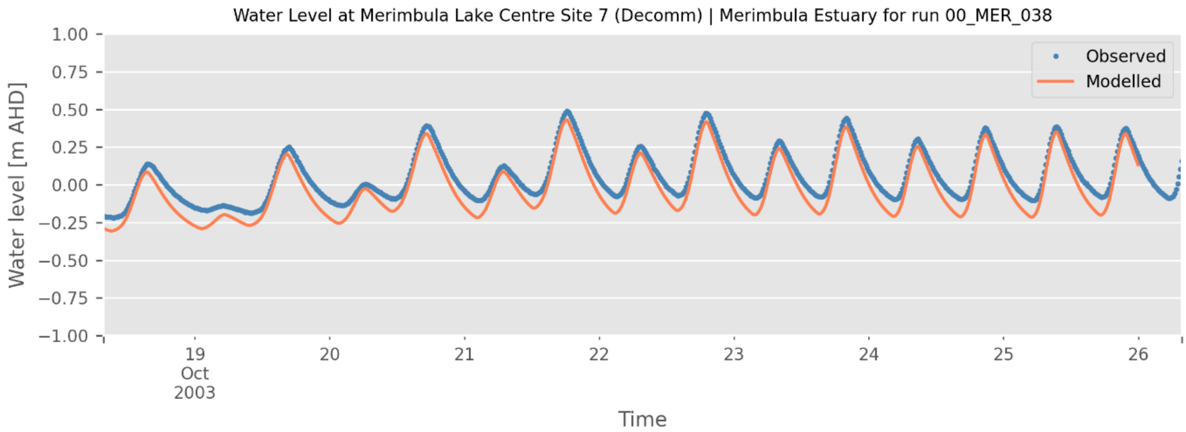

Figure B-6 2003 water level calibration – Location 4 – Merimbula Lake Centre

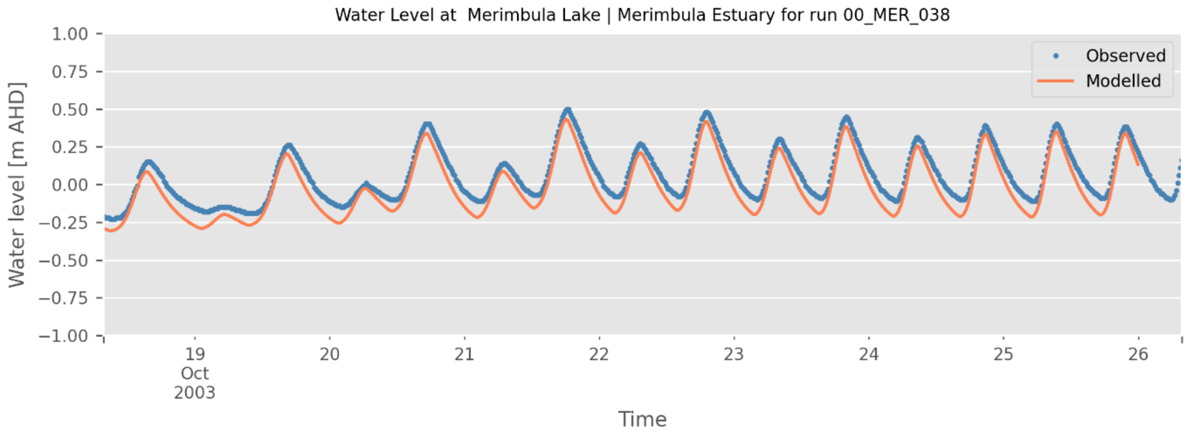

Figure B-7 2003 water level calibration – Location 5 – Merimbula Lake (MHL)

