Job No. 1075

10 November 2020

Christchurch City Council
Kristine.bouw@ccc.govt.nz

Attn: Kristine Bouw

Technical Memo: Marine Structures Design Process, Naval Point Development

Christchurch City Council (CCC) are planning a development of Naval Point to better suit the needs of its users. Naval Point is an important marine and recreational asset for Lyttelton and the region, and is one of the few all-tidewater access points for marine recreation in Christchurch. The purpose of this memo is to set out the process undertaken by the design team to arrive at the concept design for the marine structures. The design process was a collaborative, and this memo covers design work by the design team, not just inputs by Enviser Ltd.

1 Project aims (marine)

A key aim of the Naval Point development poject is to provide safer public boating facilities and improved access to Whakaraupō/Lyttelton Harbour. Being able to safely launch and retrieve vessels at the public ramp in most conditions is critical to this aim. Currently, the public ramp is protected from northerly and easterly sector winds and waves, but very exposed to the southerly. A breakwater of has been identified as necessary to protect the public ramp from the southerly sector wind and waves. The protected area created by the breakwater needs to be large enough to enable vessels to approach and depart the ramp as well as to undertake manouverng associated with launching and retrieval.

In addition to the breakwater, the existing public ramp is to be rebuilt and a new hand-launching ramp (for unpowered craft) is to be built. Ancillary structures to support these ramps, i.e. access pontoons/jetties and temporary vessel waiting areas will be provided.

This technical memo primarily sets out the design process for the breakwater, but also covers in less detail the public ramp and hand-launching ramp.

It is also important to set out matters that the project is **not** seeking to provide,. The project does not seek to provide:

- A protected area large enough to support the existing or a future marina

- Protection of the Naval Point Club Ramp or Pontoon (noting the design allows for a privately funded extension to the breakwater)
- A protected area large enough to provide for activities other than for vessels accessing and using the ramp(s).

2 Parties involved in the design

The design team for the marine facilities comprises several technical experts and CCC staff. The parties involved and their roles are set out in Table1. In addition, crucial design input was received from many stakeholders, including Te Hapū o Ngāti Wheke, Naval Point Club Lyttelton, Coastguard Canterbury, Canterbury Windsports Association as well as a number of local boaties. In addition the plan was presented to the Recreational Boating Users Forum in mid-October.

Table 1 – Design Team

Individual	Role	Organisation
Kristine Bouw	Project Manager	CCC
Kim Goodfellow	Landscape Architect	The Goodfellow Group Ltd
Gary Teear	Marine Design Engineer	OCEL
Rob Eaton	Marine Design Engineer	OCEL
Alexis Berthot	Hydrodynamic and wave modelling	MetOcean Solutions
Mike Pearson	Navigation Safety and risk	GBT International
Ian Fox	Harbourmaster	ECan
Jared Pettersson	Environmental and advisory	Enviser Ltd

3 Design considerations

3.1 Design wave criteria

For safe launching and retrieval of vessels, waves at the ramp(s) need to be below an acceptable wave height, or design wave criteria. Two cases have been established to evaluate the effectiveness of the breakwater designs. They are:

- **Normal conditions**, the wave climate should be well controlled, provide a high level of amenity and be very safe in launch and retrieve conditions (i.e. a low wave height and limited surge conditions).
- **Extreme conditions** very few vessels would use the ramp for launching, the ramp would mainly be used for retrieval for vessels caught out by a weather change, and the Coastguard responding to emergencies. In these conditions, the amenity expectation would be lower,

with the primary focus being the ability to safely retrieve a vessel, possibly on a limited section of the ramp. The extreme case is also used for design loads on structures.

To establish the design wave criteria for both cases, a return period event and acceptable wave height must be selected. For the 'Normal conditions', a 1 in 5 year wave event has been selected to generate the waves impacting the breakwater. Using this return period means there should be less than a 20% chance the design wave criteria will be exceeded in a one year period[1].

In terms of allowable wave height at the ramp, the Australian Standard (AS3962-2001) for marina design recommends boat ramps are "aligned to the dominant waves from swell, sea and boat wash" and sheltered from waves greater than 0.2m. The Permanent International Association of Navigational Congresses (PIANC) recommends launching and retrieving areas are subject to no more than 0.15m high waves. For Naval Point, the more conservative 0.15m wave height has been selected as the design wave criteria for the 'normal conditions'.

For the extreme case, PIANC suggests that a design event of 1 in 50 years is appropriate for marina type structures with a design life of 30 years. This results in a 45% chance of the design storm occurring in the projects life. There is no guidance for an acceptable wave height in these types of conditions, although PIANC notes for marinas that 'moderate conditions' can be up to 1.67 times 'excellent conditions'. This would equate to a design wave height of 0.25m[2] in the 1 in 50-year event.

A summary of the design criteria is included in **Table 2**.

Table 2. Summary of potential design wave criteria

Design case	Return period event	Max wave height (m) within protected area.	Considerations
Normal conditions	5 year	0.15	Period and wave/swell angle.
Extreme event	50 year	0.25	

Note: The design wave for the breakwater design will be the incident wave (i.e. at the outer face fo the breakwater) in a 1 in 50-year storm event.

3.2 Existing site conditions

The Naval Point site comprises flat reclaimed land and southerly facing embayment within Whakaraupō/Lyttelton Harbour. The bay is enclosed to the southeast by a rock breakwater and to the northwest by the Magazine Bay Marina, the rocky shoreline of Magazine Bay lies beyond that. The current shoreline protected with rock and rubble rip-rap and is over-steepened in many places.

The bay is shallow (depth 2-4m CD), with a gentle southward seabed slope into the wider harbour. The seafloor generally comprises soft fine-grained sediments (silts and muds) which extend to some depth. Isolated bedrock exposures exist around the NPCL ramp and pontoon.

