Marine SOLUTIONS TASMANIA PTY LTD

www.marinesolutions.net.au

ENVIRONMENTAL IMPACT ASSESSMENT

WAVE SWELL ENERGY TEST SITE

GRASSY HARBOUR, KING ISLAND, TASMANIA

prepared for

Wave Swell Energy

February 2023

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Version	Contributor/s	Date reviewed	Reviewed by	Notes
1	G. Williams	14 Feb 2023	L. Smith	-
2	G. Williams	22 Feb 2023	L Smith	
3	G. Williams	23 Feb 2023		

Cover photo: UniWave installation (left - https://www.waveswell.com/technology/), Grassy Harbour, King Island (right - Google Earth).

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Executive Summary

Marine Solutions conducted an environmental survey in Grassy Harbour, King Island on the 19th of December 2022, to facilitate an Environmental Impact Assessment (EIA) of the UniWave installation. The objective of the EIA is to determine if the 2-year deployment and operation of the UniWave had any detectable impact on the ocean, seafloor and ecology of the immediately surrounding area.

A suite of environmental data was collected in surveys at the UniWave site, and at two control sites at a nearby reef and inside the Grassy Harbor marina. The environmental data collection at all three locations included underwater habitat surveys, water quality profiling and sediment analysis (contaminant and particle size). An additional bathymetric mapping of the seabed around the UniWave installation was conducted.

The bathymetric mapping revealed a gently sloping uniform seabed with no notable depressions or crests around the UniWave installation. A dive survey found that the hull of the unit had been colonized by green and brown algae. These were representative of the species in the surrounding area and expected for a benign submerged installation of this duration.

Measurements of temperature, salinity, dissolved oxygen and turbidity in the receiving environment showed a shallow, fully mixed water column with little fluctuation across sites and depths and did not appear to be influenced by the UniWave. Similarly, concentrations of heavy metals and total petroleum hydrocarbons were low in the vicinity of the installation. By comparison, there were slightly elevated levels of arsenic and nickel observed in the control site in the marina.

Sediment particle size varied across the three sites and was largely related to local habitat structure. The substrate near the UniWave installation and the marina largely consisted of fine and coarse sand whereas the substrate near the reef consisted of a mixture of very fine sand and silt along with large pieces of coarse sediment and shell grit. Particle size analysis did not show any evidence of deposition or erosion caused by the presence of the UniWave structure.

There were no detectable environmental impacts of the installation beyond the obvious expected impacts of the physical structure itself (i.e. footprint on seabed, structure for substrate for colonising algae).

Overall, with respect to the parameters tested in the survey, the UniWave does not appear to have had any noticeable effects on the receiving environment during its operational phase.

1 Introduction

1.1 Proposal Brief

Marine Solutions was invited by Scott Hunter from Wave Swell Energy to conduct an environmental impact assessment of the UniWave installation in the harbour adjacent to the town of Grassy, Tasmania. The UniWave was installed in January 2021 and connected to the King Island electrical grid in June 2021 (WSE, 2021). The operational phase of the project was completed in late 2022 and the unit has now been decommissioned and scheduled for removal in early 2023.

1.2 Purpose and Scope

The purpose of this report is to detail the methods and findings of a marine site survey at the UniWave installation and nearby control sites to determine if there were any detectable environmental impacts on the receiving environment in Grassy Harbour, King Island, Tasmania. The information presented in this report will provide Wave Swell Energy (WSE) with data and analysis to include in future proposals for UniWave deployments internationally. Specifically, to provide a case study to address potential concerns around environmental impacts.

The project includes the following:

- Bathymetric mapping of the seabed
- Water quality profiling for temperature, salinity, stratification, dissolved oxygen and turbidity
- Underwater habitat characterisation
- Sedimentary particle size analysis, to determine substrate composition and stability
- Sedimentary contaminants (heavy metals and Total Petroleum Hydrocarbons)

1.3 Study Area

The study area is located close to shore in Grassy Harbour, King Island (Figure 1). The region is renowned for its fishing, scuba diving and local penguin colony at Grassy Penguin Island. The UniWave was partially submerged on the seabed approximately 100 m from shore in 5.75 m of water (WSE, 2021).

Figure 1. Map showing the location of the survey sites around Grassy Harbour (base image source: Google Earth). Environmental data from west and east of the UniWave installation as indicated.

