Independent Investigation into Water Quality and Local Current Flows at Mullaloo Beach

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Important Note

Version Register

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Rev A	DWER Review	S. Watson	G. Motherwell	S. Morillo	16/Jan/2025
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O2 Metocean (An O2 Marine Company)

ABN 29 630 318 848

Head Office – Fremantle, Western Australia

20 Mews Road Fremantle WA 6160

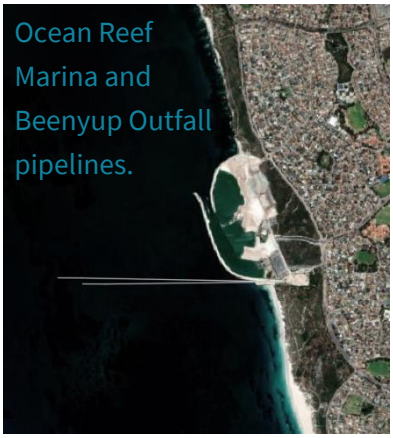
T 1300 739 447 | info@o2marine.com.au

Acknowledgement of Country

O2 Metocean acknowledges Aboriginal and Torres Strait Islander people as this land's first storytellers and holders of scientific knowledge through their ongoing and continued connection to land, sea and community. We pay our respect to Elders past and present for their custodianship of the land and sea over millennia, which inspires us daily in our collective responsibility to sustain the land and sea country which we live by, work in and dream about.

Introduction

This report provides a high-level summary of an independent investigation of the influence of the Ocean Reef Marina redevelopment on local currents and the mixing of the Beenyup Wastewater Treatment Plant effluent which was carried out in 2024. Oceanographers and marine scientists used three approaches: (1) collating community concerns, (2) conducting an independent review of existing water quality data, and (3) creating a hydrodynamic model of the local coastal environment. A hydrodynamic model is a computer simulation. The model used was custom-designed for the ocean conditions of Mullaloo and Ocean Reef.



Engaging the community

To begin the investigation, community concerns and observations were collected. This included a community consultation workshop that was held on the 29th of August 2024. Following a period where the people could directly submit data, observations and concerns. Full details and results from engaging the community have been published in the Community Consultation Report. **Information from the public was crucial to designing the hydrodynamic modelling.**

Data Review

Water samples have been collected at multiple locations around Mullaloo/ Ocean Reef. Samples have been collected by people from three different organisations – Water Corporation, the Department of Health and the Department of Water, Environment and Regulation. Samples were taken from along the shoreline and from boats. The data review looked back at results from 2018 to 2024.

Sources in the data review included:

Data source	Data supplied by	Time frame
PLOOM monitoring (raw data)	Water Corporation	July 2022 – January 2024
PLOOM annual reports	Water Corporation	2018 – 2023
Microbial testing results	Department of Health	November 2022 – April 2023 November 2023 – March 2024
Algal and physiochemical monitoring data	Department of Water, Environment and Regulation	Jan – April 2024

Perth Long-Term Ocean Outlet Monitoring (PLOOM)

The PLOOM program is how the Water Corporation has monitored treated wastewater discharged via ocean outfalls along Perth since 1995. This includes outfalls in Ocean Reef (Beenyup), Point Peron and Swanbourne. It takes samples from what is released through the outfalls (tested before release) and from the surrounding ocean water (samples taken from the ocean up to 1.5 km from the outfall). Water samples were tested for physical characteristics (i.e. temperature, salinity), biological toxins, nutrients, and bacteria. Samples were analysed in a nationally accredited laboratory.

