12. COUNCIL REPORTS FOR DECISION

12.1. PORT LINCOLN TOWN JETTY SWIMMING ENCLOSURE

REPORT INFORMATION	
Report Title	Port Lincoln Town Jetty Swimming Enclosure
Records Reference	9.24.1.2 REP23117
Organisational Unit	Environment & Infrastructure
Responsible Officer	Project Manager - Master Plan Projects - Kathleen Brannigan
Report Attachment/s	Yes Attachment 8 I223976 Assessment Report on Town Jetty Swimming Enclosure (June 2022) I231611 Peer Review of Assessment Report on Town Jetty Swimming Enclosure (July 2023)
REPORT PURPOSE	
The purpose of this report is to provide Council with a report about the current swimming enclosure pontoon structure at the Port Lincoln Town Jetty and recommend next steps.	
REPORT DECISION MAKING CONSIDERATIONS	
Council Role	Owner / Custodian - Manage community assets including buildings, facilities, public space, reserves on behalf of current and future generations
Strategic Alignment	SDP GOAL: Goal 5: Community Assets and Placemaking SDP ACTION: Not Applicable
Annual Business Plan	ABP INITIATIVE: Choose an item. ABP PROJECT: Choose an item.
Legislation	Not Applicable
Policy	Not Applicable
Budget Implications	As per approved budget
Risk Implications	Moderate Risk
Resource Implications	This is a planned resource allocation
Public Consultation	Not Applicable
IAP2 Commitment	Not Applicable

OFFICER'S RECOMMENDATION
That Council: 1. **Endorse remedial works being undertaken to the existing structure as proposed in the Assessment Report (June 2022) and confirmed by Tonkin.** 2. **Note that improved wave attenuation in the form of a wave attenuation pontoon will be investigated.**

12.1 PORT LINCOLN TOWN JETTY SWIMMING ENCLOSURE

REPORT DETAIL

Background

Following storm damage to the swimming enclosure in September 2021 Council met with the manufacturer, Seaslip, to discuss and resolve rectification of the damage. Magryn Associates Preliminary report: *Failure of Pontoon System Jetty Swimming Enclosure* (October 2021) prepared for Seaslip found that the "… most probable cause of damage to the pontoon system was the extensive marine growth on the predator exclusion nets suspended under the pontoons". Council had arranged for the nets to be cleaned in September 2021 (after the storm).

Following a Confidential Council report in February 2022 Council allocated $25,000 to obtain independent engineering advice and design rectification to resolve issues with swimming enclosure. The Assessment *Report on Town Jetty Swimming Enclosure Port Lincoln for City of Port Lincoln* (Magryn, June 2022) recommend remedial works to the floating pontoons, locations/guide piles and predator exclusion nets. The *Assessment Report* formed the basis for the scope of repairs and specifications that were included as part of the Request for Tender (RFT) to undertake the remediation work. The RFT process was conducted during September 2022 with the preferred supplier identified and notified in November 2022.

There was further storm damage to the swimming enclosure structure in mid-November 2022 and another confidential report (due to commercial in confidence matters discussed) provided to Council in November 2022. The report addressed tender prices received, discussed the whole of life costs of maintaining the existing structure and whether it is 'fit for purpose' in its environment. Council approved a funding allocation for immediate repairs and requested a report to investigate alternative structures to the current pontoon.

Current Position

To assist decision making about whether to invest in repairing the existing swimming enclosure or an alternative option Tonkin were engaged to complete a peer review of the *Assessment Report on Town Jetty Swimming Enclosure Port Lincoln* (Magryn, June 2022). Council has allocated capital expenditure of $500,000 to the swimming enclosure in its 2023/24 Budget.

Peer Review Findings

Key points highlighted in the peer review are that:

- The location has a severe wave climate for the siting of floating structures and the current system is likely to be one of the most robust for this location. Tonkin's opinion is that all marina systems installed in this configuration and location would be susceptible to damage.

- The system is susceptible to damage from waves approaching from the north. The waves approach at 45 degrees to the enclosure and this results in a complicated arrangement of wave loads being applied to the northern corner of the structure.

- All marine structures require maintenance through their design life. This may be the result of corrosion or deterioration, vessel or debris impact damage, or storm damage. Cleaning of marine growth from floating structures is a common requirement and necessary for the system to maintain the performance as designed.

Relocation to eastern side of the jetty

Tonkin does not recommended relocation of the structure to eastern side of the jetty as the wave attenuation provided by the jetty in its current form is limited and would only provide minor improvement in the wave climate for a potentially large cost.

Feedback on Recommended Remedial Works (*Assessment Report on Town Jetty Swimming Enclosure, June 2022)*

Repair of floating pontoons (Section 6.1):

- Adding an articulated joint in the location where the structural framing failed, as proposed, is expected to substantially reduce (but not eliminate) the likelihood of damage resulting from typical waves from the north. Alternatively, the connection between the pontoons could be removed completely. Tonkin considers that the following remedial works proposed in the June 2022 Assessment report to be appropriate:
  - Repair of pontoons P18 and 19
  - Incorporation of new hinge joints into pontoons P18 and 19 at the break line.

  Other recommended works to the pontoons are not considered to be of benefit.

Remedial work to piles (Section 6.2):

- Tonkin considers recommendations in this section appropriate and further that the pile inside the damaged HDPE sleeve should be inspected to determine extent of corrosion and replaced if required.

Water access stair pontoons:

- The peer review concurred with the June 2022 report that the four step platforms create a vertical load on the pontoon frame causing damage and recommends that the water access stair pontoons be replaced with an alternative design that moves the stair outside the perimeter of the pontoon.

The peer review notes that most of the other elements within the structure appear to be in satisfactory condition.

Keep and maintain existing structure or replace

With regards to recommendations to keep and repair the current structure or replace Tonkin provided the following advice:

1. The least cost option is replacement of the damaged pontoons at the northern corner, as well as a range of other works to piles, most of which are recommended in the June 2022 report.

2. Installation of another marina system could be explored however the cost is likely to be significant to achieve something that would perform better with similar or less maintenance. There are very few systems that would be expected to perform better.

3. It is noted that all marine structures require maintenance through their design life. This may be the result of corrosion or deterioration, vessel or debris impact damage, or storm damage.

4. A floating or piled wave attenuator could be considered in future to improve the wave climate.

5. Alternatively, a netted enclosure consisting of netting supported on cables suspended from perimeter piles could be constructed, with less likelihood of damage. However, this arrangement is still expected to require regular cleaning of the net. New structures or part retention of the existing structure would also be required to provide access into the water via gangways and floating pontoons.

Tonkin considers the preferred option is to retain and repair or modify the structure with a modified joint arrangement at the northern corner.

Conclusion

The swimming enclosure is a valued and well utilised community asset. There is the opportunity to complete recommended repairs and modification while the jetty renewal works are underway, and the swimming enclosure shut.

Based on the review by Tonkin it is recommended that remedial works to the existing structure as proposed in the Assessment Report (June 2022) and confirmed by Tonkin be undertaken, noting that a RFT process has been completed and a preferred contractor identified. In addition, improved wave attenuation in the form of a wave attenuation pontoon should be investigated.

A programmed maintenance regime including regular inspection and predator net cleaning must be implemented, as a priority once repairs are completed. The inspection and maintenance program should be outsourced to a suitably qualified contractor for a fixed period e.g., four years with appropriate oversight and reporting by Council officers.

ATTACHMENT 8	**I223976**
REPORT 12.1	**ASSESSMENT REPORT ON TOWN JETTY SWIMMING ENCLOSURE (JUNE 2022)**
	I231611
	PEER REVIEW OF ASSESSMENT REPORT ON TOWN JETTY SWIMMING ENCLOSURE (JULY 2023)

ASSESSMENT REPORT

on

TOWN JETTY SWIMMING ENCLOSURE
PORT LINCOLN

for

CITY OF PORT LINCOLN

Project No.: 22206
June 2022

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Attachments:

Seaslip Design Drawings for Swimming Enclosure

Meinhardt Certificate of Adequacy

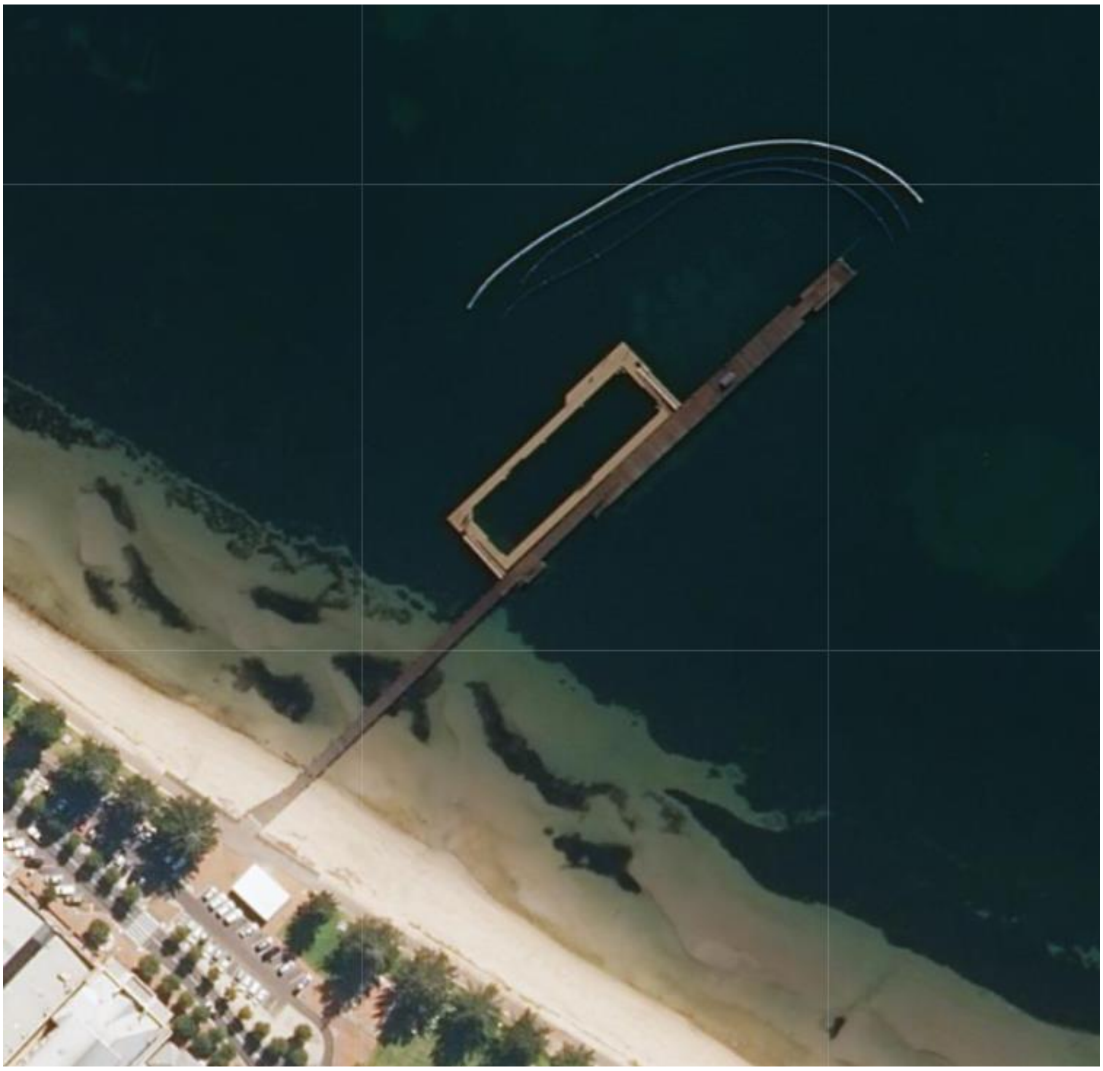
Magryn Drawing 22206-1 “Recommended Remedial Works”

1. GENERAL

A public swimming enclosure was built in Boston Bay for City of Port Lincoln on the north western side of the Town Jetty and completed in February 2016.

This facility incorporated:

- Floating pontoons which form a walkway around the swim enclosure
- Driven piles to locate the pontoons but allow them to move vertically with changing water levels. Some piles were existing prior to the construction of the swimming enclosure. Some were new steel tubular piles.
- Two gangways from the jetty to the pontoons. The floating pontoons, piles and gangways were designed and installed by Seaslip.
- A predator exclusion net extending from under the pontoons to the seabed.
- A wave attenuator around the northern side of the enclosure and outer end of the jetty (added around 2016). Seaslip state that this is not a wave attenuator for the swim enclosure, but is meant to provide a safer area for swimming outside the enclosure. The attenuator was not designed or installed by Seaslip.



The construction of the facility is as described below.

1.1 Design Basis of Facility

The piles, pontoons and gangways were designed, documented and constructed by Seaslip.