[1] Referred to as the encounter probability (PIANC Report No. 149 Part 2)

[2] 1.67 times the normal conditions height of 0.15m

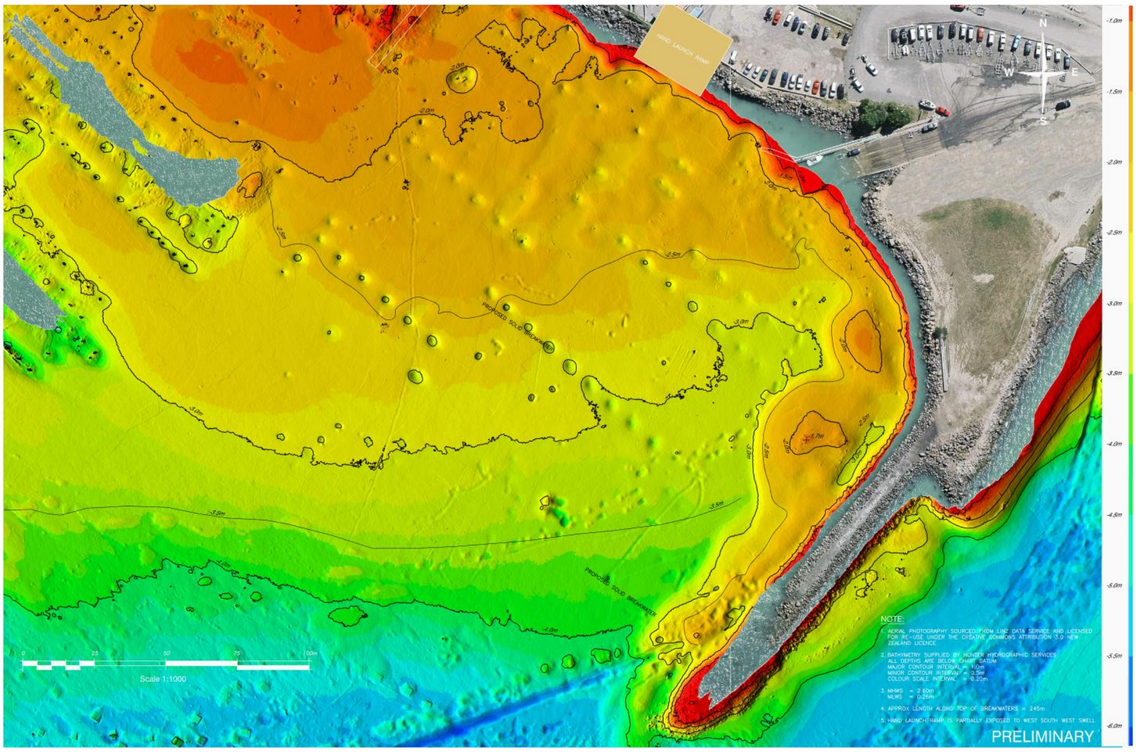


Figure 1 – Bathymetry at Naval Point

Spring high tides reach 2.51m above chart datum during perigean spring tides[3] and current speeds in the bay are low (<0.1 m/s). Accelerated currents (0.43m/s mid-tide) exist off the southern end of the breakwater and in the channel between the breakwater and the reef.

3.3 Wind and wave modelling

MetOcean have produced a high-resolution hindcast wind model for Lyttelton harbour to support the wave modelling for this project. The modelling provides 10 minute averaged wind data (at 10m elevation) on a 500m grid for a 10-year period (2009-2018). This wind data is used to drive the locally generated wind waves in the wave model. Oceanic scale waves propagating into the harbour are also modelled. These are driven by a global oceanic wave model, nested down in three steps to the site scale.

[3] Effects of Channel Deepening Project on Waves and Tidal Currents in Lyttelton Harbour/Whakaraupō, Mulgor Consulting Ltd for LPC, 2018

