
Finance and Performance Committee MINUTES ATTACHMENTS

Date: Wednesday 22 April 2026
Time: 9.30 am
Venue: Camellia Chambers, Civic Offices,
53 Hereford Street, Christchurch

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Submission on Akaroa Waste Water



Overhead bullet point summary
By Bruce McLean and Lee Robinson

Details of Presenters

Bruce McLean BE(Hons)

- **Graduated 1972 from University of Canterbury with Bachelor of Civil Engineering.**
- **Fellow of Engineering NZ with 50+ years experience.**
- **Diverse project and general management and governance experience including advisor to the Prime Minister.**
- **Board of SCIRT in Christchurch post earthquakes as Crown Representative.**
- **Family has owned Bruce's property in Akaroa since 1973.**

Lee Robinson LLB; MNZM

- **Family have owned Lee's property in Robinsons Bay since 1952.**
- **50 years experience as legal Partner and Commercial Lawyer and with 35 years governance and management experience.**
- **Past Chair and Founder of Robinsons Bay Ratepayers' and Residents' Association.**

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- 1. We represent a group of Akaroa business people including Engineers, Lawyers and others.**

2. The Akaroa community is strongly opposed to the land based option.

- As the community has come to better understand the land-based wastewater scheme it has become strongly opposed. Of the submissions for the recent consents 94% were opposed with support primarily from Ngai Tahu and people who had sold land for the irrigation. Opposition numbers have continued to grow since then.**
- Primary reasons for opposition are: escalating costs, the significant negative impact on Akaroa's recreational hub, discharges into Children's Bay of untreated and treated wastewater, significant traffic disruption of two to three years during construction, and high ongoing operating costs.**

3. Its design has been fraught from its inception and its implementation will be disastrous for the community.

- **The land-based scheme is a one-of-a-kind project that is over reliant on many constantly changing and sensitive factors. These include wildly varying inflows; inadequate storage; sensitive soils; small pipes traversing streams, slips and roads; being buried in the main access to Akaroa; irrigation soils that are sensitive to moisture; maintaining drippers amongst Kanaka trees and constant maintenance.**
- **Incredibly to date, the terminal dump station has been sited on Akaroa's former rubbish dump and the treatment plant sited on an active slip.**
- **It is no wonder the design has been constantly changing.**

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4. Council costs for the land- based scheme are no longer credible. They have increased 300% since 2020 and will only continue to increase despite attempted savings. Yet the design is still only at preliminary stage

- **The evolving design has driven the costs up dramatically.**
- **But the increase of 300% since 2020 is beyond normal.**
- **The design is still only at preliminary stage and the costs can be expected to continue increasing as design is developed.**

5. The 2.7km harbour outfall has been rejected previously in a Consent application for cultural reasons.

- **It is a smaller version of the ocean outfall and is cheaper. However, it is likely to be resisted by some members of the Community including iwi. Consents would potentially be more difficult to obtain than the ocean based outfall based on the new WEPS standards.**
- **Pragmatically, we would accept this alternative if the Council wished to adopt it.**

6. An ocean outfall is the only viable resilient option, and in our opinion would be supported by our community.

- **Unlike the land-based scheme the ocean outfall is a “repeat project” with plenty of other similar projects around New Zealand. The contractor that has provided costs to the Council (McConnell Dowell) has undertaken most of these projects including in Lyttelton Harbour and New Brighton. Their estimated costs and methodology can be relied on.**
- **The outfall consists of a robust welded 355mm polyethylene pipe.**
- **It has twice the capacity of the land-based pipe and will handle any conceivable flow well into the future.**
- **The Council has not attempted to optimize this option. For example: potentially the pipe does not need to be buried as indicated by Beca. After all the Cook Strait cable is not buried and it is critical infrastructure.**

6. (cont.)