The design parameters stated by Seaslip were as noted on their drawing 4515-01, being:

1% AEP High Water Event	2.23m CD	1.48m AHD
Highest Astronomical Tide (HAT)	1.915m CD	1.165m AHD
Indian Springs Low Water (ISLW)	-0.035m CD	-0.835m AHD

(CD is chart datum. AHD is Australian Height Datum)

Environmental Loads

Wave			
	Local Sea ARI 50 year	H_{max}	= 1.8m
		H_s	= 0.9m
		T	= 2.4sec
Wind			
	Region A Basic Wind Gust Speed all directions	V_p	= 41m/s (80 knots)
	Height	H_z	= 3.0m
	Terrain Category 2	$M_{(z,cat)}$	= 0.48 (dynamic)
Current			
	Current velocity	V_c	= 4 knots
	Flood zone		N/A
Berthing – Dedicated Swim Zone Facility – No Vessel Requirement			
	Berthing velocity	V_b	= N/A
Live Load – Buoyancy Stabilized – Unrestricted Walkways			
		LL	= 1.5 kPa UDL
	Freeboard of pontoons		= 400mm
Live Load – Stability – Stabilized – Unrestricted Walkways			
		LL	= 1.5kPa UDL
Live Load –			
	Structural Walkways	LL	= 1.5kPa UDL, or 4.5 kN point load
	Gangways	LL	= 1.5 kPa UDL, or 4.5 kN point load

The pontoon system was designed by Seaslip for this particular site, and their drawings refer. Their project number is 4515 and their drawings are:

DRG No.	REV	DRAWING TITLE
General		
4515-00	C	Drawing List – As Constructed
4515-01	A	General Notes For Construction
4515-02	D	Locality & Site Plan – Final Layout
4515-03	B	General Layout
4515-04	B	General Layout – Piles
4515AC-PP1	B	Pontoon Plan As Constructed
4515AC-P9	B	STD Pontoon 2.4m x 9m Plan
4515AC-P/2	B	STD Pontoon 2.4m x 9m Elevations
4515AC-SP9	B	Standard Integrated Step Pontoon
DATA SHEET	D	Data Sheet For Duralco Ampligrid Step Units
AJ1	A	Walkway to Walkway Connection Detail
4515-FC/01	A	Flexi Connections Under Load
4515AC-P1/P2	B	Typical Pontoon Corner Connection P1 to P22
Gangways		
AC4515-GW/6	B	Gangway Frame 6040 x 1500
AC4515-GW/9	B	Gangway Frame 9040 x 1500
AC4515-16/1	A	Gangway Plans/Sections/Elevations
AC4515-16/2	A	GW Truss & Handrail Detail
AC4515-16/3	A	GW to Timber Jetty
AC4515-16/4	A	GW Slide BKS & Treadplates
AC4515-AJ3/1	B	Articulated Hing Joint – Fixed Jetty To Gangway Plan & Sections
AC4515-AJ3/2	C	Articulated Hing Joint – Fixed Jetty To Gangway Bracket Details
Other		
4515-SP/01	A	Existing Jetty Survey
4515-07/1	A	Safety Access Ladder Layout
4515-07/2	A	Safety Access Ladder Details
Frame Sections		
TS 52997/A	-	SSPP Cross Member ‘CM’
TS 52998/A	-	SSPP Side Waler
TS52999/A	-	SSPP Connection Profile
TS26582/B	-	End Channel ‘EC’
Floatation Units		
F1-01 TO F1-03	C	Float Detail F1
F4-01 TO F4-03	A	Float Detail F4
FL-750	A	Float Detail F7

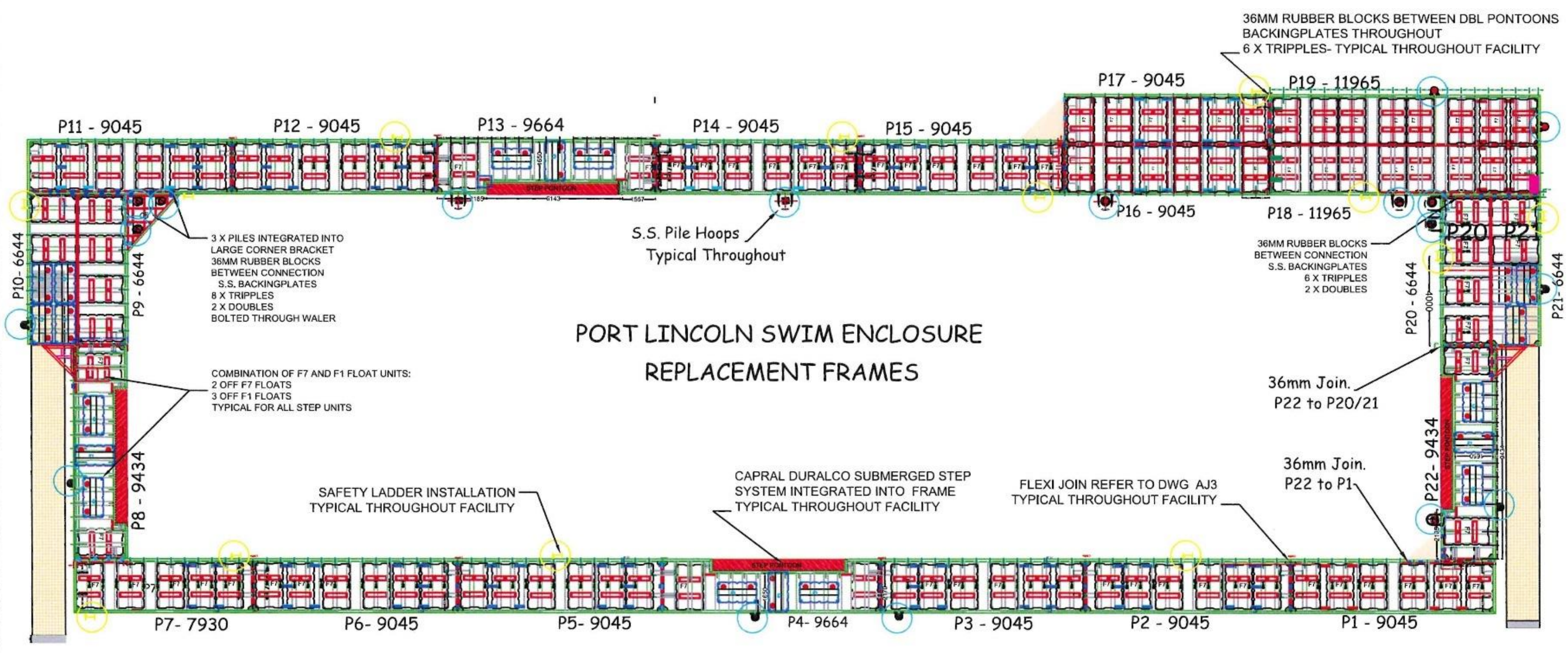
The structural adequacy of the swimming enclosure structure was checked by Meinhardt and their certificate of adequacy is attached.

1.2 Floating Pontoons Arrangement

There are 22 pontoons, varying in size from 6.64m to 12m long, and 2.2 to 2.4m wide.

The pontoons are Seaslip manufacture, and are generally a single line of pontoons except for the northern and western corner, where the pontoons are two wide.

The Seaslip pontoons are comprised of a heavy aluminum welded frame, with plastic floats under and plastic deck mats over.



PLAN VIEW OF SWIM ENCLOSURE

NOTE:

1.0 PONTOONS TYPICAL 9045mm X 2390mm (refer to DWG 4515AC-P9)
2.0 STEP PONTOONS TYPICAL 2390mm X approx. 9m (specific lengths as marked) (refer to DWG 4515AC-SP9)
3.0 CORNER CONNECTIONS TYPICAL (specific lengths as marked) (refer to DWG 4515AC-CP1)
4.0 HOOP PILE BRACKET TYPICAL (specific sizes to suit piles small and large) (refer to DWG 4515AC-HPB1)
5.0 DURALCO STEP UNITS TYPICAL (refer to DWG 4515AC-DSU1)
6.0 FLOAT UNITS TYPICAL (refer to SSPP component DWGS)
7.0 ALUMINIUM FRAME SECTIONS TYPICAL (refer to SSPP component DWGS)

Issue	Description	Date
B	REVISED & ISSUED FOR CONSTRUCTION	30/10/15
A	ISSUED FOR CLIENTS APPROVAL	

Scales: NTS
DO NOT SCALE FROM DRAWING — A3 ORIGINAL SIZE

Client: PORT LINCOLN CITY COUNCIL

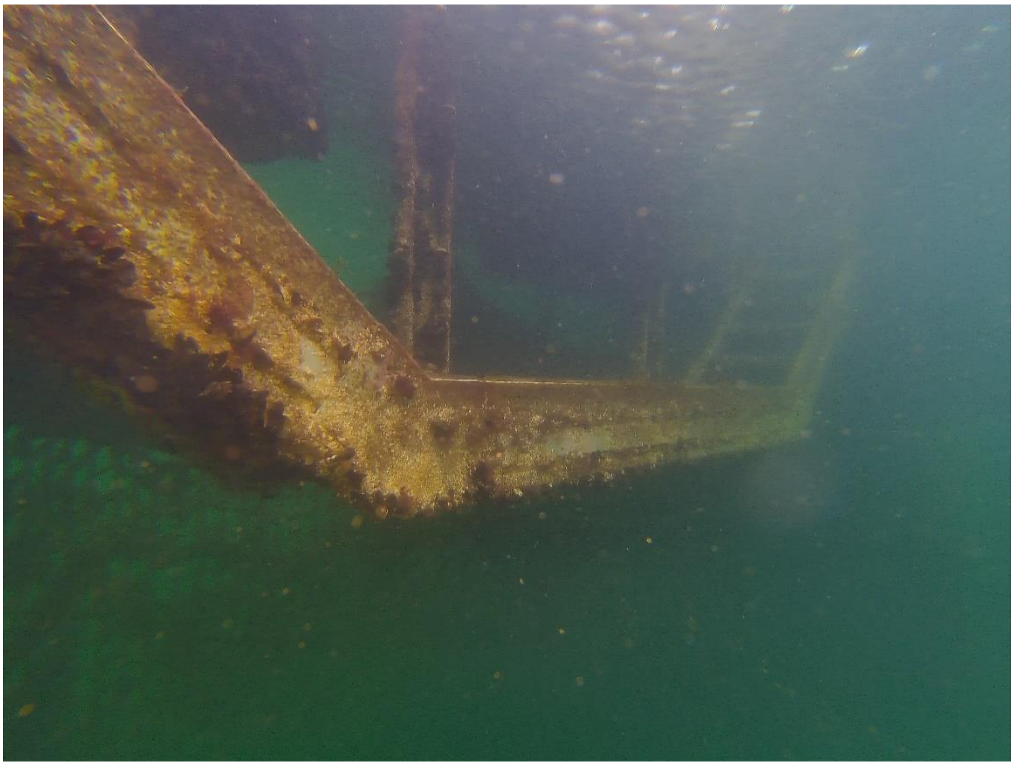
SSPP

Drawn	PC
Designed	LB/DY
Checked	LDB
Approved	LDB

Project: PORT LINCOLN SWIM ENCLOSURE
Title: GENERAL LAYOUT OF SWIM ENCLOSURE
Drawing Number: 4515AC-03
Rev: B - - -

Four of the pontoons (one on each edge of the enclosure) have steps with platforms leading into the water. These are pontoons P4, P8, P13 and P22. The original details of these step platforms are shown on drawing 4515AC-SP9.

It is reported that a local fabricator has retrofitted heavy channels to these steps to reduce flex in this structure. This was reportedly arranged by Council.



Some pontoons also have normal ladders extending into the water, both on the inside and outside of the swimming enclosure.

The pontoons are joined together with “Flexi Joins”, which are described on Seaslip drawing 4515AC-P9. These incorporate three 25mm blocks of rubber (one inside the end channel of each pontoon and one between the pontoons) which are bolted through with stainless steel bolts.

1.3 Location/Guide Piles

The swimming enclosure pontoons are located on site by 17 piles. The pontoons have either:

- Stainless steel hoops around the piles, or,
- The piles are set into the pontoon frames,

and have neoprene rubbing strips to allow them to move up and down the piles with changing water levels.

Some of the piles are noted to be "Existing Concrete Piles to be extended by 2m, HDPE sleeve installed".

Some piles are new steel tubular CHS piles.

All piles have HDPE sleeves around them and white plastic conical caps over to exclude air transfer, preventing rusting and corrosion inside of the piles.

1.4 Gangways

There are two aluminum gangways from the jetty to the pontoons, which are:

- 15m x 1.5m wide at the southern corner,
- 12m x 1.2m wide at the eastern corner.

Both of these gangways are trussed aluminum construction, with Seaslip deck mats as the walking surface. Both gangways are hinged at the jetty, and slide on the pontoons with changing tide level.

Seaslip drawings 4515-GW/6, 4515-GW/9. AC4515-16/1 to 16/4 and AC4515-AJ3/1 to AJ3/2 refer.