Results from the samples of the released wastewater show that:

- There has been no recent increase in the quantity discharged
- No new toxins have been detected
- Levels of nutrients are below the Australian and New Zealand standards
- Levels of bacteria were slightly lower in 2024 compared to 2023 (only sampled in 2023 and 2024)

Results from surrounding water tests:

- Physical characteristics (i.e. temperature, salinity) are typical for natural marine conditions
- Nutrient levels in the treated wastewater were slightly higher over the 2023/24 summer when compared to the previous year
- The concentration of nutrients lowers as the water mixes outside of the outfall pipes – higher nutrient levels are barely detected in samples taken 1.5 km from the outfall
- Bacteria known to be associated with faecal matter was detected at shoreline locations in Ocean Reef on the 23rd of January 2024, which suggests a local source (i.e. poorly maintained sanitary waste systems on boats or pump-out systems at marinas)
- No toxic phytoplankton (microscopic plants) were present above the WA standards (standards set based on the safe consumption of shellfish)

Microbial Testing

The Department of Health tested water samples from Key West, Mullaloo and Pinnaroo Point every week during summer. Microbial testing looks at microbes – organisms that are too small for the human eye to see. Scientists use a microscope to look at the microbes.

The purpose of testing for microbes was to assess if there was any faecal pollution. Samples are tested for levels of the bacteria *Enterococci*. Levels are compared to the two values released by the National Health and Medical Research Council as safe for human interaction. The first value is based on safe levels for humans to be immersed in water (i.e. swimming, snorkelling or diving). The second value is based on safe levels for humans to be closely interacting with water (i.e. boating and fishing).

Results show that:

- No samples at Mullaloo Beach and Key West recorded levels above the safe swimming value
- One sample at Pinnaroo Point recorded levels above the safe level for humans to be immersed in the water (water sample taken on the 2nd of November 2022)
    - This result is consistent with water samples that were regularly taken between 2002 and 2016; where samples were infrequently above the safe swimming level

The source of this pollutant is likely the Hillarys Animal Exercise Beach which is approximately 200 m south of the sampling site.

Algal and Physiochemical Testing

The Department of Water, Environment and Regulation conducted water quality monitoring in response to complaints of poor water quality at Mullaloo Beach. Water samples were tested for physical characteristics (i.e. temperature, salinity, suspended solids) hydrocarbons, metals, nutrients, acidity and algae. Samples were analysed in a nationally accredited laboratory.

Results show that:

- No hydrocarbons or metals (particles or dissolved) were found in any water samples
- Normal levels of nutrients and acidity were recorded across all samples
- Higher suspended solids were present in samples collected from the shoreline
- All species of algae are known to live in marine coastal waters
- *Trichodesmium* spp. was detected in samples collected on the 17th of January, and the 24th and 26th of April 2024

Trichodesmium is a type of cyanobacteria (blue-green algae) that naturally occurs in tropical and subtropical waters during warmer conditions. It is also known as sea sawdust or sea scum. Public complaints of a slimy greasy feel in the water, brown surface scum, and rotting smell match a description of a *trichodesmium* bloom – a thick patch that grows quickly. *Trichodesmium* grows up taking nitrogen from the air (made up of ~78% nitrogen gas). Converting the nitrogen gas into ammonia, nitrate and nitrite – more user-friendly forms of nitrogen for the marine food chain. *Trichodesmium* are small – ranging from the diameter of a single strand of hair to the thickness of a credit card. They clump together and float to the surface making them visible to the human eye. At the surface, they do not survive long as they start to decompose in sunlight (UV radiation). Strong smells are often noticed when they decompose. Smells can be described as 'fishy' or like rotting plants.

Hydrodynamic Modelling

Two stages were involved in designing the hydrodynamic model. The first stage aimed to describe the movement of the outflow directly from the wastewater outfall pipes. The second stage expands on the first stage and aims to describe how water moves in the surrounding Mullaloo/ Ocean Reef area. Oceanographers focused on the ocean from the shoreline out to 2.5 km along a 4.5 km stretch of

coast from Shenton Avenue to Tom Simpson Carpark. This area is centred on the redeveloped marina with 1.5 km of coastline to the north and 1.9 km of coastline to the south.

Inputs into the model

The model uses data sources from a much larger area to ensure the accuracy of the model in the focus area. Therefore, detailed bathymetry (the shape and contours of the sea floor) was sourced out to 200 km from the redeveloped marina.