2 Local Bathymetry

2.1 Methods

Bathymetric mapping of the seabed was conducted on the 19th of December 2022 in the vicinity of the UniWave installation and surrounding area in order to characterise the seafloor and highlight any benthic features.

The study area was mapped using a CHIRP-enabled broadband sounder and Garmin EchoMAP plotter, logging GPS positions and water depth every two seconds. This information was logged at sufficient resolution, such that representative interpolations between data points could be made, to produce accurate bathymetric data of the given area to Australian hydrographic survey requirements. Depths were measured to the nearest tenth of a meter, and tidally and barometrically corrected for Chart Datum (CD) using tide charts and observations from the Bureau of Meteorology. The results were interpolated using GIS software Surfer 11.0 to create a bathymetric profile of the area (Figure 2).

2.2 Results

Seabed bathymetry across the UniWave deployment area showed a uniform increase in depth with distance from the shore (Figure 2). Depths reach approximately 9 m below chart datum at around 150 m offshore and the seabed was largely characterized by fine to coarse sand particles. At the time of the survey, there were no remarkable bathymetric features to note and no evidence of any artificial depressions or crests that would suggest any influence of the UniWave operation or interaction with local tides/currents.

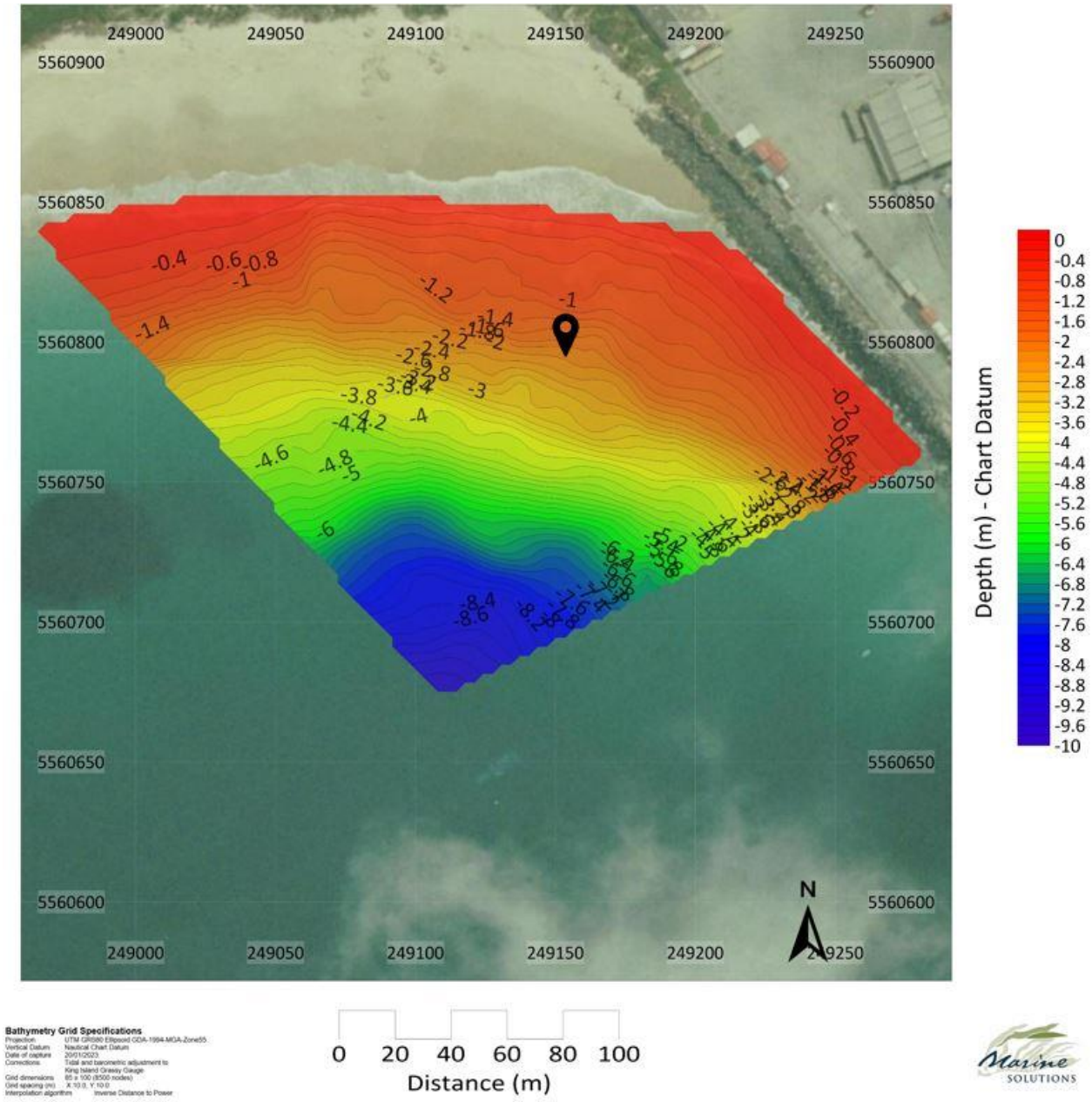

Figure 2. Bathymetric contour map of the UniWave deployment area. The approximate location of the UniWave at the time of the survey is represented by a black pin. The map is tidally and barometrically corrected to Chart Datum.

3 Underwater Habitat Characterisation