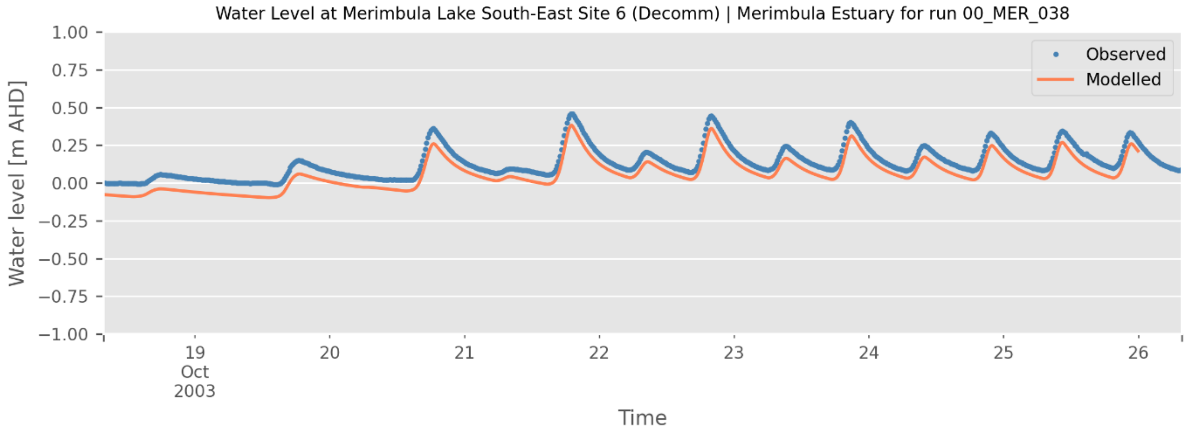

Figure B-8 2003 water level calibration – Location 6 – Merimbula Lake South

B1.3 Tidal flow gauging calibration – 2023

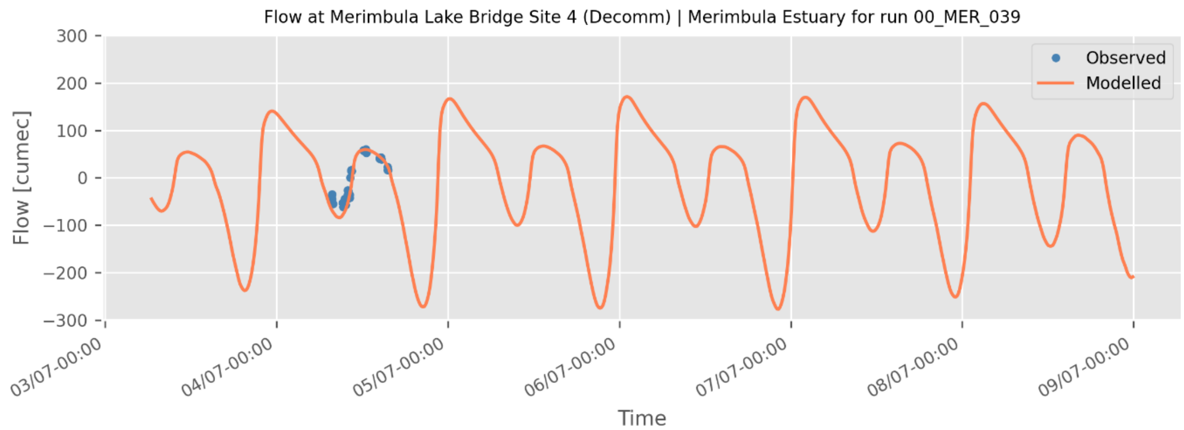

Figure B-9 2023 tidal flow calibration – Location A – Merimbula Lake Bridge

B1.4 Water level calibration – 2023