1.5 Predator Nets Under Pontoons

There are tuna farm nets hung under the floating pontoons, from the pontoon to the seabed. The net lies on the seabed so that they cover the entire water column during all tidal stages.

There is no documentation regarding the predator nets except for a note on drawing 4515-02 "Location and Site Plan" which is "Predator Net fitted to perimeter to Pontoons. Net Type as per Client's Requirements."

Seaslip have stated that they advised Council that these nets should be cleaned of marine growth annually or more frequently.

1.6 Wave Attenuator

The wave attenuator was installed after the pontoon arrangement was built, and consists of three poly pipes, each 450mm diameter and approximately 140m long. The outer pipe is painted white. The pipes are roped together to restrain them and keep them apart, with anchors set inside and outside the pipes to keep them on location.

The attenuators originally had four Danforth 500kg ships anchors to the west, and another to pull the end around to the pontoons. The ropes used were 40mm fibre ropes to the anchors.

The anchors have been augmented by 1.3t concrete blocks placed by Southern Ocean Dive and Marine, to better restrain the attenuator.

There is no documentation for the attenuator or anchors, and it was not designed or installed by Seaslip.

This type of wave attenuator using HDPE pipe with a net under does not provide good attenuation of waves. A similar attenuator consisting of three HDPE pipes with a net under one pipe which was installed at another location was analysed for it performance and found to reduce the energy of passing waves by only 13%. However, this is approximate only, and will depend on factors such as the weight and porosity of the net, which will change with the amount of marine growth on the net. The wave action of a severe storm may also cause a significant amount of marine growth to fall off the net, changing it’s performance.

2. HISTORY OF DAMAGE EVENT

On 2 September 2021 the structure was damaged by a storm event. High wave action on that day caused pontoons P18 and P19 to tear across their structural aluminium frames and break apart. One float was lost and other floats sustained damage. Some floats were partially flooded, causing listing of some areas of pontoons.

Locals report that the facility was subjected to a wind of 35kts (18m/s) of wind and wave heights of 1m on the day the damage occurred.

Wind records from Bureau of Meteorology taken at Pt Lincoln on that day show a maximum gust wind speed of 83km/hr (44kts or 23 m/s) from the north, with other readings of:

9am 52km/hr (28 knts) from the North
3pm 30km/hr (16 kts) from the North West.

The pontoons were inspected after the storm event by Seaslip (on 3rd, 7th and 11th of September 2021) and Southern Ocean Dive and Marine (on the 7th of September 2021).

Seaslip noted the following damage in their reports:

- P18 and P19 were broken/cracked across the width of both pontoon structures.
- A float was torn off P19.
- There were cracks in the top of the plastic floats.
- Pontoon P1 was low in the water at the eastern corner. Water ingress into floats was found to be a problem.
- Pontoons P14, P15, P16, P17, P18 and P19 were listing toward the east at high tide.

Southern Ocean Dive and Marine noted:

- A large amount of marine growth on the nets under the pontoons.
- A large amount of marine growth on the bottom of the pontoons.
- A chain entangled in the netting on the south eastern side of the enclosure, preventing the rise of the pontoons at high tide.

3. SITE INSPECTION

The swim enclosure facility was inspected by the undersigned on 18 May 2022 and 21 and 22 June 2022 above water and below water using a drone.

The following defects were noted on site.

3.1 Floating Pontoons

The water depth at the floating pontoons is around 3m. The pontoons were inspected from above in detail, with the deck mats lifted in several critical areas. The inspections showed:

- A major break in the pontoon frames of P18 and P19, in line with the inner side of P20. The P18 and P19 frames have completely broken through the whaler members, and are no longer connected. The pontoon parts are now chained together, with barriers over to prevent people accessing the pontoons.

- The P13 pontoon aluminium frame at the south western corner of the steps into the water is showing severe cracking at the weld to a cross member, in two locations.

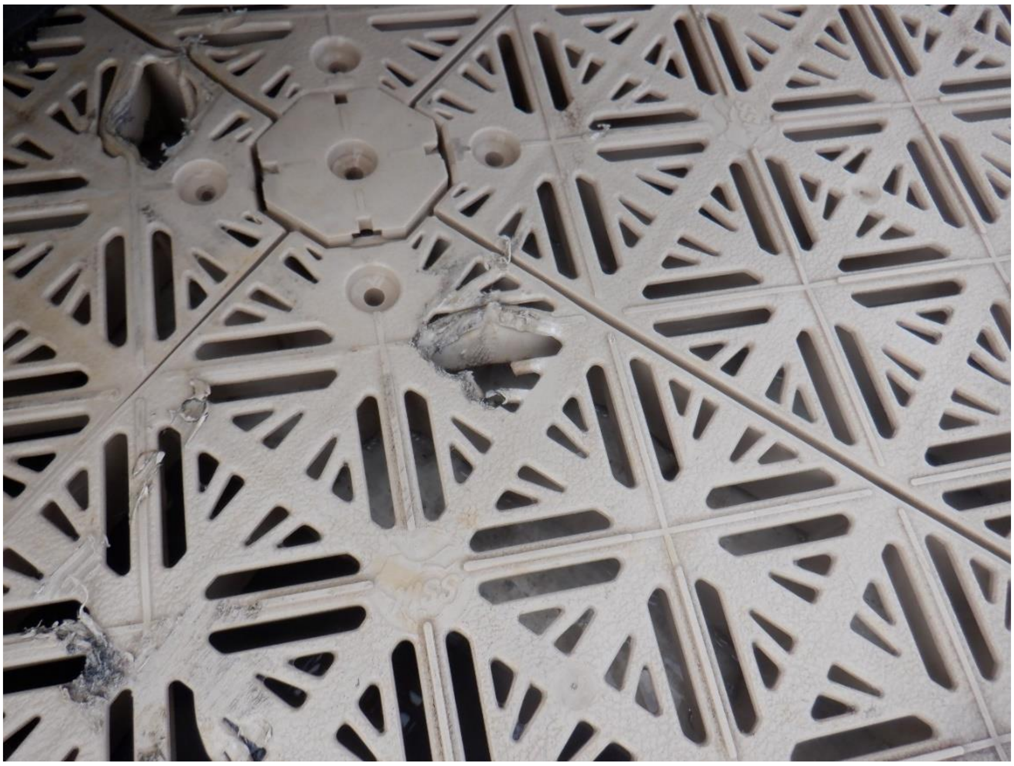
It is also showing cracking in the aluminium member at the other corner of the steps.

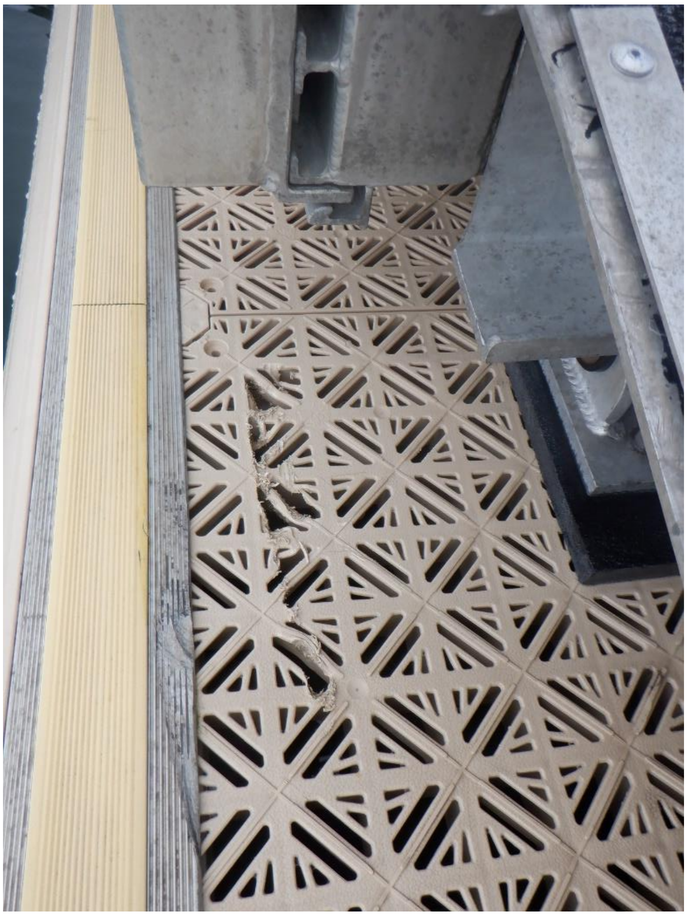
– Breather holes have been drilled into the tops of some floats.

– The pontoon aluminium frame on pontoon P4 is showing cracking at both corners of the steps into the water.

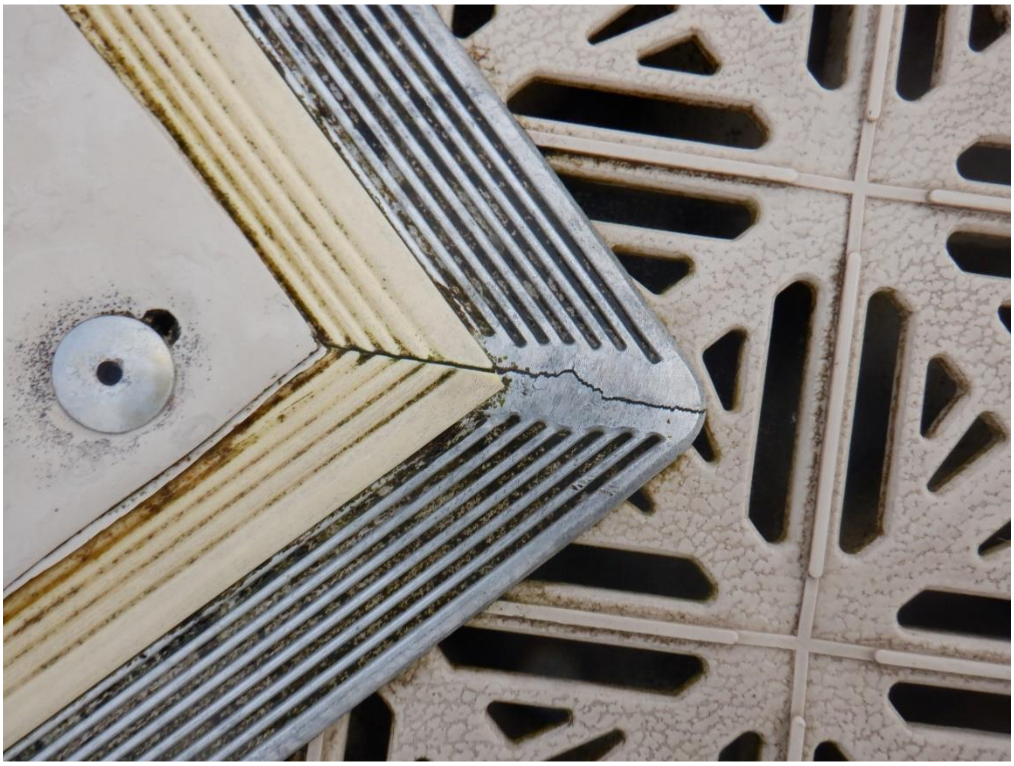
- The walkway plate from the northern gangway to the pontoons appears bent.

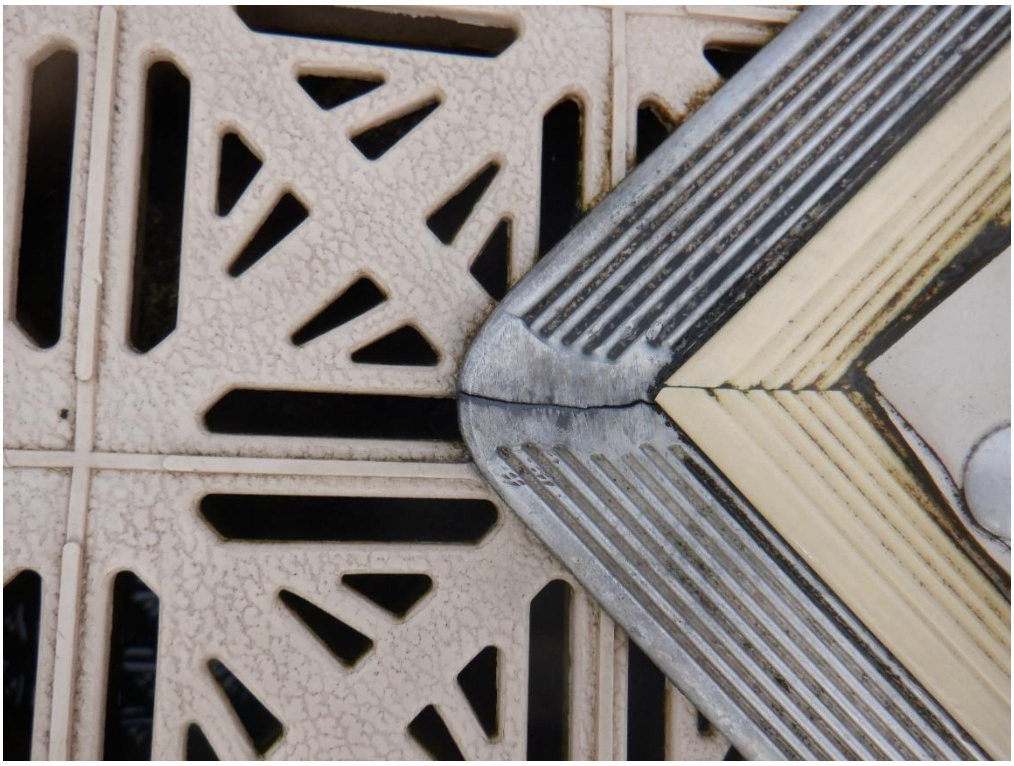
– The deck mats at the north western end of the north eastern gangway are damaged, possibly during installation of the gangway.