3.1 Methods

An underwater habitat characterization was conducted by divers on the 19th of December 2022 in the vicinity of the UniWave and the surrounding area (Appendix 1). Specifically, the underwater habitat survey was conducted at three different locations: at the UniWave (split into East and West components) and two nearby reference sites at a local reef further to the west and marina to the east (Figure 1, Appendix 2). The purpose of the survey was to provide information on habitat structure, community type and species composition and to assess any impact of the UniWave installation relative to the reference sites.

The dive surveys were conducted using a random roaming visual census technique for approximately 10 minutes at each site with the divers swimming from the deepest to the shallowest contour of the seabed. The survey was filmed using an Olympus TG-6 camera in an Aquapazza housing along with a GoPro to collect continuous video footage of the seabed. The video footage is available from Marine Solutions upon request (Appendix 3).

3.2 Results

3.2.1 UniWave - Primary Site

The visibility in the water at the time of the survey was around 10 m. The substrate surrounding the UniWave was comprised of fine and coarse sand and largely devoid of algae, seagrass and invasive species. Rockbags used to hold the unit down and prevent scour were exposed on the seabed (Figure 3b). Along both sides of the hull was a uniform growth of brown and green algae (primarily *Ulva sp.*) together with a sparse presence of turbo snails (*Turbo undulatus*) and soft sponge species. Barnacles were present in small numbers with an increasing abundance along the intertidal zone of the hull relative to the subtidal and supratidal zones.