Previous scientific studies concluded that the water mixing at Mullaloo can be primarily described by the tide and surface wind (wind that moves directly over the surface of the water). Therefore, the sources used to design the Mullaloo/ Ocean Reef model included:

- Tides
- Observations and forecasts from weather stations (including surface wind speed and direction)

Testing the model

Before a hydrodynamic model is used, it needs to be tested for accuracy. The model was tested by comparing its predictions for a specific location and time with data gathered from dedicated instruments that measure wave and current conditions. Each test compares three months of data. One test was carried out during the summer months of 2019, before the marina was redeveloped. The other test was carried out during the winter months of 2022, after the marina was redeveloped.

Next, the model was tested for accurately predicting the movement of treated wastewater from the outflow over 48 hours. The direction and speed of water movement were compared between the model and measurements from the dedicated instruments. These instruments were located close to the new marina and approximately 1 km east of the outfall diffusers (end of the outfall pipelines).

The tests showed the hydrodynamic model was accurate.

Using the Model

The wind and weather conditions that members of the public associated with poor water quality guided the oceanographers to look at 10 scenarios. The 10 scenarios were:

- Four scenarios related to water movement around the marina (did not focus on the Beenyup outfall). They considered both summer and winter, before and after the redevelopment of the marina.
- The remaining six scenarios are related specifically to the Beenyup outfall and what its water does after being discharged into the ocean.

Results

Has the Marina Changed the Movement of Treated Wastewater from Beenyup?

No, there is no evidence that the discharged treated wastewater moves differently from the outfall when comparing before and after marina redevelopment conditions.

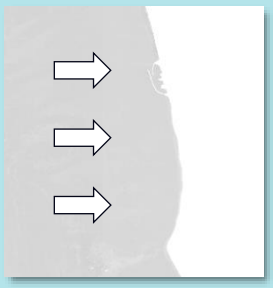
Predicted Movement from Beenyup Outfall

How the treated wastewater becomes diluted:

As soon as the treated wastewater exits the outfall pipeline it begins mixing with the ocean water. It will immediately move towards the surface as it is freshwater and 'lighter' than the saltwater of the ocean. As more treated wastewater exits the pipeline and rises to the surface, it pushes previous discharged water further away from the pipeline and continues to mix with ocean water. Wind and waves help with its mixing too. The further it travels from the pipeline, the more and more it resembles the characteristics as the ocean water. Oceanographers measure this in the number of dilutions. For example, a typical cordial drink has four dilutions (1 part cordial concentrate mixed with 4 parts water). **In general terms, by the time the treated wastewater reaches 500 dilutions, it is barely discernable from local ocean water.**

Predicted Movement in Different Wind Conditions

In the following wind conditions, the treated wastewater from Beenyup will move as follows:

Wind conditions	Length of time	Movement of treated wastewater from Beenyup outfall
 Persistent north-westerly winds	Less than 12 hours of consistent winds	Moves south, parallel to Mullaloo Beach. Does not move closer to the coast.
	Between 12 – 24 hours	Moves south, parallel to Mullaloo Beach. Moves slightly closer to the coast. At 800 m due west of Mullaloo Beach it has reached 500 dilutions.
	Between 24 – 36 hours	Moves south, parallel to Mullaloo Beach. At 800 m due west of Mullaloo Beach and 500 m due west of Pinnaroo Point it has reached 500 dilutions.
 Persistent westerly winds	Less than 12 consistent hours	Moves south, parallel to Mullaloo Beach (as far south as Mullaloo Surf Lifesaving Club). Does not move closer to the coast.
	Between 12 – 24 hours	Moves south, parallel to Mullaloo Beach. Moves slightly closer to the coast. At 800 m due west of Mullaloo Beach it has reached 500 dilutions.
	Between 24 – 36 hours	Moves southeast towards Mullaloo Beach. At 500 m southwest of Mullaloo Surf Lifesaving Club (at more than 150 m from the shore) it has reached 500 dilutions.