- **This option is far more favourable to the environment. According to the Council’s independent consultant Beca the discharge would likely not be detectable in the ocean. It has a dilution factor of 385 to one and that does not take into account the dilution impact of the Southland current which flows at one to two knots around the peninsula.**
- **In an emergency untreated wastewater can be discharged through the ocean outfall. This is far better than discharging into Childrens Bay.**
- **According the Ministry of Health (MOH) 74% of treated waste water is discharged into the ocean in New Zealand, including the Christchurch outfall and the Waimakariri District outfall.**

7. The ocean outfall is cheaper than the land based option if estimated costs are treated the same.

- **Council has added costs to the Ocean Outfall estimates that are not needed. For example the Council has added 15% for professional fees which is unreasonably high given that McConnell Dowell are offering a design-build solution.**
- **A margin of 50% has been applied to the ocean outfall which is excessive compared to the land-based option. McConnell Dowell have already included contingencies of about 30 % and the Council is applying 50% on top of that. We have contingency on top of contingency.**
- **The geotechnical risk for the marine pipeline is relatively low compared to the land-based option and contingencies should reflect that.**
- **The ocean outfall will have far lower operational costs than the land-based scheme. This is not reflected in the operational costs provided by Council.**

8. The ocean outfall best meets the requirements of the Local Government (Water Services) Act 2025

- In our view the Ocean Outfall best meets the requirement of the Local Government (Water Services) Act which are:
 - *(a) to provide water services that— (i) are **reliable**; and (ii) are **resilient to external factors**, for example, climate change and natural hazards; and (iii) are of a **quality that meets consumer expectations**; and (iv) **meet all regulatory requirements**, including, if the water service provider is responsible for water supply services, providing drinking water that is safe for consumers; and (b) **to ensure that it provides water services in a cost-effective and financially sustainable manner***

9. The ocean outfall should at least be kept as an option at this stage.

- **The ocean outfall is in summary:**
 - **More acceptable to the community**
 - **Cheaper to build and run**
 - **More resilient with double the capacity**
 - **Far better for the environment**

It needs proper consideration not just treated like a long list item that can be dismissed with loaded costs.

10. Finally, the Council should understand that any decision it takes that is not well founded could well be subject to a review by the Commerce Commission or other review body or bodies.



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Christchurch City Council
Finance and Performance Committee

Presentation by
FRIENDS of Banks Peninsula
Endorsed by Akaroa Civic Trust, Akaroa Ratepayers & Residents
Association, Robinsons Bay Ratepayers & Residents Association
regarding
Akaroa Wastewater Cost Reduction Opportunities
22 April 2026

Suky Thompson
Brent Martin

FRIENDS of Banks Peninsula Inc.

Akaroa's Community Environment Society since 1990

21/04/2026

FOBP long involvement

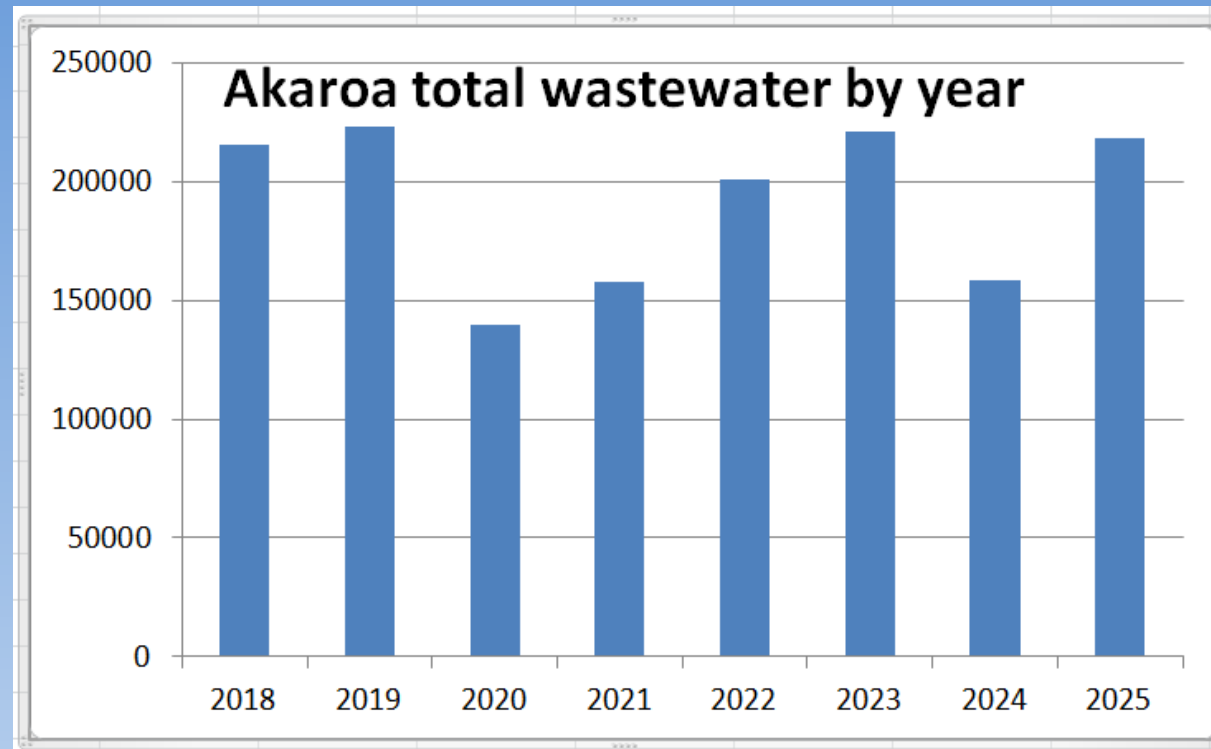
- Technical expertise – we have read and analysed all technical documents since 2016
- Our work has picked up multiple critical errors leading to discovery of
 - faulty flow meter
 - true wastewater flow volumes
 - I&I levels and
 - overflows
- Validated by CCC experts and Hearing expert conferencing