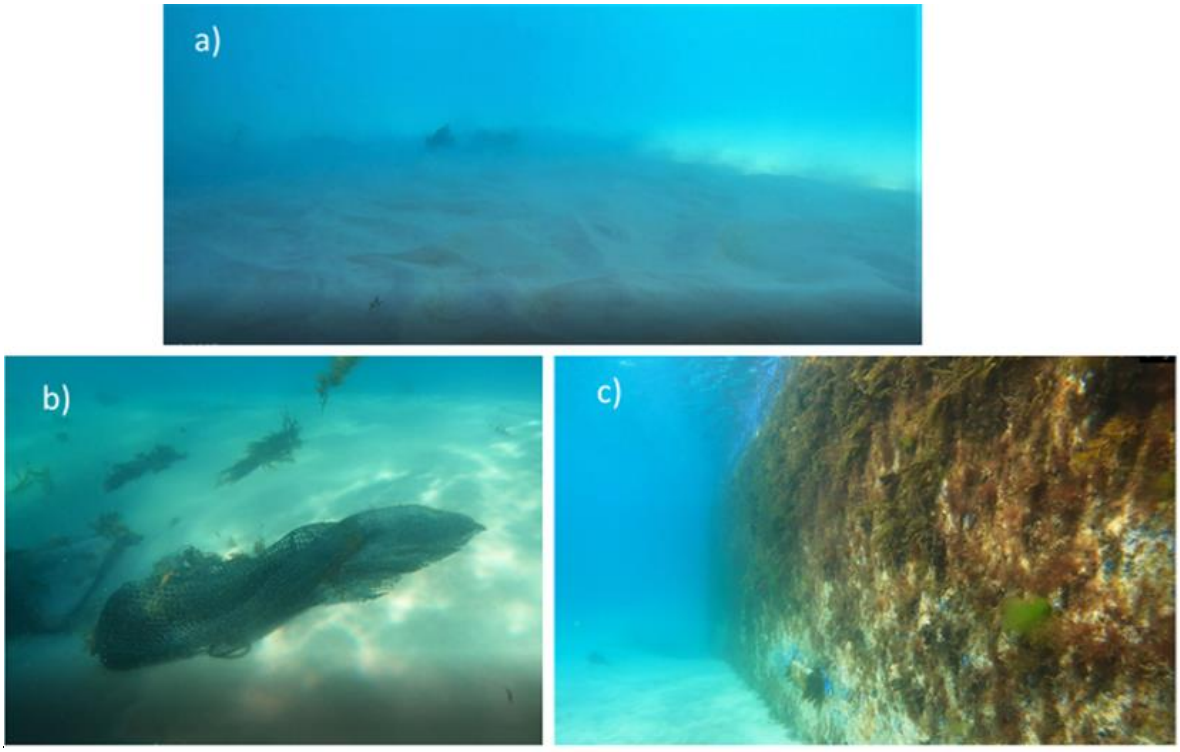

Figure 3. Images from the underwater habitat survey surrounding UniWave showing a) sandy sediment substrate b) exposed 'rockbags' on the seabed c) brown and green algae growing on the hull.

To the west of the unit was dislodged brown algae (*Phyllospora comosa* & *Ecklonia radiata*) accumulating in a turbid pinch point. To the east side of the unit was a remnant kelp (*E. radiata*) garden and the presence of numerous purple wrasse (*Notolabrus fucicola*).

3.2.2 Reef – Control Site

The reef control site was approximately 100 – 150 m west from the UniWave and dominated by brown algae. There was a noticeable sand depression between two bomboras with a high abundance of blue-throated wrasse (*Notolabrus tetricus*) and scalyfin (*Palma victoriae*) around the reef. Short-spined sea urchins (*Heliocidaris erythrogramma*) were also present (Figure 4).

Figure 4. Images from the underwater habitat survey at the control reef site. Top: *H. erythrogramma* between two boulders. Bottom: Brown algae growing on the reef.

3.2.3 Marina – Control Site

The area surrounding the marina control site consisted of a mixture of rocky reef and seagrass habitat (Figure 5). The reef was dominated with turf algae and had a higher fish abundance compared to the other two sites. Additionally, the sediment at the marina was visibly coarser and darker in colour.

Figure 5. Images from the underwater habitat survey at the marina control site.

4 Water Quality Profiling

4.1 Methods

Water column profiles from the seabed to the sea surface were obtained in the vicinity of the deployment and at the two reference locations (Figure 1). A Xylem EXO 3 multi-parameter water quality sonde was used for *in situ* water quality profile measurements of temperature (±0.05 °C), salinity (±0.1 ppt), dissolved oxygen (±1% air saturation) and turbidity (±0.3 FNU).

4.2 Results

4.2.1 Stratification

As anticipated for shallow sites in the littoral zone, all sites exhibited a well-mixed and essentially homogenous water column from the surface to the seafloor.

4.2.2 Temperature

Characteristics of the water column were broadly similar across the different sites and depths. Temperature ranged from approximately 15 – 16 °C with the highest temperature of 16.2 °C being recorded in the surface waters at the marina reference site and the lowest temperature of 15.2 °C recorded in the surface water at UniWave E.

4.2.3 Salinity

Salinity values ranged from 34.8 to 35.1 ppt with the lowest salinity value being recorded in the surface water at the marina reference site. Overall, salinity values near the UniWave were consistent with those at the reference sites.

4.2.4 Dissolved Oxygen

Dissolved oxygen levels were all just above 100% air saturation, with some slight variation through the water column across the different sites (Figure 6).

At the UniWave site, dissolved oxygen levels stayed relatively consistent throughout the shallower, wave-mixed water column with levels persisting around 104 %. In contrast, both the reef and marina sites had increasing dissolved oxygen from the surface to the seafloor, with a minimum 101 -103 % in the 0 -1 m depth range at the marina reference site and a maximum of 107% at 6m depth at the reef reference site. This sub-surface elevation of dissolved oxygen is common during early morning surveys where photosynthesis is occurring. The relatively high dissolved oxygen at the Control Reef site may correlate to increased photosynthetic activity in a localised area of higher plant biomass. All values are above 100% saturation.