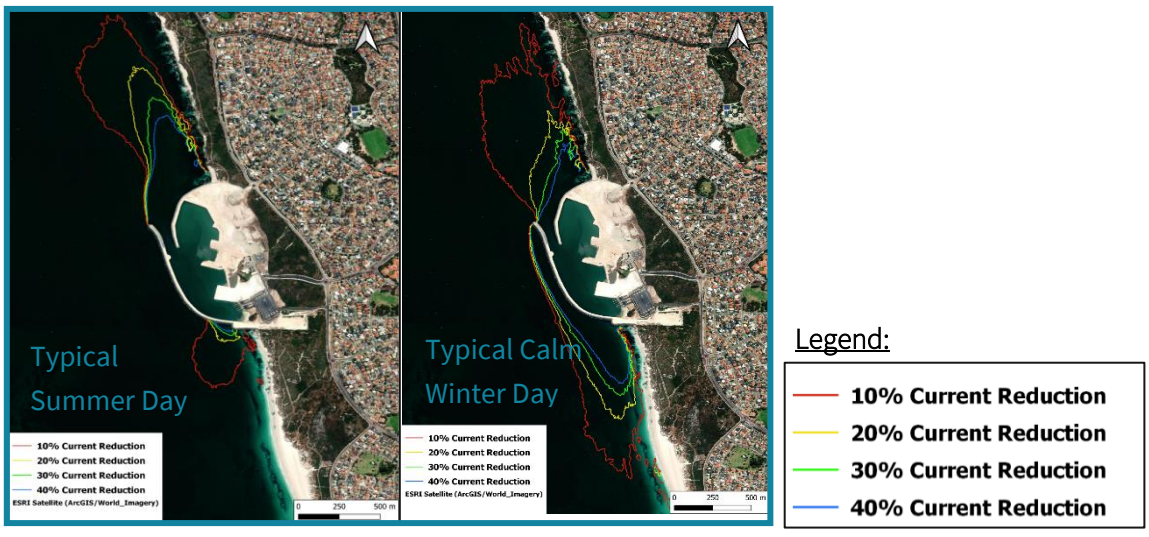
Wind conditions	Length of time	Movement of treated wastewater from Beenyup outfall
	Less than 12 consistent hours	Moves north (as far as the northern end of the marina). Moves slightly further out to sea. Does not move closer to the coast.
	Between 12 – 24 hours	Moves north (as far as 600 m further north of the marina). Moves slightly further out to sea and slightly closer to the coast. At 500 m due west of the marina boat entry, it has reached 500 dilutions.
Persistent south-westerly winds – "Seabreeze"	Between 24 – 36 hours	If winds are consistent for more than 24 hours, it will be trapped in an eddy (whirlpool) near the marina entry. If winds are consistent for more than 36 hours, movement will continue northwest. It may reach the shoreline between Iluka and Burns Beach Foreshore Parks but will have already reached at least 400 dilutions. It is predicted that less coastline will be influenced after the marina in comparison to before.

How has the Marina Reduced the Flow of Water at Mullaloo/Ocean Reef?

The hydrodynamic model was used to predict the changes in water currents. It compared before the redevelopment and after the redevelopment of the marina.

On a typical day it predicted that the marina would reduce currents up to the following distances:

Season	North of marina	South of marina
Summer	1,500 m	500 m
Winter	1,100 m	1,200 m



Please note: this study was not able to determine if reduced water currents around the redeveloped marina (predicted by the hydrodynamic model) helps create ideal conditions for algal blooms. Further information and data would need to be collected to investigate this.

Conclusion

- The water quality review showed no evidence that the community should be concerned about the Beenyup Outfall affecting water quality at Mullaloo Beach.
- The hydrodynamic modelling showed no difference in how the treated wastewater from Beenyup moves from before and after marina redevelopment.
- The hydrodynamic modelling found that the Ocean Reef Marina has reduced current velocities north and south of the marina during typical summer and winter conditions.
- Water quality, including the development of algal blooms, is influenced by several natural and anthropogenic factors, which may include temperature, changes in current velocities, winds, groundwater seepage, discharge from boats, marina activities, etc.

o2marine.com.au

WA Marine Pty Ltd trading as O2Marine
ACN 168 014 819
20 Mews Road Fremantle 6160
T: 1300 739 449
E: info@o2marine.com.au