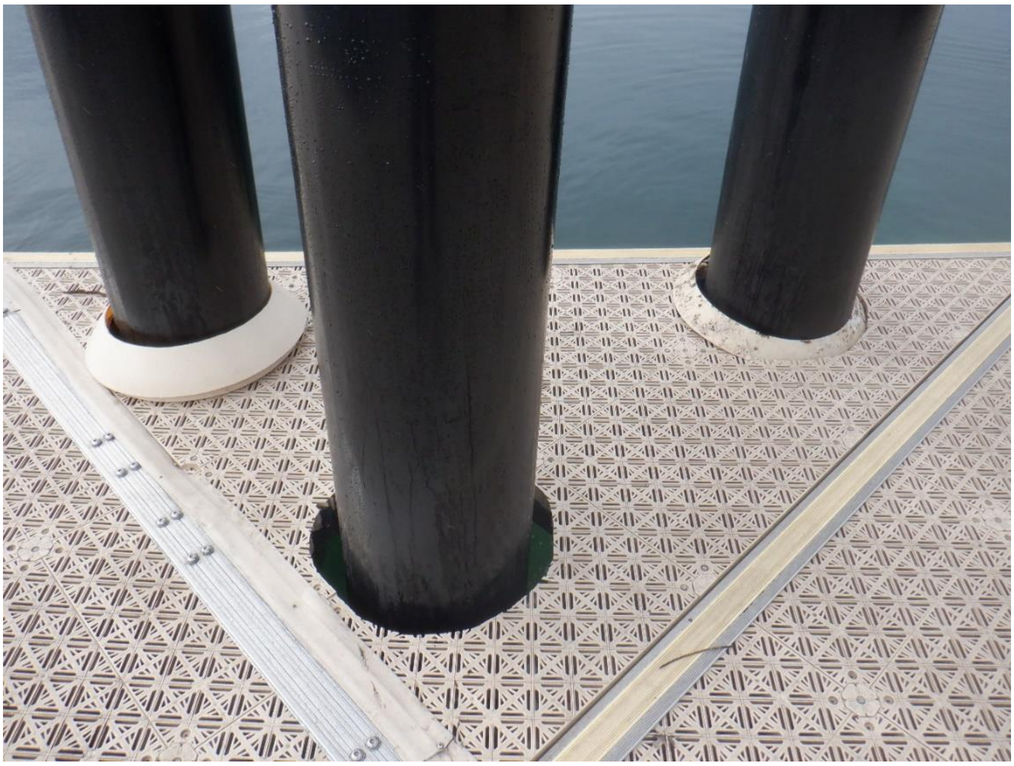
– The pontoon aluminium frame on P22 is showing cracking to the aluminium at both corners of the steps into the water.





– The pontoon floats are heavily encrusted with marine growth generally.

- The three corner piles at the western corner have their collar rings displaced or missing from the pontoons.

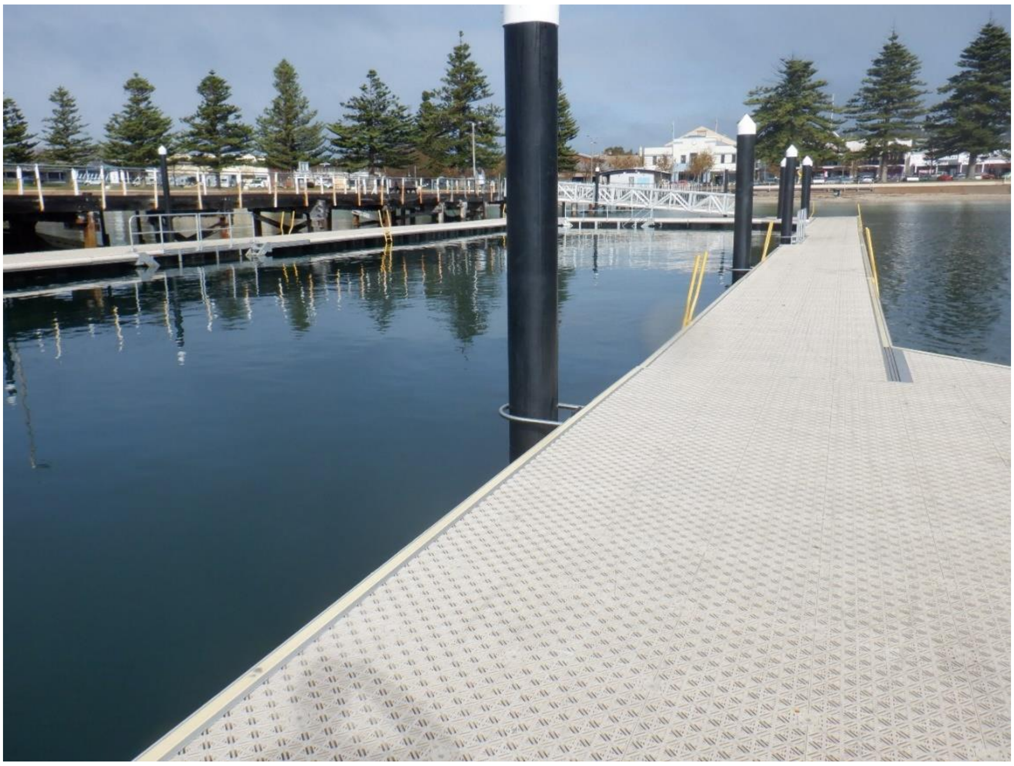


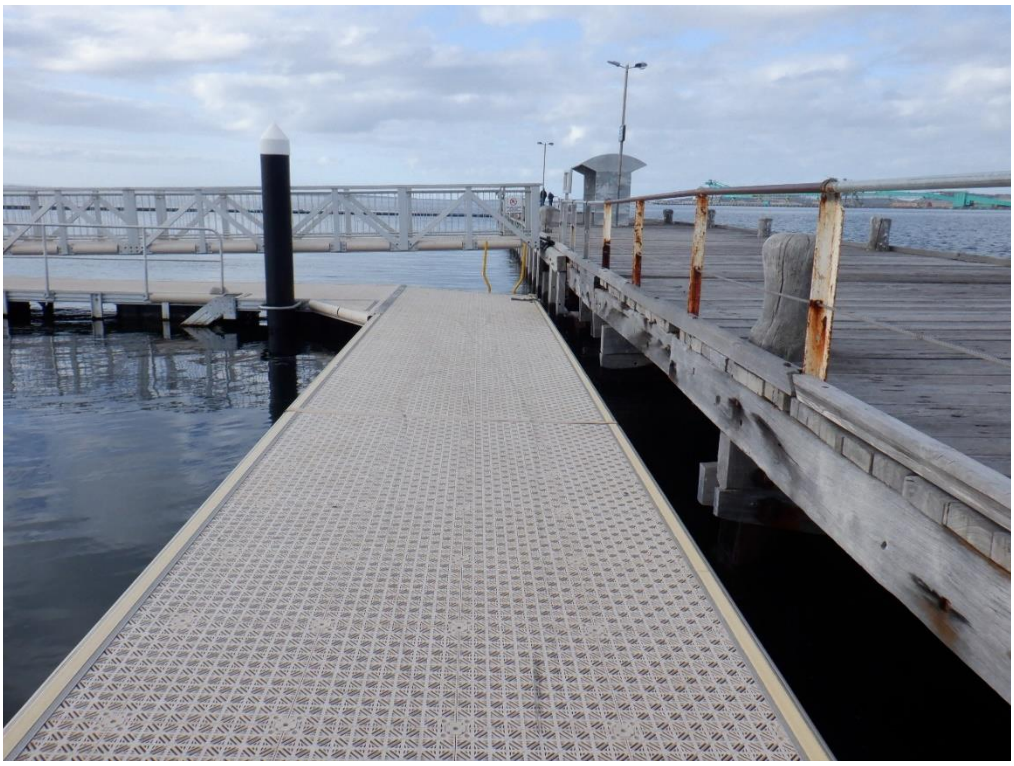
– The deck mats on the pontoon floats were checked for level, which indicates listing or out of level of the pontoons. The results of this were:

Pontoon	Perpendicular to Pontoon		Longitudinal along Pontoon
	Outer (northern) end	Inner (southern) end	
P1	2.9°	-1.4°	0.25°
P2	1.1°	0.6°	0.2°
P3	0.15°	0°	0.1°
P4	0.6°	-0.25°	-0.2°
P5	-0.2°	-0.2°	0.2°
P6	0.05°	-0.3°	-0.15°
P7	-0.35°	0°	0.2°
P8	-0.4°	0.15°	-0.1°
P9	0.1°	0°	0.15°
P10	-0.85°	-0.5°	0.85°
P11	1.25°	-1.9°	0°
P12	-1.9°	-1.9°	-0.5°
P13	-3.05°	-2.1°	-0.55°
P14	-1.8°	-2.85°	-0.05°
P15	-0.8°	-1.4°	0.2°
P16	-0.45°	-0.45°	-0.4°
P17	-0.45°	-0.9°	0.55°
P18 main section	-0.3°	-0.45°	0.15°
P18 broken off end section	-0.25°	0°	0.8°
P19 main section	0.3°	-1.45°	1.3°
P19 broken off end section	-0.25°	0°	0.8°
P20	-0.8°	-0.75°	0.2°
P21	-0.8°	-0.75°	0.2°
P22	-0.15°	0.25°	0.25°

These results show listing of the pontoons, generally sideways, varying from -3.05° to 2.9°.

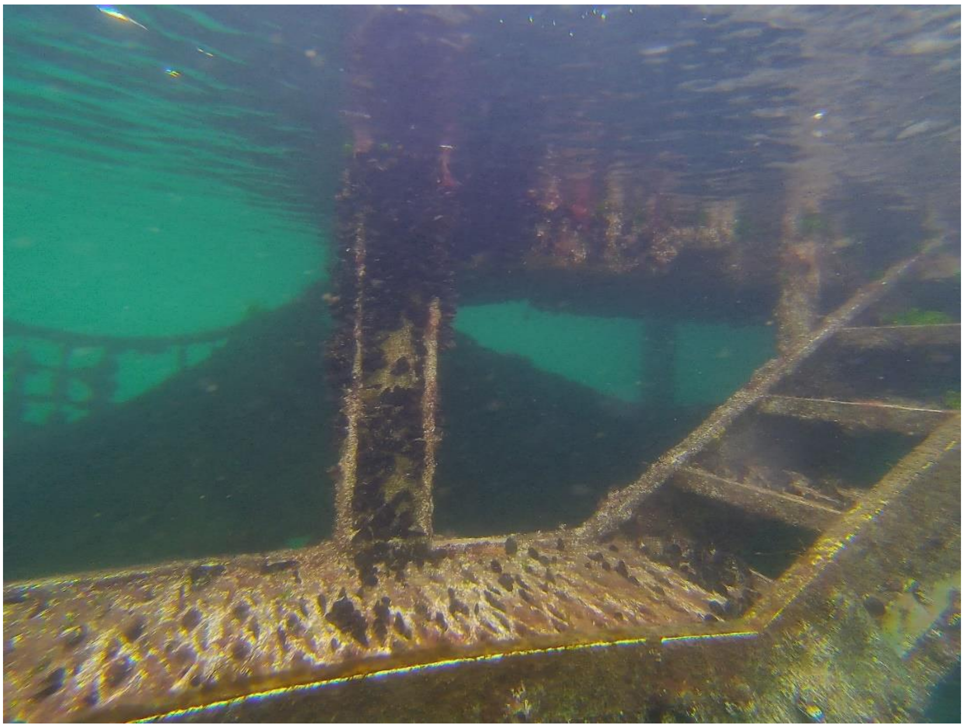
The above measurements are in degrees. For the perpendicular to pontoon measurement a positive figure indicates that the pontoon was lower on the inner edge of the swim enclosure that the outer. For the longitudinal measurement a positive figure indicates that the outer seaward end (north eastern or north western end) is lower than the shoreward end of the pontoon.