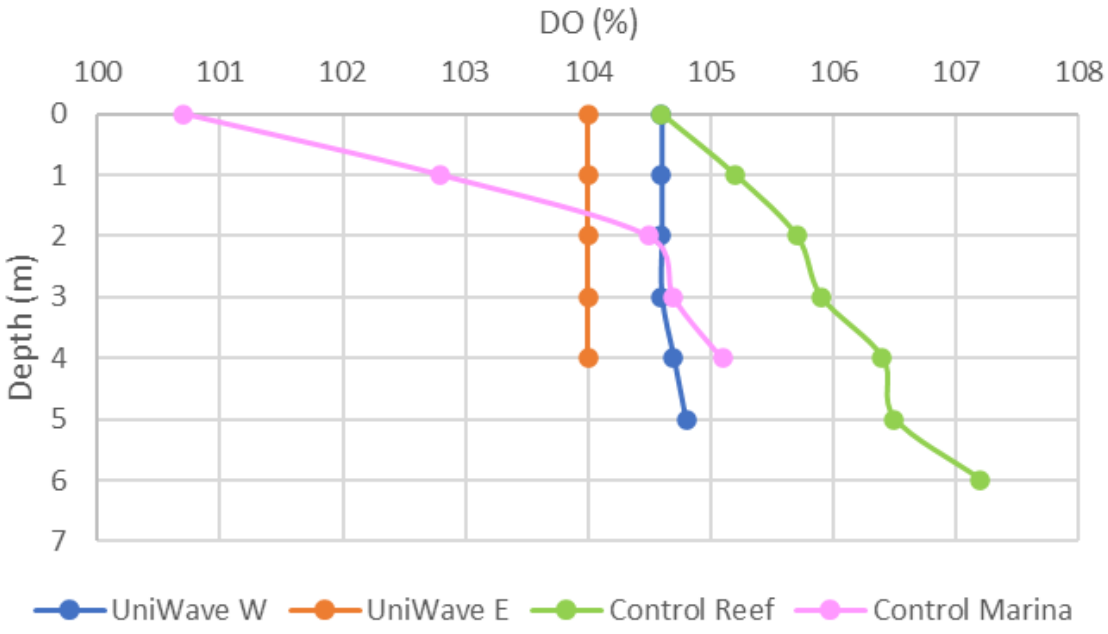

Figure 6. Dissolved oxygen profiles for different sampling sites in Grassy Harbour.

4.2.5 Turbidity

Potentially the most likely water quality parameter to be impacted by a moored installation, turbidity values ranged from 0.25 to 3.47 FNU at the time of sampling (Figure 7). These are relatively low values indicative of a benign environment. The highest turbidity levels were recorded in 0 - 1 m

depth at the UniWave and gradually decreased with increasing depth. Turbidity levels at the two reference sites showed little variation with increasing depth and consistently stayed below 1 FNU.

Although the recorded turbidity levels are considered low across all sites and depths, small variations in readings, for example in the case of the higher turbidity readings at the sea surface, may be from the interaction of the wind-driven waves at the time of sampling (10 knots from the NE), creating greater surface turbulence at WSE-East, relative to the other side of the installation at WSE-West.