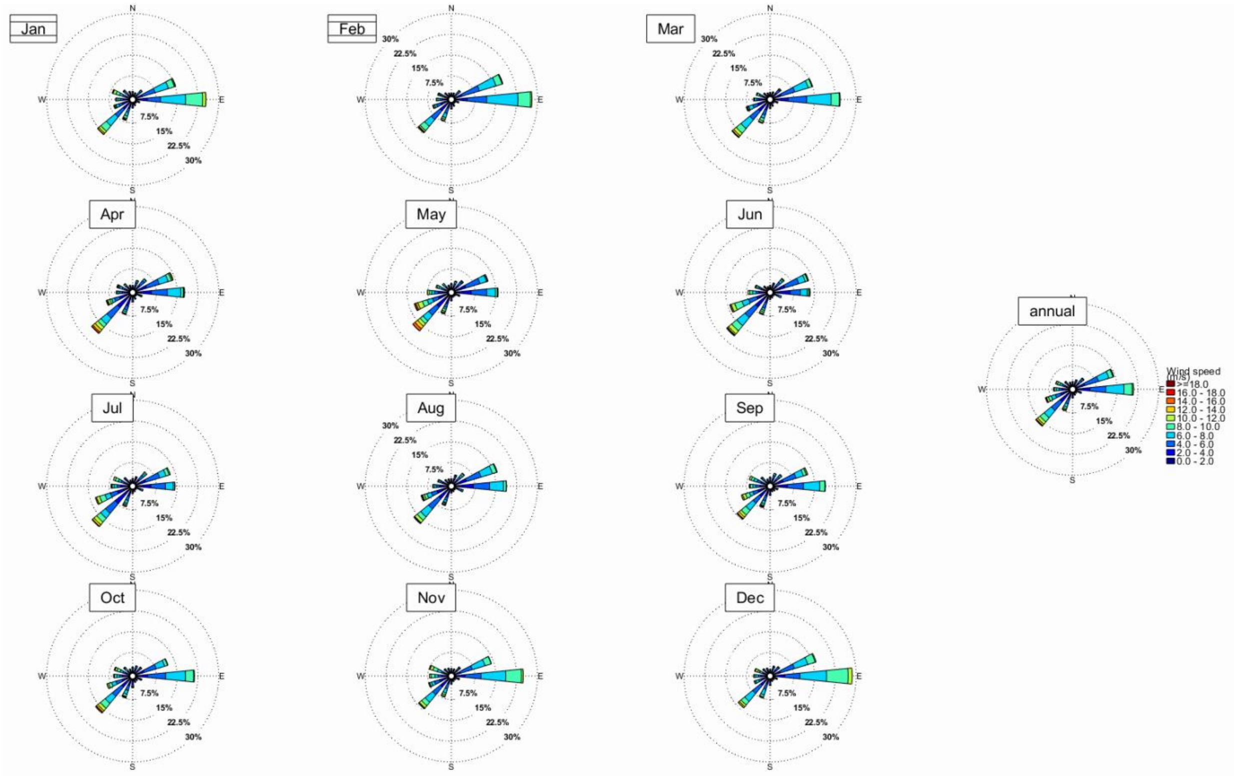


Figure 2 Monthly and annual wind roses for Naval Point showing the strength, percentage of time and direction of the wind (sectors indicate the direction from which the wind blows)

The wave model was used to ascertain the wave conditions, i.e. the size and period of waves which the breakwater would need to attenuate. Various statistics have been generated from the modelling to describe the wave environment (size, direction, period) and how often the different wave conditions are expected to occur. Table 3 summarises the results, in terms of the significant wave height (Hs). A significant wave height (trough to crest) is the mean wave height of the highest third of waves. It roughly relates to the wave height a trained observer would estimate, but does not represent the maximum wave height. It is a commonly used measure in physical oceanography.

Table 3 shows the minimum, maximum and mean Hs for each month, and across the four seasons. It also includes the exceedance percentile for each month. This is useful as it describes how often the waves are less than a certain height. For example, in the month of January, 50% of the time the Hs is expected to be smaller than 0.13m and 99% of the time the Hs is expected to be smaller than 0.42m (or 1% of the time it will be greater than 0.42m). Table 1 also shows the main wave directions. In summary, for the majority of the time, the significant wave height(without a breakwater) is expected to around 0.2m or less, and largely from the east through to southwest.

Table 3 - Significant wave height statistics

Period (01 Jan 2009 – 31 Dec 2018)	Total significant wave height statistics (1)													
	Total significant wave height (m)				Exceedance percentile for total significant wave height (m)									Main (2) Direction(s)
	min	max	mean	std	p1	p5	p10	p50	p80	p90	p95	p98	p99	
January	0.01	0.60	0.14	0.09	0.02	0.04	0.05	0.13	0.20	0.26	0.30	0.37	0.42	E SE SW
February	0.01	0.53	0.13	0.08	0.02	0.03	0.04	0.12	0.19	0.23	0.28	0.35	0.38	E SE SW
March	0.01	0.79	0.14	0.10	0.02	0.03	0.04	0.12	0.19	0.26	0.32	0.42	0.46	E SE SW
April	0.01	0.64	0.13	0.10	0.02	0.03	0.04	0.10	0.19	0.26	0.36	0.46	0.50	E SE SW
May	0.01	0.71	0.14	0.12	0.01	0.02	0.03	0.10	0.21	0.33	0.43	0.52	0.57	E SE SW
June	0.00	0.66	0.15	0.11	0.01	0.02	0.03	0.12	0.23	0.31	0.37	0.44	0.50	SE SW
July	0.01	0.60	0.14	0.11	0.01	0.02	0.03	0.11	0.21	0.29	0.36	0.44	0.47	SE SW
August	0.01	0.61	0.13	0.10	0.01	0.02	0.03	0.10	0.19	0.25	0.33	0.43	0.50	E SE SW
September	0.01	0.67	0.14	0.10	0.02	0.03	0.04	0.11	0.20	0.28	0.35	0.45	0.50	SE SW
October	0.01	0.57	0.14	0.09	0.02	0.03	0.04	0.12	0.20	0.25	0.32	0.39	0.45	SE SW
November	0.01	0.54	0.14	0.08	0.02	0.03	0.04	0.12	0.20	0.24	0.28	0.35	0.39	SE SW W
December	0.01	0.57	0.14	0.08	0.02	0.03	0.05	0.13	0.20	0.24	0.28	0.32	0.38	E SE SW
Winter (Jun-Aug)	0.00	0.66	0.14	0.11	0.01	0.02	0.03	0.11	0.21	0.28	0.36	0.44	0.49	SE SW
Spring (Sep-Nov)	0.01	0.67	0.14	0.09	0.02	0.03	0.04	0.12	0.20	0.26	0.32	0.40	0.45	SE SW
Summer (Dec-Feb)	0.01	0.60	0.14	0.08	0.02	0.03	0.05	0.13	0.20	0.25	0.29	0.35	0.40	E SE SW
Autumn (Mar-May)	0.01	0.79	0.14	0.11	0.01	0.03	0.04	0.11	0.20	0.28	0.37	0.47	0.53	E SE SW
All	0.00	0.79	0.14	0.10	0.01	0.03	0.04	0.12	0.20	0.26	0.33	0.42	0.48	SE SW

Notes: (1) All statistics derived from hindcast wave data for the period 01 January 2009 to 31 December 2018.
(2) Main directions are those with greater than 15% occurrence and represent directions from which the waves approach.