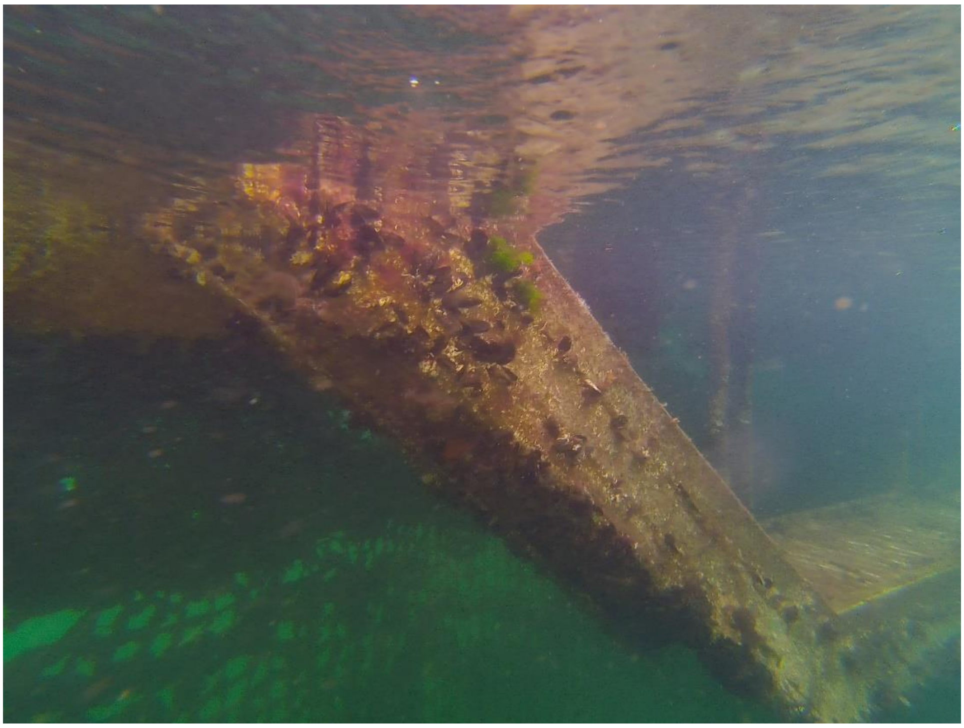




The measurements were taken using an Empire digital spirit level, which has a resolution of 0.05°.

– The steps into the water from the pontoons, on pontoons P4, P8, P13 and P22 are all typically well encrusted with marine growth.





3.2 Location/Guide Piles

There are 17 piles of varying sizes around the pontoons of the swim enclosure. These are a combination of pre-existing concrete piles and new steel tubular piles. All piles are sheathed in HDPE sleeves with white conical caps.

The following piles were noted to move easily laterally under load:

- South eastern side of P3, between the pontoon and the jetty.
- South western side of P8 between the pontoon and gangway.
- The western pile in the group of three at the junction of P9 and P11.
- South eastern side of P14.
- South eastern side of P16.
- North western side of P19.
- North eastern side of P19.
- North eastern side of P21.
- North eastern side of P22, between the pontoon and gangway.

This is 9 piles out of the 17 around the structure.

Mooring ropes from the pontoons, running as spring lines to the seabed were also noted at:

- From the eastern corner of the pontoons (pontoon P1) running north west along P22, P20.
- From the eastern corner of the pontoons (pontoon P1) running south west along P1, P2 and P3.

These mooring lines are not in the Seaslip documentation, and no details of them are known, including:

- why they were installed,
- who they were installed by,
- what they are anchored to at the seabed, and
- the type of rope, and how fixed.

3.3 Predator Nets Under Pontoons

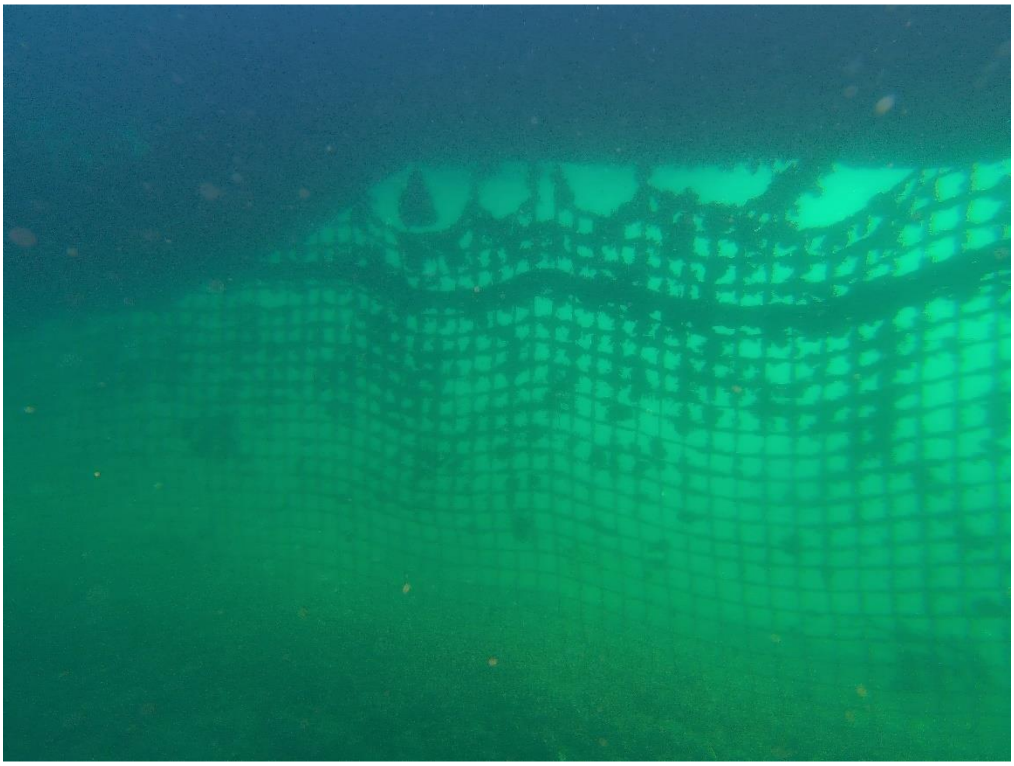
Predator exclusion nets have been hung under the pontoons. These are 50mm square x 4mm fibre rope tuna nets, which have been hung from the outer side of the pontoon frames. They extend from the bottom of the pontoon level to the seabed, and have lead lines through the centre of the nets and at the bottom.

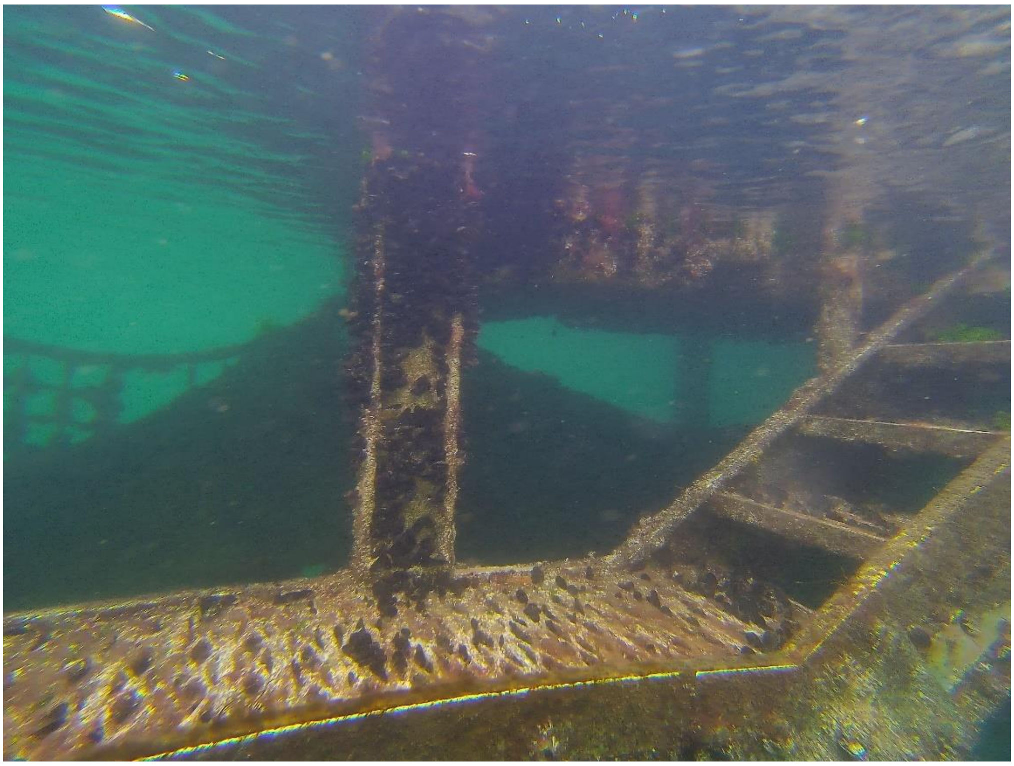
Seaslip state that they informed council that the nets were required to be cleaned of marine growth on a regular basis (annually), which was initially undertaken, but had not been done for several years prior to the 2021 storm event.

After the September 2021 storm event, the nets were cleaned by Southern Ocean Dive and Marine using high pressure water spray. They reported that the nets had severe marine encrustation prior to cleaning, and one section of net 0.3 x 0.3m had 5kg of marine growth (weighed in air). This is an “in air” weight of 50 to 60 kg/m^2.

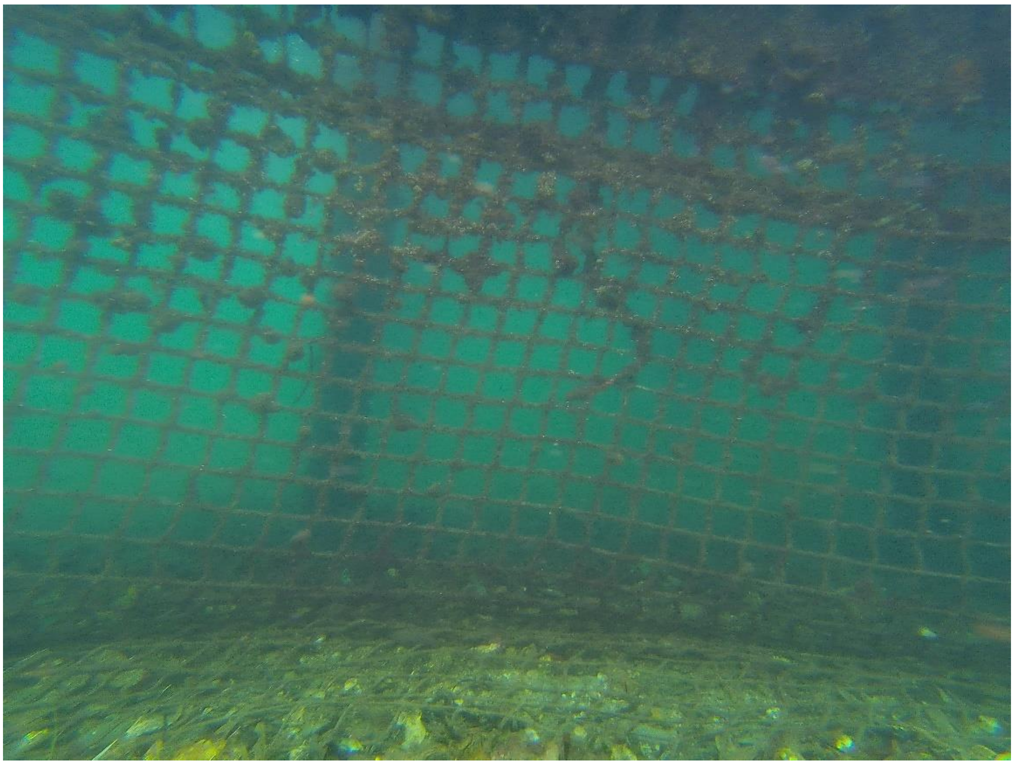
The inspection by drone on 21 June noted the following:

- There were some large gaps over the nets, under the pontoons. However, it is not known how ineffective these gaps would make the nets.