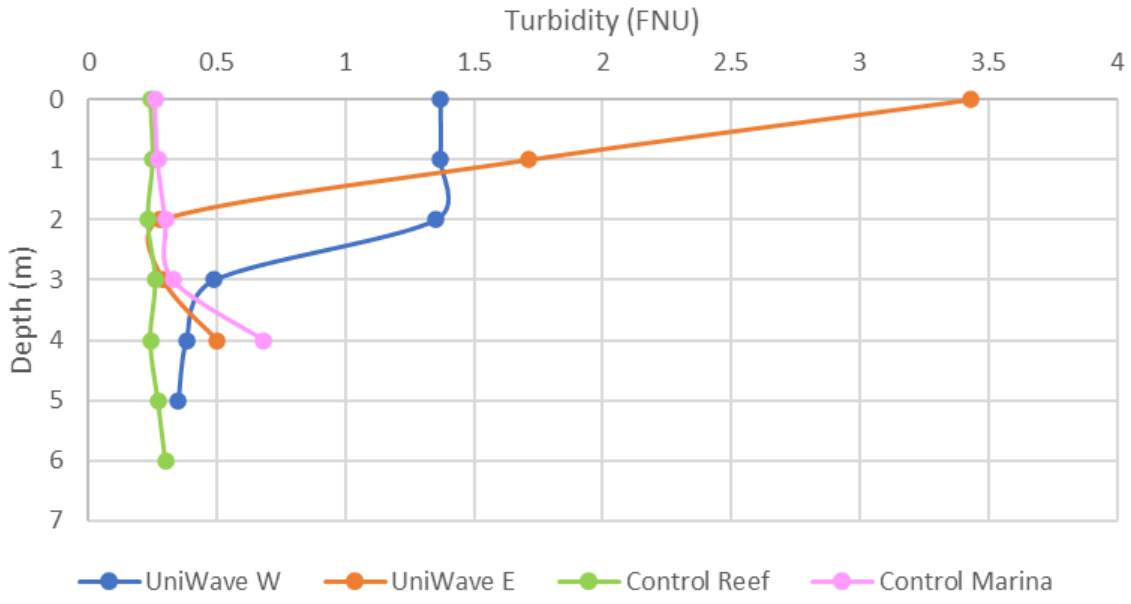

Figure 7. Turbidity profiles across the different sampling sites in Grassy Harbour.

4.2.6 Summary of Water Quality Properties

Overall, the water quality properties surrounding Grassy Harbour do not appear to be influenced by the UniWave deployment, with all properties near the deployment broadly consistent with those at reference sites.

5 Sediment Contaminants and Particle Size Analysis

5.1 Methods

Sediment samples were collected at the UniWave and the two reference sites (Figure 1) for an assessment of contaminants, specifically heavy metals (and metalloids) and total petroleum hydrocarbons (TPHs). Sediment particle size was also investigated to give an indication of substrate composition and stability. Since particle size influences both chemical and biological characteristics, it can be used to account for any possible variability found in contaminant testing results and ecological datasets.

5.1.1 Contaminants

Duplicate benthic sediment samples were collected by a diver using a handheld corer at two locations for each of the three sites (total of 12 samples). At the UniWave, one sample was taken to the west of the unit while the other sample was taken to the east of the unit (Figure 1).

The top 10 cm of the cores were extruded into clean laboratory glassware and sent to Analytical Services Tasmania (AST) - a NATA accredited laboratory - for analysis. Specifically, the samples were tested for the following parameters:

- Metals including As, Cd, Co, Cr, Cu, Mn, Ni, Pb, Zn and Hg.
- Total Petroleum Hydrocarbons (TPH total, TPH C06-C09, TPH C10-C14, TPH C15-C28, TPH C29-C36)

Laboratory results for the above parameters were then compared to the Australian & New Zealand Guidelines (ANZG) toxicant default guideline values for sediment quality (ANZG, 2019 - Table 1).

The default guideline values for sediment quality (ANZG DGVs) indicate the concentrations below which there is a low risk of unacceptable effects occurring, and should be used, with other lines of evidence, to protect aquatic ecosystems. In contrast, the DGV-High values provide an indication of concentrations at which one might already expect to observe toxicity-related adverse effects.

5.1.2 Particle Size

Two sediment cores were sampled at each site (same sites as above) (Figure 1) and extruded into glassware. Particle size distribution of the different sites was assessed volumetrically in-house by wet sieving sediment samples through a series of stainless-steel sieves (4 mm, 2 mm, 1 mm, 500 µm, 250 µm, 125 µm and 63 µm). The content of each sieve was drained and transferred to a measuring cylinder, beginning with the coarsest sediment fraction (4 mm) and working down to the finest (63 µm). The volume of sediment in the measuring cylinder was recorded for each size class. The sediment fraction < 63 µm was assumed to be the total volume of the sample minus the combined volume of all other size classes.

5.2 Results

5.2.1 Contaminants

Concentrations of all metal contaminants at the UniWave and the Control Reef site were below the recommended Australian & New Zealand threshold default guideline values (DGVs) (ANZG 2019) (Table 1). At the Control Marina site, all metal concentrations were significantly higher, with both arsenic (As) and nickel (Ni) slightly above the DSG threshold at Control Marina A. These results are not unexpected for an active marina in an enclosed port area.