Table 4 shows representative wind statistics for a point near the middle of the Naval Point embayment, in metres per second (note 1m/s =1.94 knts). The results show the southwest sector has the strongest storm generated winds, with the 1 in 50 year event generating winds of 43.7knts[4].

Table 4 - Wind strengths (m/s) for various return periods and directions

Wind direction	Units	Return period (year)			
		1	25	50	100
N	*m/s*	-	-	-	-
NE		10.82	14.81	15.59	16.35
E		12.00	15.04	15.69	16.34
SE		-	-	-	-
S		-	-	-	-
SW		17.34	21.65	22.47	23.26
W		12.44	17.48	18.61	19.77
NW		11.51	17.70	19.37	21.12
Omni-directional		18.16	23.52	24.64	25.74

To investigate the more extreme events, which occur infrequently, but are the most energetic with strong winds and large waves, extreme statistics, based on storm peaks were generated. Table 5 sets out those extreme wave statistics for the same point in the bay. The data clearly illustrates the difference between the significant wave height and the maximum wave heights. For a 1 in 50-year event, the Hs is 0.8m whilst the Hmax is 1.56m.

Table 5 - Wave statistics for various return periods

[4] This is a 10-minute average, gusts will be higher than this.

Parameter	Symbol	Units	Return period (year)			
			1	25	50	100
Significant wave height	H_s	m	0.64	0.78	0.80	0.81
Peak wave period	T_p	s	2.73	2.94	2.96	2.98
Maximum individual wave height	H_{max}	m	1.21	1.52	1.56	1.60

This extreme wind and wave data has been used to understand the sites exposure to storm wave and wind energy, and inform breakwater design options for the extreme event case.

3.4 Current and future site users

In addition to accounting for the physical, wave and meteorological aspects of the site, the design must also provide for the site users, existing and future. Naval Point has a diverse range of users with a wide range of vessels, as well as activities which do not involve vessels (i.e. fishing, ocean swimming etc).

The way the facilities are currently (and will be) used is a key driver of the marine facilities design. The facilities and features that are important to current and future site users were established based on consultation with existing users, published guidelines and research. Table 6 summarises the key user requirements and the design response.

Table 6 – User design requirements for the marine facilities

<table>
<tr><th>Aspect</th><th>Response</th></tr>
<tr><td>Designing the public facilities to cater for the size and type of vessels which use the ramp, including potential growth in vessel size.</td><td>The following design vessels are used to size the on-water space, water depths and entrance/exit channel. These vessels will continue to be used through the detailed design phases.
<table><tr><th>Vessel</th><th>Length</th><th>Beam</th><th>Draught</th></tr><tr><td>Powerboat</td><td>8m</td><td>2.55m</td><td>1.2m (outboard down)</td></tr><tr><td>Trailer-sailer</td><td>8m</td><td>2.5</td><td>1.5m (board down), 0.5m board up.</td></tr></table>The design has also considered the of ramp for the following vessels:<table><tr><th>Vessel</th><th>Length</th><th>Beam</th><th>Draught</th></tr><tr><td>Waka Ama</td><td>14m</td><td>2.5m</td><td>0.5m</td></tr><tr><td>Haul Out</td><td>12m</td><td>5m</td><td>2.2m</td></tr><tr><td>Large powerboat</td><td>10m</td><td>3m</td><td>1.2m</td></tr></table>Note: The design vessel does not represent the maximum possible vessel, rather a size that represents the largest vessel commonly launched at the ramp

The size of the protected area is based on the broad guidelines set out in AS 3962—2001 (Guidelines for Design of Marinas) and with reference to other existing facilities in New Zealand.</td></tr>
</table>

Ensuring unimpeded access to NPCL ramp and pontoon, for unpowered (sail) and powered vessels	New structures should not encroach into the existing access to NPCL ramp and pontoon. Access defined by current sailing approach angles to ramp and pontoon in predominant winds. Noting that the current sailing approach (in easterly conditions) is constrained by the existing breakwater and the NPCL pontoon. The predominant wind directions are easterly (32%), southwesterly (26%), northwesterly (13%) and northeasterly (11%). The shortening of the existing breakwater, and a breakwater closer to shore will result in slightly wider sailing angles to the NPCL ramp and pontoon than currently exists. This will make the approach slightly easier for unpowered sailing vessels. Particularly for those that need higher speeds for stability and are not well suited to low-speed manoeuvres (like foiling dinghies). Provide two-way channel width between breakwater and the NPCL pontoon. This ease of access to the NPCL facilities will be further improved with the removal of the outer sections of the Magazine Bay Marina.
Provide space for two-way vessel traffic into and out of the protected area	Design entrance points to protected area as two-way in accordance with AS 3962—2001 (Guidelines for Design of Marinas).
Layout to physically separate hand launch and main public ramp. Layout to also encourage circulation patterns which reduce conflicts between powered and non-powered craft	Physically separate the two ramps as far as possible, whilst retaining wave protection. Rebuild public ramp at a more southerly angle to encourage powerboat movements to use the eastern entrance to the protected area. Consider using signs and buoyage to further encourage the desired circulation.
Allow for sailing approach angles to/from the hand launching ramp.	The hand launch ramp has been placed at the western end of the breakwater to provide good sailing access and a degree of wave protection. Provide sufficient space between the breakwater and the current NPCL pontoon to allow for sailing dinghies to preforming tacking manoeuvres.
Layout to encourage low vessel speeds within protected area	The breakwater and access points have been arranged to encourage low speeds within the protected area, whilst ensuring there is sufficient space for vessel maneuvering.
Minimise reflected wave energy to the approaches to the protected area and the NPCL ramp	A fixed breakwater with a rip-rap face reflects less energy than a breakwater with a vertical/or semi-vertical face whilst still providing good protection. Detailed design will further analyse wave reflection under a range of weather scenarios and adjust the design to achieve the best outcome.