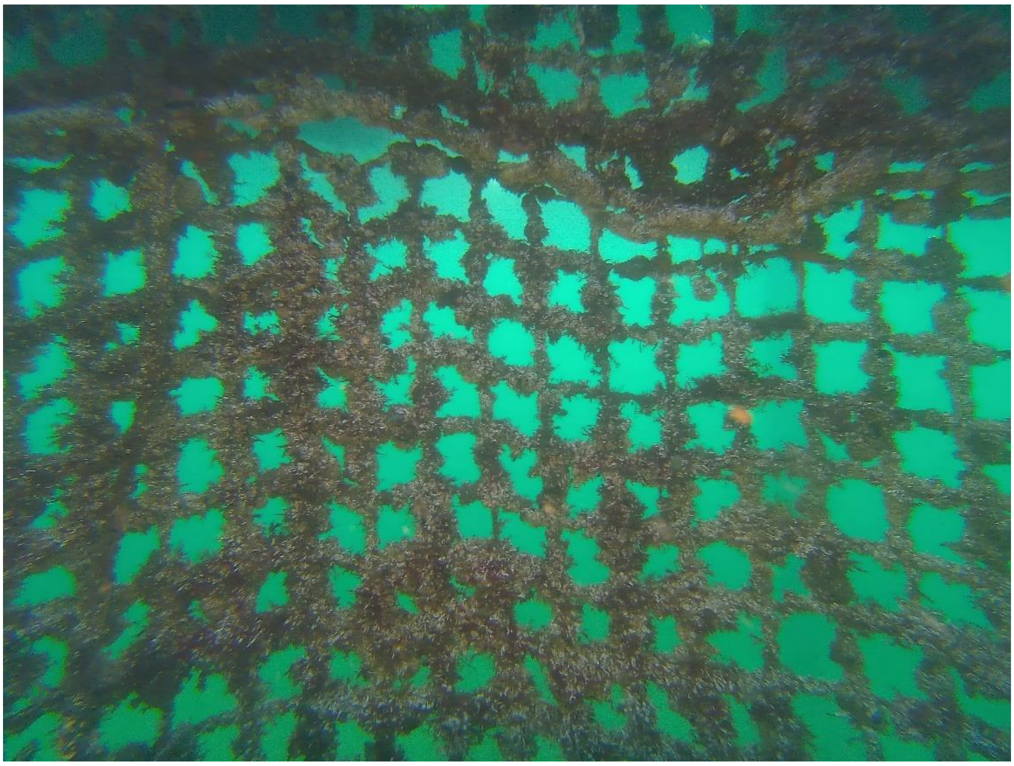




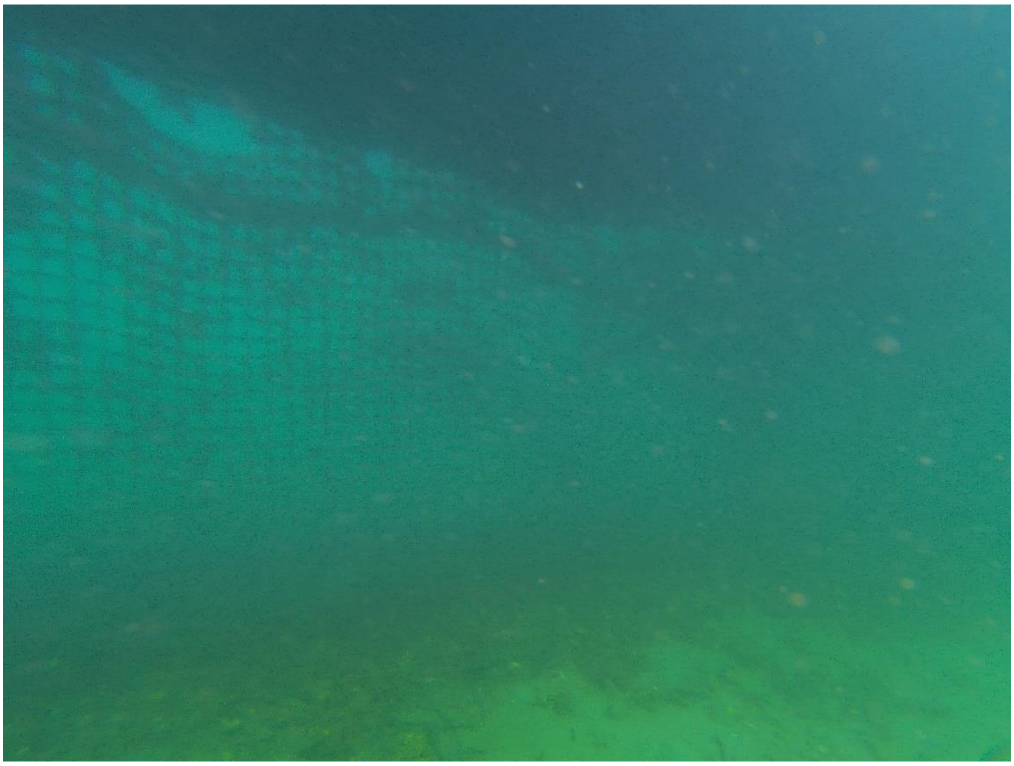
– The bottom of the nets lay on the seabed.



- There was substantial marine growth on the nets (even though they were cleaned September 2021).



- The condition of the nets was reported by Southern Ocean Drive and Marine as poor.

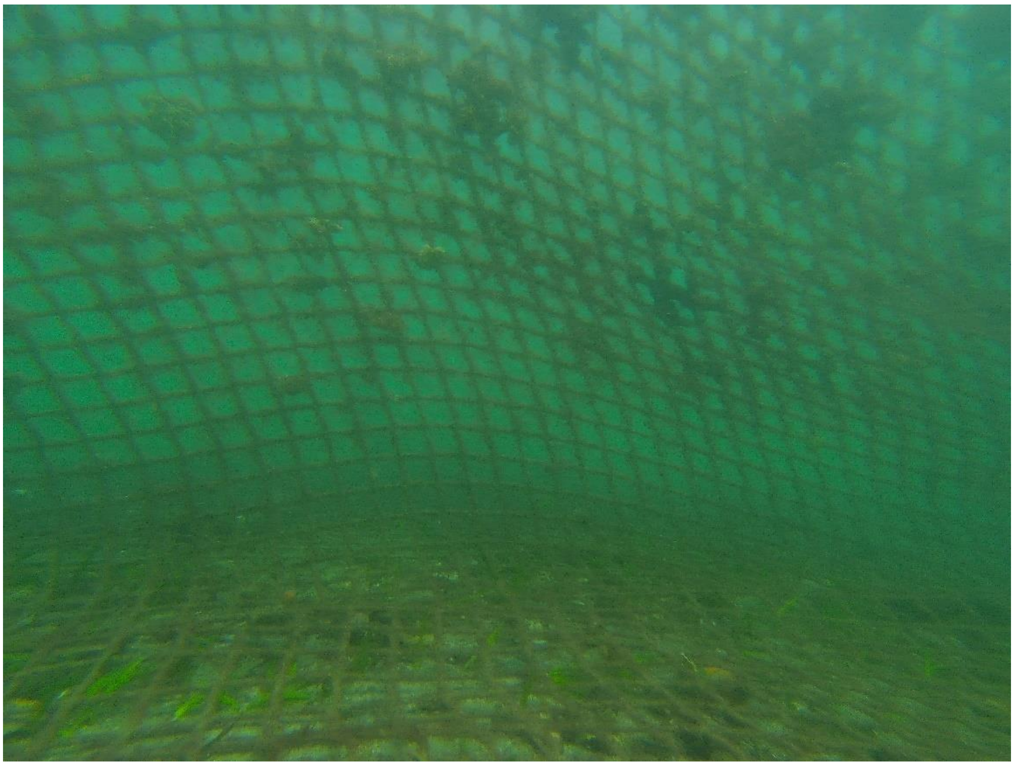


3.4 Wave Attenuator

The water depth at the wave attenuator was around 3m or deeper. The wave attenuator was inspected by drone only. The following was noted:

The predator nets under do not generally extend to the HDPE pipes at the surface, but extend down to the seabed. They are heavily encrusted with marine growth, and reportedly have never been cleaned. The nets appear to be the same 50mm square 4m fibre netting used under the pontoons.

The HDPE pipes appear to be in good condition, but are heavily encrusted with marine growth.



The HDPE pipes appear to be in good condition, but are heavily encrusted with marine growth.

The condition of the ropes is unknown due to their location and extent of marine growth.

4. WATER LEVELS

The performance of the facility is dependant on water movement at site, in particular:

- Water level variation due to tides and other effects,
- Waves,
- Currents.

4.1 Water Level Variation at Site

The water level at site varies due to normal tidal cycles, with other effects from atmospheric conditions superimposed on this.

Tidal levels at site as noted by SA Government Tide Tables are:

	Chart Datum	AHD
Highest Astronomical Tide	1.97m	1.14m
Mean Higher High Water	1.54m	0.71m
Mean Sea Level	0.89m	0.06m
Indian Spring Low Water	-0.02m	-0.85m

These are due to normal tidal changes.

Other atmospheric conditions which will alter the water level at site are:

- A low pressure atmospheric system will raise the water level up to 0.3m. Similarly, a high pressure atmospheric system will lower water level.
- Wind shear across the surface of the water will push the water in the direction of the wind. If the extent of water is restricted (as in a long bay or a gulf) and the wind is blowing into the coast, the water will tend to raise at the coast. This is very pronounced at the northern end of Spencer Gulf due to its shape, and this effect can raise water levels at Pt Augusta by up to 1m above normal tidal levels. As Pt Lincoln is at the base of the gulf (rather that the head) this effect is minimal at Pt Lincoln. This is termed “storm surge”.
- Wave set up is the raising of the average still water level between the breaker zone and the beach due to the energy released by the breaking of the waves. This effect is not relevant for this facility as it is outside the general wave breaker zone.
- Wave run up is the raising of the water level due to a wave breaking and running up onto the beach. This effect is not relevant for this facility.

The total cumulative result of all the above, including tidal variation, is assessed by analysis of actual tidal records. This was undertaken for Pt Lincoln, and provides an 1 in 100 year Average Return Internal (ARI) High Water Level. This is the highest average still water level (without the fluctuation of wave action) that would occur on average once every 100 years. For Pt Lincoln at the swim enclosure (which is offshore of the breaker zone) this has been assessed by the National Tidal Facility to be 1.90m AHD. This level does not include for wave effects.

4.2 Sea Level Rise

Due to climate change, sea level rise is anticipated to occur.

The current predictions are:
- 0.3m to 2050,
- A total of 1.0m to 2100.

Please note that the actual sea level rise which occurs at the site may be above or below the predictions above.

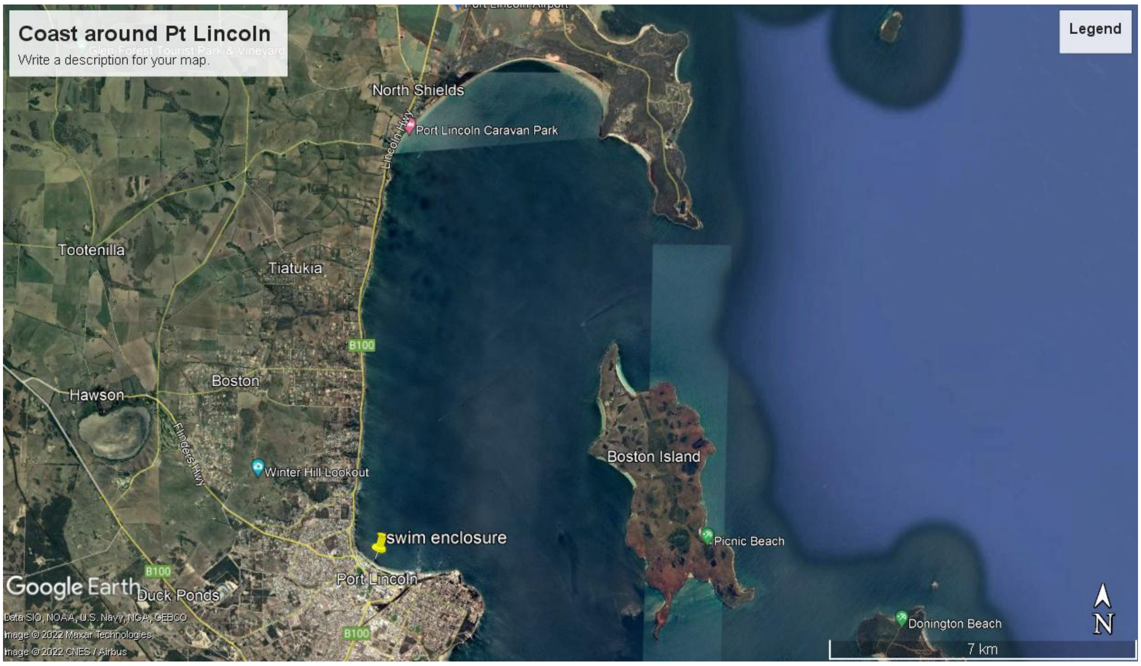
The result of an increased sea level is that the water will be deeper at the facility. This will:
- Require the nets to be deeper to extend to the seabed normally and in a high water level event.
- Any forces on the pontoons or wave attenuator will be higher above the seabed, causing increased moment on the guide/location piles and steeper angles from horizontal on the anchor ropes. This may have a negative effect on performance of the facility.

4.3 Wave Assessment

The site is quite protected from by long period ocean swells, as these generally approach from the west or south west. The site is inside Boston Bay, in the lee of Boston Island.

The site is subject to locally generated wind waves. These waves are generated by local winds blowing over the water. It is important to note that the wind speed considered in this assessment is the average wind speed while the waves are being generated, not a 3 second maximum gust speed.

The fetch for this wave generation is limited to the north by Point Boston (11.5km) and Boston Island to the east (6km).