Table 1. Results of contaminant analysis of sediment samples. Cells highlighted in yellow indicate levels that exceed the ANZG toxicant default guideline values (DGVs) (ANZG 2019).

Analyte	Units	ANZG DGV	ANZG DGV - High	Site					
				UniWave – E	UniWave – W	Control – Reef A	Control Reef B	Control – Marina A	Control – Marina B
As	mg/kg	20	70	2	3	4	3	21	9
Cd	DMB	1.5	10	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Co		-	-	<1	<1	<1	<1	4	6
Cr		80	370	3	3	7	3	43	68
Cu		65	270	<1	<1	<1	<1	19	33
Mn		-	-	10	10	66	14	488	697
Ni		21	52	<1	<1	2	<1	18	25
Pb		50	220	<1	<1	<1	<1	2	2
Zn		200	410	<1	<1	3	<1	21	29
Hg		0.15	1.0	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Total Petroleum Hydrocarbons (TPH)		280	550	<100	<100	<100	<100	<100	<100
C6-C9		-	-	<25	<25	<25	<25	<25	<25
C10-C14		-	-	<25	<25	<25	<25	<25	<25
C15-C28		-	-	<100	<100	<100	<100	<100	<100
C29-C36		-	-	<100	<100	<100	<100	<100	<100

5.2.2 Particle Size

The sediment sample at UniWave E consisted of fine sand and silt (0.125 mm or smaller) interspersed with approximately 41.8% coarse sediment (0.5 mm or larger – see Figure 8). The sediment sample at UniWave W was similar to UniWave E but with a slightly higher proportion of coarse sediment (~ 53.8%).

The sediment collected from Control Reef A was predominantly comprised of fine sand (0.125 mm) and silt (<0.063) apart from one large piece of granite (~ 5 cm) and a few larger pieces of shell grit. However, the sample from Control Reef B had a much higher abundance of coarse sediment and nearly no silt. The variation in particle size at the reef may be due to the reef's structural diversity and complexity and samples being collected in slightly different habitat zones. For example, Control Reef A was sampled at a reef depression in 4-5 meters depth and Control Reef B was sampled from a reef crest at 5-6 m depth.

Both sediment samples from Control Marina A and B predominantly contained fine sediment along with a few small broken urchin spines and shells. Overall, the results of the particle size analysis show no evidence of particle size disturbance from the UniWave.

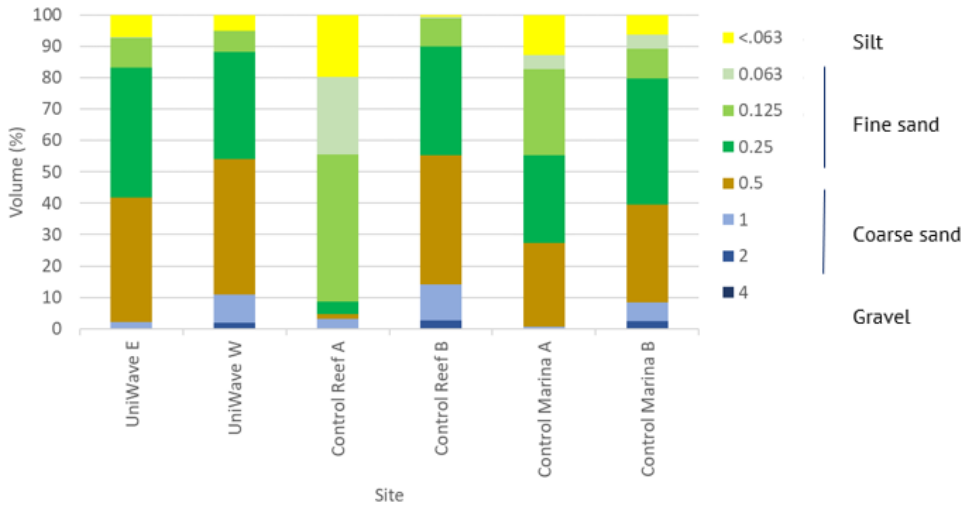

Figure 8. Particle size distribution measured at the different sampling sites.