3.5 Cultural considerations

The Naval Point area is significant due to the longstanding settlement, occupation and use of the harbour by Ngāti Wheke and their tūpuna of Ngāi Tahu, Ngāti Mamoe and Waitaha. Key cultural narratives associated with the area include kōrero auaha / creation traditions, kōrero ahikaaroa / settlement and occupation, and ngā ara wheke / traditional trails. The ability to practice mahinga kai, and most significantly the health and abundance of kai moana, is of central importance to Ngāti Wheke culture and identity.

Ngāti Wheke has provided input into the design process, and provided valuable advice on how the design can achieve both the marine recreational goals and respect the cultural heritage and values associated with the site and Whakaraupō. Some of the key elements or outcomes of these discussions were:

- Avoid the use of polystyrene in the breakwater (i.e. concrete-encased polystyrene) due to the risk of pollution if the elements fail (as occurred in the previous development)
- Minimise the existing and future restrictions on current flow
- Look at ways to prevent the accumulation of sediment, for example by allowing flow through culverts under the existing breakwater
- Design the breakwater to provide habitat for kai moana, likely best achieved with a rock breakwater

These elements were incorporated into the process and directly informed the design of the proposed marine facilities.

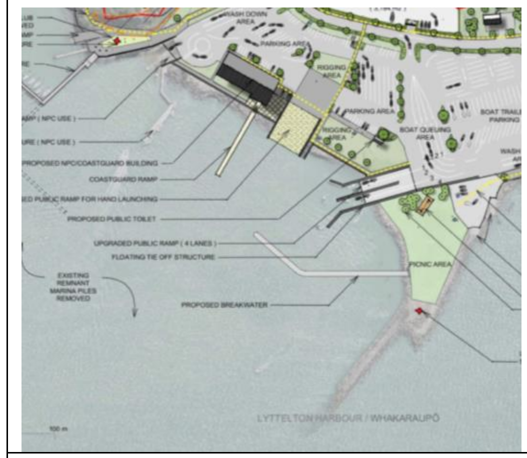
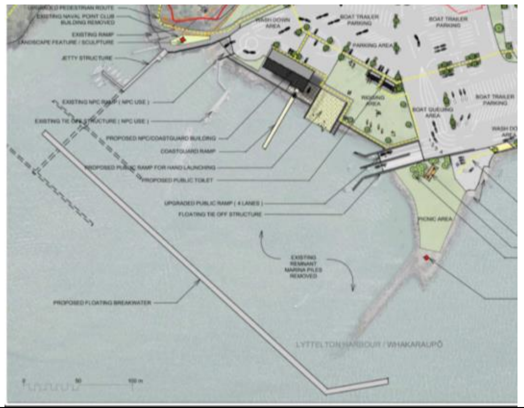
4 Design process and outcomes

4.1 Breakwater

As stated previously, the breakwater is the keystone feature of the development. An area of protected water will provide safer launching/retrieval at the main public ramp and the public hand launching ramp in a wider range of conditions. It will also provide a safe area for vessels to wait and manoeuvre whilst using the ramp. Additionally, it will serve to protect the public assets from wave action, extending their life and reducing maintenance.

With the aforementioned design criteria, and user requirements in mind, several breakwater options were considered. The options included both type of breakwater structure and the location/geometry of the breakwater. The following table sets out the options and comments on their positive and negative aspects.

Table 7 Assessment of breakwater types and initial options

Design option	Positives	Negative	Outcome
Breakwater type			
Floating breakwater	• Lower initial cost • Less of a restriction on tidal flows, if in a location with current. • Effective at reducing shorter period waves and 'chop'	• High longterm maintenance requirements and cost • Less effective at reducing wave energy, particularly at longer periods • Negative community perception in this location • Use of polystyrene within the breakwater not desired by iwi. • Needs to be located further from shore and be longer to achieve protection	Not preferred
Pile and panel breakwater	• Moderate cost • Good wave protection • Can provide for tidal flow if water deep enough to allow a gap between the base of the panel and the seafloor.	• Visually dominant (large concrete panels extending ~2m above sea level). • Moderate maintenance costs	Neutral
Solid, rock breakwater	• Moderate cost • Best wave protection across the widest range of conditions • Visually similar to the existing environment • Low maintenance costs • Can provide habitat for marine ecologies	• Can restrict current flow and alter sediment transport patterns if sited in areas of current flow. • Larger physical footprint per unit length, and more disruptive during construction	Preferred
Breakwater location/layout			
Short breakwater attached to existing rock breakwater (as per option 1 in original consultation) 	• Relatively low cost as can be built from land • Could allow for walking/recreational access (i.e. fishing) along the top of the breakwater. • Does not impinge on sailing access to NPCL facilities.	• The layout is unlikely to meet the design wave conditions in southwesterly wind conditions. • Creates potential vessel conflict between hand launch and public ramps • Hand launch ramp largely unprotected • Likely to create sediment deposition in the eastern corner of the protected area	Not preferred, needs modification
Long floating breakwater with large protected area (included in Option 2) 	• Provides a larger area of protected water • Some level of protection for NPCL ramp	• High cost due to longer breakwater • Reduced options for breakwater types due to cost, access and water depth • Forces all craft (powered and sail) to exist from two constrained points, with most traffic likely through one point (eastward entrance) • More difficult access for sail craft • Does not encourage low speeds within protected area, potential safety issues • Larger footprint within Whakaraupō/Lyttelton Harbour. • Relies on marina being removed for breakwater construction • Breakwater would need to extend into the channel between the existing breakwater and the reef, narrowing this already narrow section of navigable water	Not preferred, needs modification

As a result of community feedback, and the evaluation set out in Table 7, further design work was undertaken to refine the breakwater design options. This process sought to resolve some of the issues raised in the feedback and develop cost-effective options which would still meet the design goals.