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I&I is not under control



- Total Akaroa annual wastewater volume is as high as before any I&I repairs done
- Rain derived I&I is still the main determinant of total wastewater volume

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21/04/2026

Our view of cost cutting proposals

- **Harbour outfall**
 - Tried and trusted technology
 - Discharge into deep water with rapid dispersal in main current
 - Resilient to climate change because not affected by I&I
 - Simple to operate
 - Consentable under WEPS
- **Moving the treatment plant**
 - Highly visible from residential areas of Akaroa and roads
 - Overturns the existing 2015 consent
- **New Land Based options**
 - Reduced land area and addition of Duvauchelle means greatly increased wastewater load on Robinsons Bay sites
 - 10 years of engineering analysis being overruled - each time CCC has reduced land area it has increased irrigation rates above that which was previously deemed to be a safe level. Now double the 2023 safe levels.
 - No evidence new options supported with technical research. PDP report referenced in agenda does not include
 - Irrigating Duvauchelle wastewater to Robinsons Bay
 - Modelling of overflow days with reduced storage
 - 7.8ha of land removed from Robinsons Bay field because too steep for WEPS, but 6ha of land already considered high risk (due to elevation, downslopes and winter saturation) retained

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All existing risks exacerbated

- Irrigation to natives on sloping ground not tried anywhere else
- Irrigation is to occur year round to the point where soils are saturated
- Peninsula loess soils suffer from slips in prolonged wet conditions
- Runoff of nitrogen pollution into stream and shallow bays is a major risk when irrigating to saturation
- Risks increase with climate change storms
- The irrigation system is complex to manage with pumping stations, storage tanks and maintenance of 100s of kms of irrigation pipe and millions of drippers in a dense native forest

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21/04/2026
Analysis of saving for land options

Data extracted from Slide 17 April 15 staff presentation

	Total cost	Total saving	Moving plant	Reducing tanks and land	% of days irrigated to land (CCC data)
Current proposal	\$176m				98.6
Option 1 16,000m ³ storage	\$150m	\$26m	\$10m	\$16m	99.3
Option 2 4,000m ³ storage	\$136m	\$40m	\$10m	\$30m	97.2

- More expensive Option 1 recommended by staff instead of much cheaper Option 2 based on small difference in overflow days only
- No technical information has been provided to back up these overflow days figures

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Overflow assumptions do not match reality

- Discharge to land relies on soil and plants up-taking water, not running off. Ceasing irrigation when ground is saturated is critical.
- CCC stated in consent application that irrigation would not take place once ground was saturated
- Modelling of overflows to date does **not** take ground saturation into account, it only assumes irrigation ceases on a day when 50mm of rain has fallen.



Irrigation site in Robinsons Bay showing saturation 8 days after last rainfall and 11 days after the main storm