6 Conclusion

Based on the findings from the field surveys in December 2022, the surrounding environment in Grassy Harbour does not appear to be detectably influenced by the UniWave installation or its operation, with the exception of relatively benign impacts of the presence of the physical structure (i.e. physical footprint on seabed, structure for substrate for colonising algae).

The seafloor surrounding the unit appeared uniform with no notable depressions or crests. It is possible that there will be a temporary depression in the sediment when the UniWave unit is removed but due to the fine particle size in the area, it is expected that the depression will fill up relatively quickly.

Analysis of the underwater habitat indicated that there were no patterns in the abundance of seaweed or species composition relating to the installation/operation of the UniWave. Instead, patterns in the distribution of seaweed and ecological community types are largely related to the broad distribution of seabed structures (sand, cobble or reef) across the study area.

The hull of the UniWave had been colonized by green and brown algae. This is expected as most underwater structures offer substrate for algae and fouling organisms to grow on. It is possible that any ongoing deployment of the unit would create an extended habitat for local marine species and increase their presence in the area. This may include both native and introduced species.

As anticipated, the results from the water quality profiles showed little variation across the sites for all parameters and were confirmed to not be influenced by the UniWave installation.

Similarly, heavy metals, metalloids and total petroleum hydrocarbon levels near the UniWave were all below the Australian & New Zealand toxicant default guideline values for sediment quality. While Arsenic (As) and nickel (Ni) exceeded the ANZG lower DSG threshold at the marina reference site, this is most likely related to activities inside the marina (DCCEEW, 2022; EPA, 2007).

Particle size varied between locations, likely due to the different underwater habitat at each sampling site,. Particle size distribution was broadly consistent at each site with the exception of the reef reference site that had two very different particle size samples. However, reefs normally have a large variety of seabed structures and particle size, it was therefore expected to show slightly different particle size compositions.

Overall, with respect to the parameters tested in the survey, the UniWave does not appear to have had any noticeable effects on the receiving environment during its operational phase.

7 References

Australian & New Zealand Guidelines for Fresh and Marine Water Quality [ANZG] 2019, viewed 26 January 2023, < https://www.waterquality.gov.au/anz-guidelines/guideline-values/default/sediment-quality-toxicants>.

Department of Climate Change, Energy, the Environment and Water [DCCEEW] 2022, viewed 6 February 2023, < https://www.dcceew.gov.au/environment/protection/npi/resource/student/arsenic-and-compounds>.

EPA 2007, *Review of Sediment Sampling Program - Tasmanian Boat Maintenance and Repair Facilities*, Aquatic Science, <https://epa.tas.gov.au/Documents/Report%20-%20Review%20of%20Sediment%20Sampling%20Program%20-%20Tasmanian%20Boat%20Maintenance%20and%20Repair%20Facilities%20-%20DTAE%20-%20October%202007.PDF>.

Wave Swell Energy [WSE] 2021, viewed 23 January 2023, <https://www.waveswell.com/king-island/wave-swell-energys-UniWave-is-installed-at-king-island/>.

8 Appendices

Appendix 1. Operational Summary

Date	Personnel*	Time (start)	Time (end)	Air temp (°C)	Cloud	Rain	Wind	Swell	Current	Tide**	Works conducted
19/12/2022	T. Jones C. James	08:00	11:00	18	1/8	None	10 knots NE	0-1m	None	High	Habitat characterisation Water quality profiling Sediment collection Bathymetry

* Personnel are from Marine Solutions unless otherwise indicated.

** Tide chart information is from the Bureau of Meteorology's predictions. Descriptions are as per on-site observations.

Appendix 2. GPS Positions of sampling locations (GDA94)

Name	Zone	Easting	Northing	Notes
UniWave E	55	249150.38	5560786.58	
UniWave W	55	249138.65	5560787.53	
Control Reef	55	248959.34	5560735.36	
Control Marina	55	249603.66	5560948.38	

Appendix 3. Video Files

Refer to the following video files, available from Marine Solutions on request:

- *"Western Reef Control 1"*
- *"Western Reef Control 2"*
- *"GP Southern Reef Control"*
- *"GP Southern Reef Control 2"*
- *"GP Eastern Marina Control"*
- *"GP Eastern Marina Control 2"*
- *"UniWave site"*
- *"GP UniWave site"*
- *"GP UniWave site 2"*
- *"UniWave 200 site 2"*
- *"UniWave 200 site 3"*
- *"UniWave site*