The design process worked through many iterations of breakwater location and layout, with each one being evaluated against the design criteria and user requirements. Options included wider breakwater, various distances from shore, entrance channel widths etc. As in all design processes, some of these criteria are in direct conflict with each other and some compromises are required. Two of the designs, which best met the design criteria and user requirements, were selected for detailed wave modelling.

4.2 Breakwater wave modelling

This type of modelling simulates a range of waves propagating through the area and is used to determine how effective the breakwater is at reducing wave energy.

The two designs selected for the modelling processes were:

- **Refined Option 1**. This option was based around a fixed breakwater, most likely a rock bund type. The design aimed to:
    - Provide the optimum protection for the public facilities, whilst retaining the existing ease of access to the NPCL facilities
    - Have enough protected space so vessels using the ramps can safely access, manoeuvre and wait.
    - Balancing the protection of the hand launch ramp with the ability to sail to/from it in the predominant winds
    - Allow for possible rotation of the public ramp
    - Minimise congestion and powered/unpowered craft conflict by laying out the breakwater and entrance points to encourage traffic separation and low vessel speeds
    - Provide a cost-effective design option for a fixed breakwater that minimised future maintenance
    - Reduce the extent of the existing breakwater

Figure 3 – Refined Option 1

- **Refined Option 2.** This option was predicated on a floating breakwater, and is a modified version of the previous Option 2. The key changes, and rationale, are:
  - Reduced westward extent and rotate the westward end shoreward. This is to provide better access to the NPCL ramp for sailing vessels and reduce the previous congestion points. The rotation should also better protect the public ramp in southwesterly conditions
  - The more shoreward location reduces the footprint within Whakaraupō, which is more desirable culturally

` *Figure 4 – Refined Option 1*

These two designs were provided to MetOcean Solutions Ltd, whom undertook the wave modelling work to assess the performance of each option.

4.3 Modelling outcomes

The breakwater wave modelling looked at three cases in total:

- The existing situation
- Refined Option 1 – Rock breakwater
- Refined Option 2 – Floating breakwater

All options were modelled with the critical wave directions, being; easterly, southerly, southwesterly and westerly waves. Noting that the easterly, southwesterly and westerly are the most predominant wave directions, occurring 56%, 26% and 12% of the time respectively. Waves for both the 1 in 5-year and 1 in 50-year events were modelled.

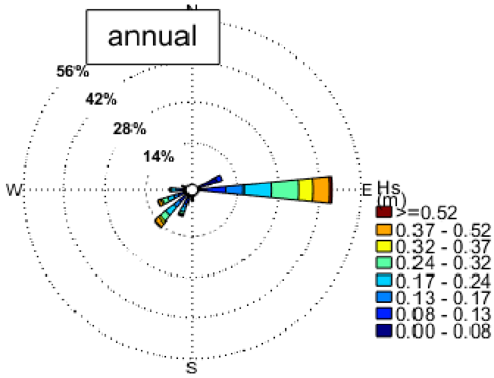


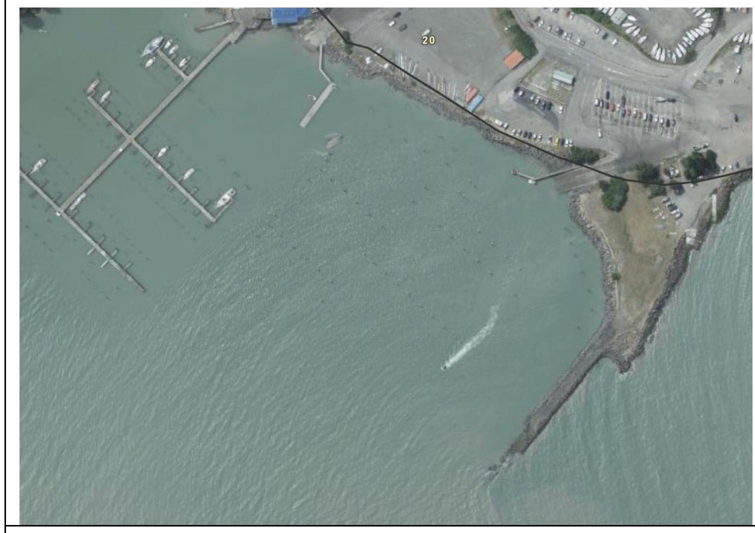
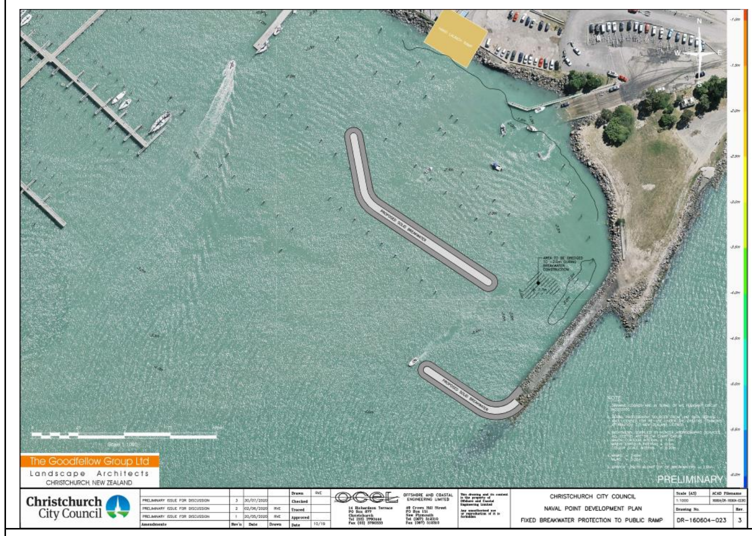
Figure 5 – Annual wave rose for Naval Point (sectors show direction waves come from)

The purpose of the modelling was to evaluate, at a concept level, which option provided the best wave protection. It was always anticipated that further design refinements would be needed during the detailed design process to refine the chosen design and ensure it met the design wave criteria for all wave conditions.