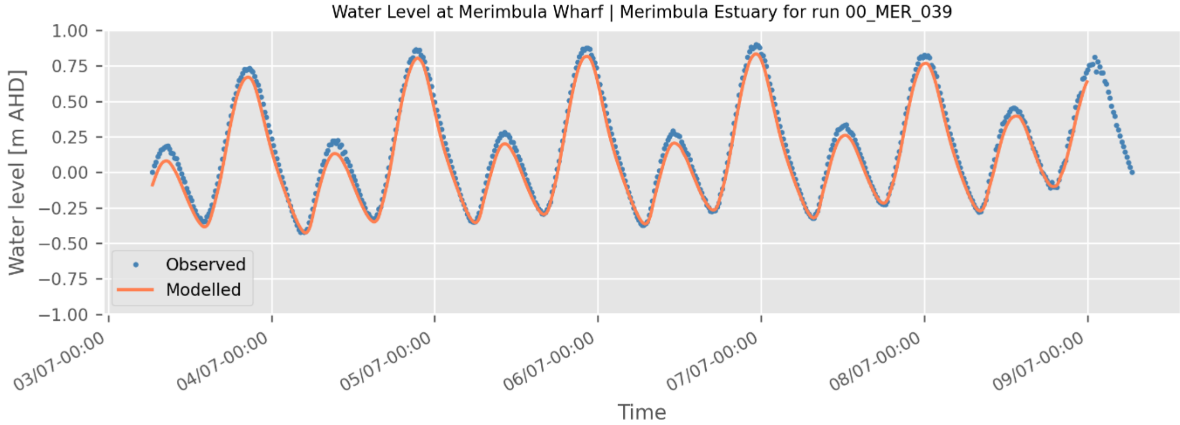

Figure B-10 2023 water level calibration – Location 3 – Merimbula Wharf

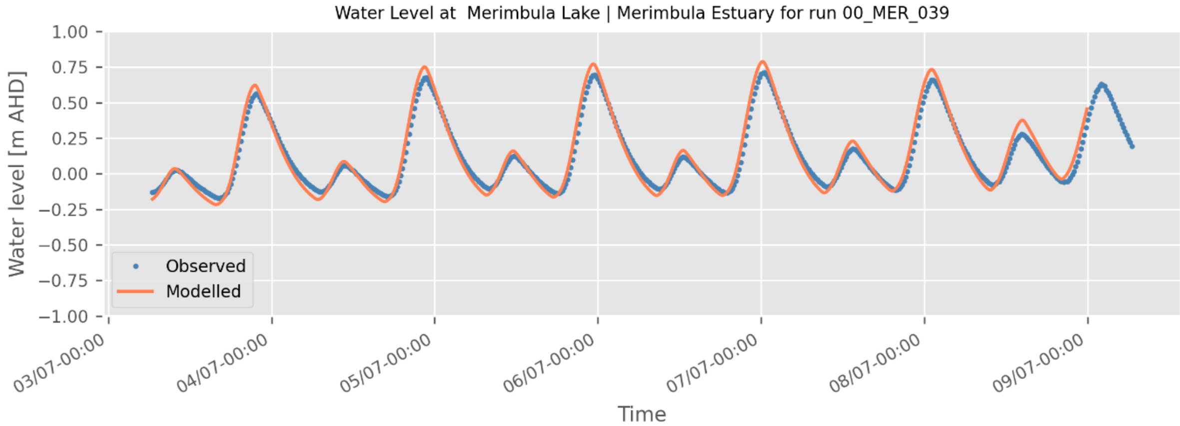

Figure B-11 2023 water level calibration – Location 5 – Merimbula Lake (MHL)

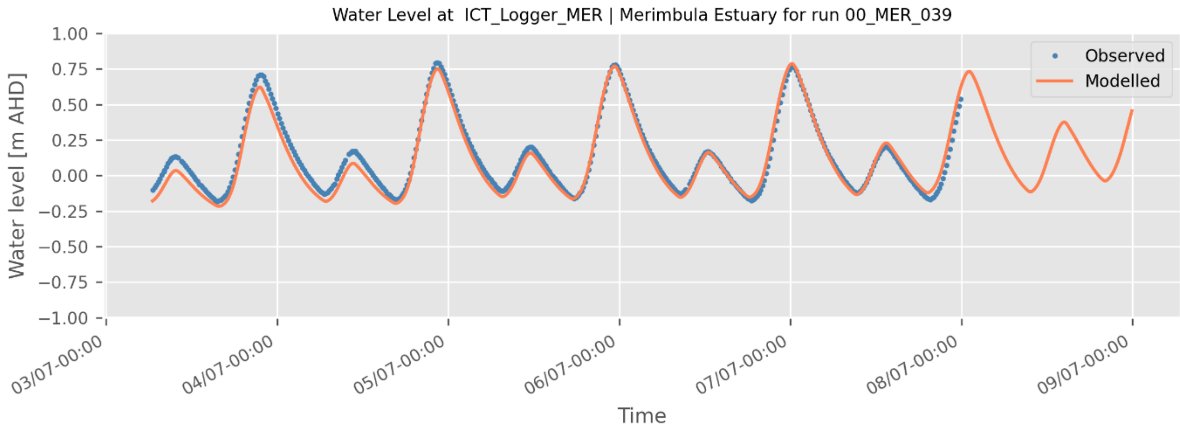

Figure B-12 2023 water level calibration – Location 7 – Merimbula Lake (ICT)