Wind Hindcasting

Wave hindcasting is the prediction of wave height and period at site, based on particular wind events. This is based on fetch (the distance of water the wind blows over), water depth, wind speed and wind duration.

The fetch across Boston Bay from the north east is 11.5km. Assuming a maximum hourly average wind speed of 30kts (56km/hr) and a depth across the bay of 6m, gives an estimated wind climate at site of:

H_{sig} = 0.75m

T = 3.15 sec

(US Army Corp of Engineers, Shore Protection Manual, Fig 3-30).

This is within the design parameters as stated by Seaslip for the facility.

H_{sig} is the significant wave height, which is the average of the one-third highest waves. The maximum wave height in this scenario is approximately $2H_{sig}$, which in this case is 1.5m.

5. DISCUSSION

5.1 Floating Pontoons

5.1.1 Pontoons P18 and P19

There are serious problems with the pontoons and the way they interact with each other under wave loading.

The largest waves come from the north and impact the facility on the diagonal. The northern corner and north eastern and north western sides of the enclosure lift and fall under the wave crests travelling south. This causes bending in 2 directions along the pontoons structure and torsion in the pontoons at the corner where the north western side pontoons connect to the north eastern side pontoons.

Pontoons P18 and P19 are 12m long and are joined together to be effectively 4.4m wide. These are the longest pontoons in the facility and are also the most exposed.

The waves discussed in the wave hind casting section above have a period of 3.15 seconds, which have a wave length in 3.5m deep water of 14.1m. Depending on the angle of approach of the wave to the pontoon, the crest to crest distance along the pontoon could be anywhere in the region of 10 to 14.1m. This is around the length of the pontoon, meaning that the pontoon will effectively span from wave crest to wave crest, with the centre of the pontoon suspended out of the water.

The pontoon is unlikely to be loaded by people during this action, however the self-weight of the aluminium frame, floats and deck mats over will cause bending in the pontoon frame.

As the wave moves on, the centre becomes supported and each end is suspended. This causes bending of the frame in the opposite direction.

As this bending/reverse bending in the frame is occurring in pontoons P18 and P19 under the passing waves, the same thing is happening to pontoons P20 and P21, which are connected to the outer end of P18. The end reactions of P20 and P21 where they are connected to P18 result in twisting and torsion on the outer end of P18 and P19 at the connection.

The aluminium pontoon frames are welded PFC sections, and as PFC’s are an open section they are very poor at handling torsion. This leads to high stresses in the PFC members and their end connections.

This bending and twisting of the pontoon frames have resulted in pontoons P18 and P19 breaking across their width at the inner edge alignment of pontoon P20. This break is complete through the pontoon frames.

This bending and torsion are exacerbated by:

- The length of P18 and P19, which are 12m each. These are the longest pontoons in the facility.
- The fact that P18 and P19 are joined along their long axis, forcing them to act as one wide pontoon, further exacerbating the stresses on the aluminium frame,
- The connection to other pontoons. The rotation between adjoining pontoons is limited by the connections, which are rubber blocks with bolts. Seaslip drawing 4515-FC/01 shows that this Flexi Connection can accommodate a maximum angular deflection of 13.7° between pontoons. If the junction of P18 and P21 is on a wave crest, and the other end of P21 is in a wave trough then pontoon P21 is on an angle of 6.5° (being 6.6m long for a 0.75m high wave). Similarly, the slope across pontoons P18 and P19 would also be around 6.5°, in the other direction. This total deflection would then be at the limit of the joint between the two pontoons, for a 0.75m high wave train. It should be noted that H_{sig} = 0.75m, and there would be numerous larger waves in the wave spectrum. This movement appears beyond the capacity of movement of the joint between pontoons.

5.1.2 Step Pontoons

There are four step platforms from the pontoons into the water, one on each side of the swim enclosure, incorporated in pontoons P4, P8, P13 and P22. These step platforms are noted to be Capral Duralco submerged step systems.

There are no drawings or details of these step platforms, however, it is noted that:

- The ends of the steps are fixed to aluminium PFC cross members in the pontoon frame.
- Additional vertical PFC members were welded/bolted into position (by others) to prevent movement of the steps.
- The steps are typically submerged, meaning that they would move up and down through the water with a passing wave.
- The steps have aluminium grating flooring, which had a significant amount of marine growth on it at the inspection.

As these steps rode up and down in the water with a passing wave, they would cause a vertical load onto the pontoon frame at the fixing point.

This load would be cyclical and repeated many times during a storm period (approximately 27,000 times a day).

This loading may overstress the pontoon frame, or cause fatigue failure.

Any significant marine growth on the floor plate of the steps will decrease their porosity, and increase the loading to the steps and pontoon.

All four step pontoons show cracking of welds and/or members in the pontoon frame at one or both supporting corners of the steps.

5.1.3 Marine Growth on Pontoon Floats and Predator Exclusion Nets

Both the pontoons and predator exclusion nets under the pontoons are subject to marine growth build up over time. As the amount of marine growth increase, it weighs more and this additional weight causes a dampening of the response of the pontoons to wave action, and hence increases the stresses experienced by the pontoon frames.

This leaves the frames more likely to experience damage from wave action in a storm event.

It is not possible to definitively correlate the amount or effect of the additional loading of the pontoon frames to amount of marine growth, as this varies with the amount of marine growth and storm waves experienced at the time.

Seaslip had advised that the pontoons and nets should be cleaned regularly of marine growth, however this was undertaken and the extent of marine growth prior to and after the storm event (as shown by SODM site reports) and at the inspection by Magryn was significant.

5.1.4 Pontoons Out of Level

Some pontoons were noted at the inspection to be out of level, with a sideways list of up to 3° and a longitudinal list of up to 0.85°.

This listing appears due to one or more of the following causes:

- Water penetration into the floats, either though damage, or via the breather hole or an inspection port into the float.
- The weight of the marine growth on the pontoons and/or nets under.
- The nets being caught in debris on the seabed, preventing the pontoons from rising with the tide.

5.2 Location/Guide Piles

There are 17 Location/Guide Piles around the swim enclosure, which are a combination of pre-existing piles and new piles. They are also a combination of 200mm and 400mm diameter (taken around the HDPE sleeve around the pile).

Of these 17 piles, inspection at site found that nine moved easily or an unacceptable amount when pushed laterally. These piles are typically in water depths of 3 to 4m.

It should be noted that these piles may have worked loose in the seabed due to wave movement during storm events.

This is an unacceptable number of loose piles around the structure, as they do not provide adequate restraint to the pontoons.

5.3 Gangways

The gangways generally, and their connection to the existing jetty structure, were in good condition.

The only defect noted was the rotating connection plate from the bottom of the gangway onto the pontoon, which appeared to have been overloaded and bent downward in the centre.

There are no details in the original Seaslip drawing to show if this plate was originally straight or curved.

However, the connection plate is functional.

5.4 Predator Exclusion Nets Under Pontoons

The predator exclusion nets hung under the pontoons are in poor condition.

These are 4mm fibre nets, nominally 50x50mm openings, and show:

- Numerous openings and gaps under the pontoons over the nets.
- Excessive marine growth on the nets.
- Some holes.

5.5 Wave Attenuator

The wave attenuators appear to be in reasonable condition, with the HDPE pipes serviceable. The anchors could not be examined, but the attenuator shows no signs of movement due to dragging anchors.

The nets under the HDPE pipes are in similar condition to the nets under the pontoons, but in the case of the attenuator marine growth on the nets increases their effectiveness in attenuating waves, as it decreases their porosity and increases their weight. There is no negative effect for the nets under the attenuator pies in having more marine growth.

The attenuators are not particularly effective in attenuating the waves. They do provide a slightly calmer area behind them for people swimming outside the enclosure.

6.0 RECOMMENDED REMEDIAL WORK

Repair and ongoing maintenance at site is important, and this should receive adequate attention. In particular, much of the structure is located in seawater, and this will allow the build up of marine growth on nets and pontoons, adding weight to the supporting structure over. This marine growth should be cleaned off the predator exclusion nets under the pontoons and off the pontoons themselves on a regular basis. Intervals of 6 to 12 months between cleans may be appropriate, and this can be assessed on site.

The following remedial works should be undertaken.

6.1 Floating Pontoons

- Repair of pontoons P18 and P19, including:
  - Incorporation of new joints into P18 and P19 at the break line (in line with the inside face of P20). This reduces the length of the pontoons P18 and P19 from 12m to 7.5m.
  - Repair of all broken welds and replacement of all damaged aluminium sections on P18 and P19.
- Incorporation of new connections between pontoons to allow more movement and rotation between pontoons, particularly between:
  - P19 A and B (being the two new pontoons replacing P19)
  - P18 A and B (being the two new pontoons replacing P18)
  - P17
  - P16
  - P20
  - P21
  - P11
  - P9
  - P10

  These new joints are recommended to be the articulating bracket type, as detailed on AC4515-16/4.
- Testing and inspection of all welds at the top of all step platforms on pontoons P4, P8, P13 and P22. Repair of all welds as required.
- Removal of step platforms into the water on pontoons P4, P8, P13 and P22, or redesign of the supporting aluminium frame structure at each end of the steps to more fully support the steps without creating torsion into the frame. This will require a full structural review of the framing of these pontoons.

- Inspect all floats for water ingress and/or damage. Damaged floats or those with water ingress should be replaced with new. Consideration should be given to filling the floats with expanding polystyrene foam to prevent/limit water ingress in the future.

6.2 Location/Guide Piles

- Remove the white conical caps on the nine loose piles.
- Redrive these piles to achieve proper embedment and fixity.
- Splice piles to existing to achieve the correct top of pile level.
- Replace the HDPE sleeve around the pile.
- Replace the conical cap with an air tight seal.

6.3 Gangways

No work required.

6.4 Predator Exclusion Nets Under Pontoons

- Replace the existing predator exclusion nets under the pontoons with new.
- It is recommended that two sets of nets be made, and one set placed in storage. Hence, when cleaning or repair of the nets is required the nets can be swapped out and cleaned off site.

6.5 Wave Attenuator

- It is not recommended that the wave attenuator be relocated.
- No work is recommended for the wave attenuator.

For Magryn & Associates Pty. Ltd.

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231044R001Rev0 Peer Review of Swim Enclosure Failure Report

11 July 2023

City of Port Lincoln
Level 1, Civic Centre
60 Tasman Terrrace
PORT LINCOLN SA 5606

Attention: Ms Kathleen Brannigan

Dear Kathleen

PEER REVIEW OF SWIM ENCLOSURE FAILURE REPORT

Introduction

This report has been prepared at the request of Ms Kathleen Brannigan of City of Port Lincoln. The report provides commentary in relation to the findings of an earlier report regarding the damage that occurred to the Town Jetty Swimming Enclosure, at Port Lincoln. The earlier report is entitled Assessment Report on Town Jetty Swimming Enclosure Port Lincoln, for City of Port Lincoln, and was prepared by Mr Terry Magryn of Magryn Engineering Consultants, dated June 2022.

The intent of this report is to review the findings of the earlier report, and provide commentary and recommendations to City of Port Lincoln that address the following queries:

1. Should the existing facility be repaired or replaced?
2. Should the existing enclosure be relocated to the eastern side of the jetty?
3. Comment on the effectiveness of the of the current wave attenuation.
4. Comment on options for alternative wave attenuation options.
5. Which recommendations for repair stated in the Magryn report do you agree with and do you have any additional recommendations.

Information Provided

The following documents were reviewed during the preparation of this report:

- Assessment Report on Town Jetty Swimming Enclosure Port Lincoln, for City of Port Lincoln, prepared by Mr Terry Magryn of Magryn Engineering Consultants, dated June 2022.
- Drawing 22206-1 rev A prepared by Magryn Engineering Consultants dated 15 July 2022
- Port Lincoln Swim Enclosure Final Structural Design & Construction Certificate prepared by Meinhardt dated 4 March 2016
- Drawing AC4515-PP1 Rev B prepared by Seaslip dated 31 October 2015.
- Port Lincoln Inspection Report dated 3 September 2021 prepared by Ms Lyn Brighton of Seaslip.

Mr Russell Howell of Tonkin attended the site on 13 September 2022 to review the Town Jetty. A number of photos and videos were taken during the visit.

Review of Magryn Report

Comments in this section reference the various sections of the Magryn report, and may need to be read in conjunction with the report.

Section 1.1 Design Basis of Facility

The loads stated here appear to be in accordance with the relevant design standards. The stated wave climate appears to correlate with wave heights and periods determined by accepted methods.

Section 1.2 Floating Pontoons Arrangement

Comments are made on page 9 regarding flexibility of the steps. Tonkin does not possess copies of the drawings so cannot comment on the stair detail.

Section 1.3 Location/Guide Piles

Paragraph 1 – Tonkin notes that the rubbing strips are likely to be HPDE, not neoprene.

Section 1.6 Wave Attenuator

This section describes the wave attenuator positioned north of the enclosure, constructed of floating tubes typically used to create floating enclosures for fish farming. The final paragraph in this section states that a net is suspended from at least one of the floating tubes.