A modelling report has been prepared by MetOcean[5], which sets out how the modelling was undertaken and the results. A summary of the outcomes for each case is set out in Table 8.

[5] Naval point Wave Study, prepared by MetOcean Solutions Ltd for the CCC. September 2020.

Table 8 Summary of wave modelling outcomes

Option	Modelling outcomes	Conclusions
Exiting situation 	In all but easterly conditions, the wave climate exceeds the design criteria of Hs< 0.15m. In southwesterly conditions the ramp currently experiences waves well above the design criteria, with a Hs of 0.64m – 0.78m for a 1 in 5-year event, and 0.73m-0.85m in a 1 in 50-year event. Similar but slightly lower wave heights are encountered in southerly and westerly conditions. As well known and documented, the ramp is not safe to use in these conditions.	The design criteria cannot be met without a breakwater.
Refined Option 1 	For normal conditions, the waves are relatively well-controlled for most directions. However, some westerly wave energy (and to a lesser extent southerly waves) does propagate around the western end of the breakwater. The breakwater performs well in the extreme case, meeting the design criteria in all but westerly conditions.	Most effective wave protection for the most predominant wave conditions. Some tweaking needed to address westerly waves.
Refined Option 2 	For the normal conditions (1 in 5-year return period) the breakwater provides minimal improvement in wave conditions and wave height remains above the design criteria (0.15m) in almost all normal conditions. Southerly wave energy propogates easily through the eastern entrance, with large (0.52m) waves impacting the ramp in the extreme southerly conditions. This compares to 0.6m in the same conditions with no breakwater.	Less effective wave protection, particularly in southerly conditions. Does not meet design criteria, significant changes would be needed.

4.4 Main Public ramp

The current public ramp has two lanes, with a piled access jetty on one side. This ramp has heavy use and is currently undersized, particularly on busy summer weekends. The structure itself is reaching the end of its useful life and needs to be rebuilt.

The proposed development plan includes a new four-lane ramp, with associated pontoons or structures to facilitate launching and retrieval. This will likely take the form of floating pontoon structures as seen on modern boat ramps across the country.

The ramp will be designed with the appropriate grade, surface and water depth to suit the design vessels. The new ramp will be rotated slightly southward to reduce the potential for conflict with vessels using the hand launch ramp, and the to make better use of the protected water behind the breakwater.

4.5 Public hand-launch ramp

Currently, hand-launched vessels (sailing dinghies, waka, kayaks etc) share the use of the public ramp, or the NPCL ramp, with larger vehicle-launched vessels. This is not an ideal scenario as it can lead to safety issues, particularly when children are hand-launching dinghies whilst vehicles with trailers (and limited visibility) are reversing down the ramps. Additionally, a hand-launch ramp has different ideal characteristics than one used by vehicles.

To provide a safer, higher amenity solution for hand-launched vessels, a separate public hand-launching ramp is proposed. This will provide a purpose-built ramp for dinghies, kayaks, waka, SUP etc, well separated from vehicular traffic. The ramp would be supported by a public rigging area, convenient public parking and be provided wave protection by the breakwater.

The grade and surface of the ramp will be designed for hand launching, and whilst the details are to be confirmed by further design, it will have a hard surface.

4.6 NPCL private ramp

The NPCL ramp is operated and maintained by NPCL for the benefit of its members. Consequently, any changes to that ramp are outside the scope of the CCC development plan and this report. Continued good vessel (sail and power) access to the NPCL ramp has been a key consideration for the breakwater design. The design included in the development plan marginally increases the sailing angles to the NPCL ramp, offering a slight access improvement over the current situation.

4.7 NPCL private Hand-launch ramp

Discussions with NPCL revealed some of their member's sailing dinghies (i.e. foiling R-Class) have specific launching requirements, which may not suit the public hand launching ramp. To account for this the development plan allows for a second private hand-launching ramp to be installed to the east of the NPCL pontoon. This can be designed and built, by NPCL to serve the specific needs of those vessels. CCC will include the potential presence of this ramp in the consent application, but it will be the responsibility of NPCL to fund this ramp.

4.8 Vessel access and circulation

To ensure safe navigation to and from the new public ramp, the public hand launch ramp and the existing NPCL facilities, careful consideration was given to vessel circulation when designing the marine facilities.

Based on feedback from users, and feedback from experts, the desired outcomes for vessel circulation were:

- Powered vessels naturally avoid the hand-launching ramp when transiting to and from the public ramp
- Non-powered vessels naturally avoid the public ramp when transiting to and from the hand-launch ramp
- Powered vessels keep a low speed within the protected area, and naturally avoid the access areas to the NPCL ramp and pontoon
- Entrance channels allow for two way traffic

The layout of the marine facilities in the development plan achieves this by:

- Making the eastern entrance, the shortest and easiest way from the harbour to the ramp. This will reduce the traffic through the western entrance, which would conflict with the hand-launch ramp and the NPCL facilities.
- Rotating the public ramp so vessels will approach (or reverse off) the ramp away from the hand-launch ramp. The rotated ramp is also further away from the hand-launch ramp.
- Located the hand-launch ramp as far to the west as possible, whilst still maintaining some wave protection for amenity and asset protection perspectives.
- Locate the breakwater within a line between the existing breakwater and the NPCL pontoon to ensure existing sailing access to NPCL facilities is maintained
- Locate the breakwater to provide plenty of space for vessel maneuvering and waiting, but close enough so vessels are discouraged from operating at speeds above 5knts within the protected area or channels.
- Design the entrance channels to provide for two-way vessel traffic.
- Including signage, and possibly buoyage, to further reinforce the design encouraged circulation.
- To reduce congestion within the protected area, temporary tie-off points (fixed or floating pontoons) and passengerpick up points are to be provided away from the ramp. This will allow vessels to wait for their trailer/vehicle driver without motoring around in the protected area.