Tonkin agrees with the statement made by Magryn. This type of attenuator is not expected to provide significant attenuation of waves. Performance of wave attenuation is difficult to predict by calculation and typically requires scale model testing to measure the level of attenuation. In addition the amount of attenuation provided generally varies depending on the wave period. More attenuation occurs of very short period waves, while little occurs for long period waves.

As general commentary, the installed attenuator is expected to only provide effective attenuation of very small waves.

Section 2 History of Damage Event

Tonkin has reviewed the Bureau of Meteorology (BOM) data from this period and has confirmed the stated wind speeds.

Section 3.1 Floating Pontoons

Damage to the floating structures noted in this section is generally consistent with the Seaslip inspection report dated 3 September 2021, however the Seaslip report does not mention damage noted to the framing around the water entry steps.

Section 3.3 Predator Nets Under Pontoons

The Magryn report notes that a significant amount of marine growth existed on the nets hung from the floating structure. The weight of the nets and the marine growth may be significant, as it can change the rate at which the pontoon moves over passing waves. Marine growth can also increase the lateral loads applied to the structure by waves.

Section 4 – Water Levels

The discussion in this section may be accurate however the water levels and potential change in water levels do not seem relevant to the damage that occurred to the structure. Change in still water levels due to sea level rise is expected to have only a minor impact to the design of a facility of this type.

Section 4.3 Wave Assessment

The predicted wave hindcast generally appears to be accurate when checked by other methods. However the average hourly windspeed that occurred on the day is not known, so the stated figures should be considered an estimate only. A more detailed analysis would be required to confirm the wind speed and actual significant wave height.

Imagery of the swim enclosure found on the internet suggests a 0.5-0.6m wave is likely to have occurred. An example is shown below however the date the image was taken cannot be confirmed.

Figure 1: Image obtained from internet search showing an estimated 0.5-0.6m wave event at the swim enclosure.

Section 5.1.1 Pontoons P18 and P19

The report discusses the manner in which waves can partly suspend the pontoons as they pass. However the hinge joints between the pontoons are provided to address this and reduce the loads on the pontoon framing as shown in Figure 1. The report does not mention this or discuss why the hinge joints did not prevent damage.

The report suggests that torsion in the PFC sections (parallel flange channel) was a contributing factor to the failure, but is not specific as to where this may have occurred. Photographs provided do not suggest a torsion (twisting) failure of the primary framing elements, as the points of failure do not appear to be deformed in this manner.

The report suggests that the hinge joints have inadequate rotational capacity for the waves that may occur at the site, but states that most of the waves that may have occurred on the date of damage were likely within the allowable range. It should be noted that the inspections undertaken did not note any damage to the hinge connections.

The report states that the longitudinal joins between pontoons P18 and P19 increased the stress on the framing but does not describe how this occurred. It is noted that the inspections undertaken did not note damage to the connections along the long axis.

Tonkin considers the mode of failure to be different to that stated by Magryn. Our brief assessment is provided later in this report. A detailed assessment of the failure is beyond the scope of this report.

Section 5.1.2 Step Pontoons

The report attributes the cracking in the framing elements at the steps to fatigue from movement caused by passing waves. Fatigue may be a factor however it is more likely that the cracking has been caused by the design of the framing arrangement, whereby the primary framing element is kinked to fit the steps within the perimeter of the float. The kink in the frame results in stress concentrations which may exceed the capacity of the aluminium during a large wave event.

Section 5.1.3 Marine Growth

The Magryn report states that the additional weight of marine growth causes a dampening effect of the response to wave action, which increases the stresses on the frames.

Additional weight will cause a damping effect however this would not necessarily increase the wave loading effects on the frames.

It is difficult to determine whether cleaning of the net would have reduced the likelihood of damage to the structure during a wave event. While in some situations the additional weight can increase loads on elements and connections, the loads may not exceed the minimum design loads for structures of this type as specified in AS3962 Design of Marinas.

Section 5.2 Location/Guide Piles

All piles should be secure in position. Loose piles provide little restraint to the structure and potentially increase the loads on the connections between floating units.

During the site attendance on 13 September 2022 it was noted that a larger opening had formed in the HDPE sleeve to the pile located to the south of the lower end of the southern gangway, at pontoon P10. The opening appeared to have been formed due to contact with a gangway framing element. The HDPE sleeve is no longer effective and requires replacement.

Figure 2: Photograph taken on 13 September 2022 showing the penetration of the HDPE sleeve to the pile at pontoon unit P10.

Section 5.5 Wave Attenuator

Tonkin generally agrees with the commentary in the report. As per the comments made relating to Section 1.6 of the report, the attenuator is only considered likely to reduce very small waves. The image below was obtained from an internet search and demonstrates attenuation of very small waves.

Figure 3: Attenuation of small waves by the floating tubes.

Wave attenuation of larger waves requires larger structures that disturb a larger depth of the water to prevent the wave passing.

Section 6.1 Remedial Work for Floating Pontoons

With regards to the repairs stated in this section, Tonkin considers the following recommendations to be appropriate:

- Repair of Pontoons P18 and P19.
- Incorporation of new hinge joint into pontoons P18 and P19 at the break line.

Tonkin does not consider the other recommended works to the pontoons to be of benefit. The other recommended works are based on an intent to install hinges within the double-width pontoons such that the pontoons can flex across the centreline. This could potentially reduce stresses in the framing but is not expected to offer a significant benefit as no damage corresponding to these stresses was recorded in the inspections.

Section 6.2 Remedial Work to Piles

Tonkin considers the recommendations in this section to be appropriate.

Tonkin Commentary Regarding Failure

The Seaslip pontoon system is intended for construction of marinas for mooring of vessels. Marinas are typically installed in locations that are protected from large waves, in order that the vessels in the marina and the marina itself are protected from damage. AS 3962 Design of Marinas table 4.2 describes the following wave climates:

- "Good" wave climate

    - 1 yr significant wave height of 0.3m
    - 50 yr significant wave height of 0.4m for oblique waves
- "Moderate" wave climate
    - 1 yr significant wave height of 0.38m
    - 50yr significant wave height of 0.5m for oblique waves
- Maximum wave height:
    - 1 year event 0.57m
    - 50 year event 0.75m

The design wave climate stated by Seaslip for the swim enclosure at the Town Jetty is:

- 50 yr significant wave height = 0.9m
- 50 yr max wave height = 1.8m.

It is noted that the design life stated for the floating structure is 25 years. This is in accordance with common practise for floating structures. The wave height forming the basis of design is based on a wind event with a 50-year probability of recurrence (should occur once every 50 years on average). This is in accordance with table 5.4 of AS 4997 Guidelines for design of marine structures.

Based on the above criteria:

- In any year there is a 2 percent chance that the design wave climate will be exceeded, potentially leading to damage of the structure;
- Over any 5 year period, there is a 10 percent chance that the design wave climate will be exceeded, potentially leading to damage of the structure;
- Over the 25 year design life, there is an approximately 40% chance that the design wave climate will be exceeded, potentially leading to damage of the structure.
- These figures are referenced from Table 2.4 of Volume 2 of the CIRIA Rock Manual C683.

It is noted that the wave climate at the town jetty is far larger than the maximum recommended wave climate for the design of a marina. The swim enclosure is not a marina however this provides an indication of the severity of the wave climate for structures of this type. Most marina suppliers would probably advise against or decline an invitation to construct a marina in this location, due to the wave climate and risk of damage.

The Seaslip pontoon system is articulated (incorporates hinged joints between the pontoon segments) specifically to improve performance in larger wave climates. Large waves typically have long periods and long wavelengths and an articulated system should accommodate waves of this type with little risk of damage.

However the Seaslip system is quite light-weight. This means that the system reacts quite quickly to waves and is more sensitive to waves with shorter periods and wavelengths. The pontoons will move to closely match the shape of the passing wave and will move rapidly to do so, and this has a tendency to create large forces in the structure. Because the system is light weight, the forces generated by movement are relatively small and the connections and structural framing should generally be able to accommodate the loads.

Our review suggests that the system is susceptible to damage from waves approaching from the north. In our opinion all marina systems installed in this configuration and location would be susceptible to damage. The waves approach at 45 degrees to the enclosure and this results in a complicated arrangement of wave loads being applied to the northern corner of the structure.

Movement of the pontoons can generally be described as 'heave' (up and down movement), and roll (twisting). Pontoons will generally respond more quickly to roll than heave.

Under a northerly wave, pontoons P18 and P19 will heave and roll slowly, while pontoons P20 and P21 will respond quite quickly. This difference in the rate of response causes stresses in the connection and the connecting framing element within P18.

Our review suggests that the combined vertical motion and twist loads applied at the connection of pontoons P20 and P21 to pontoon P18 overloaded the edge framing element of pontoon P18 about the major bending axis. Once this element failed, it allowed an overload to occur in the elements connecting P18 and P19, followed by the outer edge framing element of P19.

Adding an articulated joint at the location of the failure is expected to substantially reduce (but not eliminate) the likelihood of damage resulting from typical waves from the north.

Most of the other elements within the structure appear to be in satisfactory condition.

Response to Queries

Should the existing facility be repaired or replaced?

1. The least cost option is considered to be replacement of the damaged pontoons at the northern corner, as well as a range of other works to piles, most of which are recommended in the Magryn report. The majority of the structure is considered to be in satisfactory condition.
2. Installation of another marina system could be explored however the cost is likely to be significant to achieve something that would perform better with similar or less maintenance. There are very few systems that would be expected to perform better.
3. It is noted that all marine structures require maintenance through their design life. This may be the result of corrosion or deterioration, vessel or debris impact damage, or storm damage.
4. A floating or piled wave attenuator could be considered in future to improve the wave climate.
5. Alternatively a netted enclosure consisting of netting supported on cables suspended from perimeter piles could be constructed as a replacement for all or part of the current pontoon system, with less likelihood of damage. However this arrangement is still expected to require regular cleaning of the net. New structures or part retention of the existing structure would also be required to provide access into the water via gangways and floating pontoons.

Based on the expected cost and likely benefits of the above options, Tonkin considers the preferred option would be to retain and repair or modify the structure with a modified joint arrangement at the northern corner.

Should the existing enclosure be relocated to the eastern side of the jetty?

The structure could be relocated on the eastern side of the jetty, however the attenuation provided by the jetty in its current form is limited and would only provide a minor improvement in the wave climate, for a potentially large cost. This option is not recommended. However this would allow attenuation elements to be fitted to the jetty to improve the wave climate that reaches the enclosure. Attenuation elements would consist of panels to obstruct the passing of waves through the jetty.

Comment on the effectiveness of the of the current wave attenuation.

Comments regarding the current wave attenuation are discussed in the report, but generally Tonkin considers the attenuator to only be effective in reducing very small waves, with minimal effect on larger waves that have potential to damage the enclosure.

Comment on options for alternative wave attenuation options.

Many marinas incorporate wave attenuation. Options include:

- Wave attenuation pontoons (typically large and heavy concrete pontoons with baffles attached to the underside).
- Piled barriers that disrupt the passing waves.
- Rock groynes or breakwaters.

Of the above options only the wave attenuation pontoon seems appropriate as it will have a limited visual impact. Piled barriers or breakwaters will be a visual obstruction and affect navigation to the jetty. A floating pontoon attenuator could also provide additional vessel access to the jetty.

Examples of attenuators can be found on line, with the following examples:

Piled Barrier:

https://sisau.com.au/frp-wave-attenuation-system/

Floating Pontoon:

https://www.bellingham-marine.com/products/wave-attenuators/

Tonkin cannot provide reliable costing for these types of structures, due to variability in cost of supply, transport and other factors.

Which recommendations for repair stated in the Magryn report do you agree with and do you have any additional recommendations.

Commentary on the recommendations stated in the Magryn report is provided in earlier sections of this report. A summary is provided below.

Tonkin recommends the following:

1. Tonkin considers the most significant problems with the swim enclosure can be resolved by modifying the connections to the northern corner of the floating structure. As a minimum, an additional hinge joint can be installed at the location where the failure occurred to reduce stresses in the framing elements at this point. However the arrangement of the structure for a northerly wave approach results in twisting of the pontoons at different rates, and we consider that damage would likely occur again in future, albeit to a less significant extent.
2. Another option that could be considered is to separate the pontoons slightly at the corner, removing the connection entirely. This would allow the pontoons in the northern corner to move independently, dramatically reducing the loads on the frames.
3. It is recommended that the water access stair pontoons be replaced with an alternative design that moves the stair outside the perimeter of the pontoon. We consider the framing of these units should match the other pontoon units by removing the “kink” around the stairs, with the stairs being positioned on the side of the unit.
4. The HDPE sleeve to the pile at the lower end of the southern gangway requires replacement due to damage. The pile inside the HDPE sleeve should be inspected to determine the extent of corrosion that has occurred and replaced if required.

Yours sincerely,

R. Howell

Russell Howell

Principal Engineer – Maritime Lead

Tonkin