Figure 6 sets out the anticipated circulation patterns.

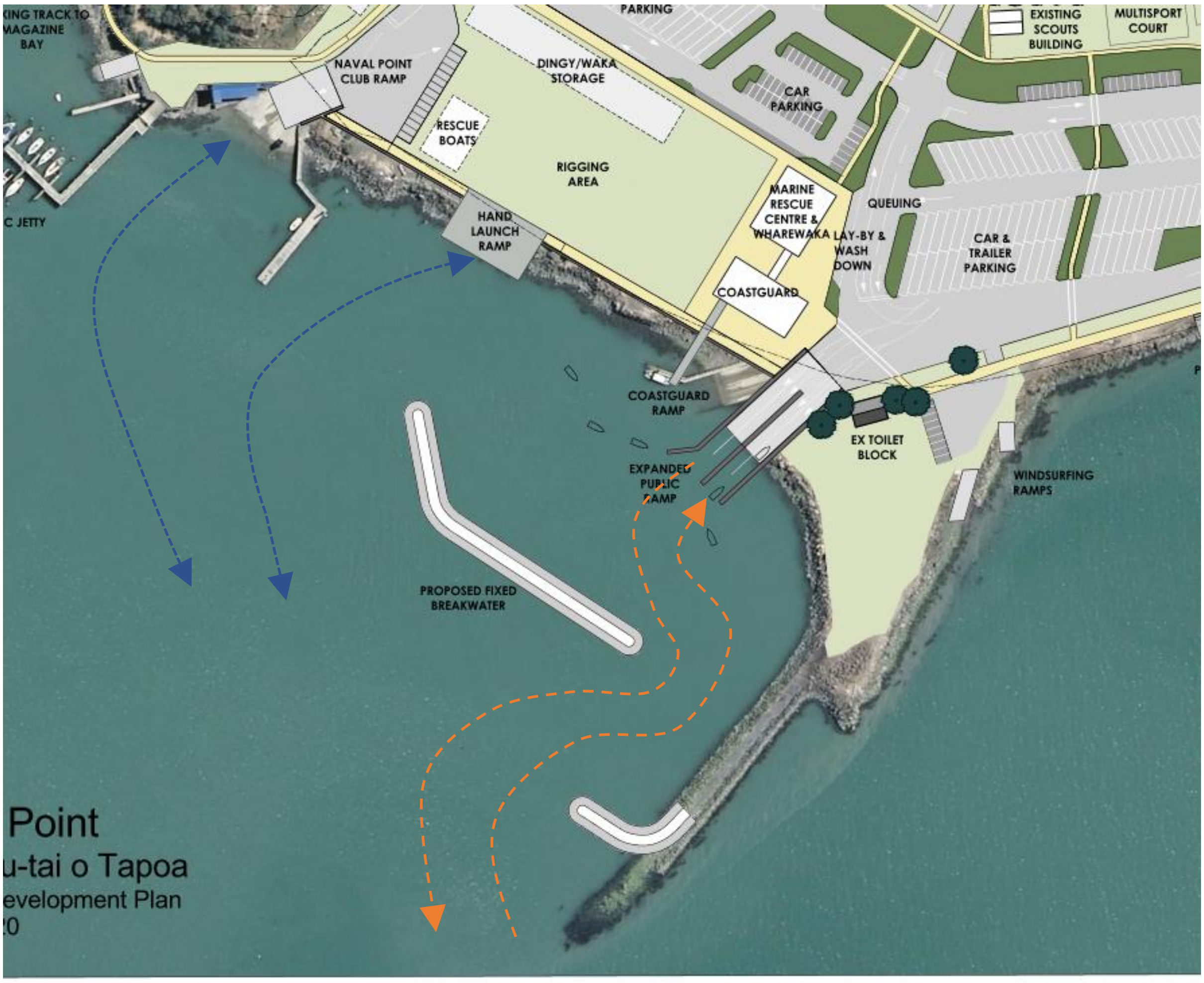


Figure 6 Development plan with anticipated circulation patterns

4.9 Environmental considerations

As with all marine projects, the environmental impacts, and potential for improvements were an important part of the design process. At this stage, broad environmental concepts were considered, more detailed studies will be undertaken on the chosen concept design to verify assumptions and support the consent applications. Some of the key environmental considerations that informed the design process were:

- Effects on current flows in the harbour, notably seek to reduce effects of exiting structures
- Potential changes in sedimentation rates or processes
- Enhancement of mahinga kai species
- Provision of habitat for mahinga kai species
- Visual effects and natural character
- Effects on water quality during construction
- Effect on marine ecology, including marine mammals (construction and long-term)
- Effects on marine avifauna
- Noise – underwater and terrestrial
- Changes in coastal process and effects on shoreline

5 Applicability

Enviser Ltd has prepared this report for Christchurch City Council (CCC) in accordance with the agreed scope. No other party, aside from the CCC (or those working on the project for the CCC), may rely on this report, or any conclusions or opinions within it, for any purpose without the express written permission of Enviser Ltd.

The opinions and conclusions within this report are a summary of information available at the time of the report, and the report includes design work and opinions of others.

We are more than happy to discuss the contents of this letter with you. If you wish to do so, please contact the undersigned on 021 679 838 or jared@enviser.co.nz.

Prepared for Enviser by:

Jared Pettersson
Director, BE(hons) ME