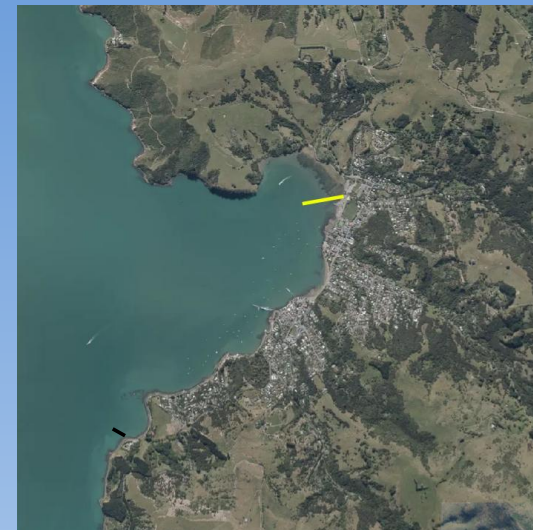
- Ceasing irrigation when the ground is saturated will result in many more days of overflows than simplistic modelling indicates
- Increased irrigation loading means more frequent saturation
- The overflow discharge also provides a critical backup for field failure

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Proposed short overflow repugnant to community



- Discharge to water bodies relies on dilution
- Proposed 300m Childrens Bay overflow is at head of a shallow, poorly flushing bay into water only 1m deep
 - By contrast current 100m outfall is to water that is 6m deep and in the main flushing current
- Contaminants will accumulate in mudflats – nitrogen, heavy metals, pharmaceutical, microplastics and forever chemicals
- In the heart of Akaroa marine recreational area

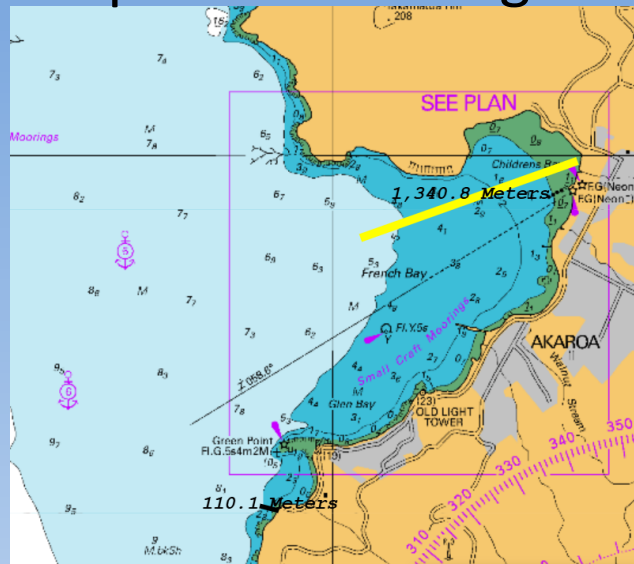
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Extending overflow to deep water essential

- Before considering any land based option there needs to be an acceptable discharge for overflows, and as a backup in case of irrigation field failures



Example of Childrens Bay overflow extended by 1km to deeper water (5m depth) and outside of shallow bay where it can flush

- Cost of extending Childrens Bay overflow by 1km to deep water would be maximum \$5.9m
 - Based on applying Harbour Outfall per meter costs

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Conclusion

- Moving the treatment plant is controversial and requires re-consenting
- Land based options present unacceptable environmental risk
 - Overflows need to be dealt with by an acceptable outfall
 - Proper technical reports must be provided for Council and public scrutiny to support any changes proposed
- At this stage the only safe and feasible solution presented is Mid-Harbour outfall
 - Simpler and cheaper to operate
 - Resilient to climate change and unaffected by I&I
 - Cultural concerns are well understood, but geography and soils, climate change, I&I and high cost mean that land disposal is increasingly impracticable and very high risk.

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21/04/2026

Our recommendations

- Less haste, enable peer review and community input
- Don't cherry pick LGA
 - Mana whenua cultural requirements are to be balanced with other matters
 - Community views must be taken into consideration under Section 78, including persons likely to be affected and those with an interest in the matter
- Water Services Act requires you to
 - Provide water services that are resilient to climate change
 - Act in the best interests of current and future consumers – debt for the future
- Your own strategic priorities include
 - Build trust and confidence in Council through meaningful partnerships and listening to residents
 - Work with Ngāi Tahu to achieve meaningful outcomes that benefit the **whole** community
- We do not support any options being put to Council and request
 - Full public disclosure of all technical information prepared for the new options
 - Meeting between FOBP and WW staff to answer questions
 - Public meeting where the Council communicates the substantial changes proposed to the full community
 - Receive community feedback before making decisions on our behalf



Rik Tainui Ōnuku Rūnanga Chair

Akaroa Wastewater Scheme F&P Report on cost savings

Dated 22 April 2026

Presenters:

Gavin Hutchison – Head of Three Waters

Brent Pizzey – Senior Legal Counsel

Kylie Hills – Senior Engineer

What the report describes

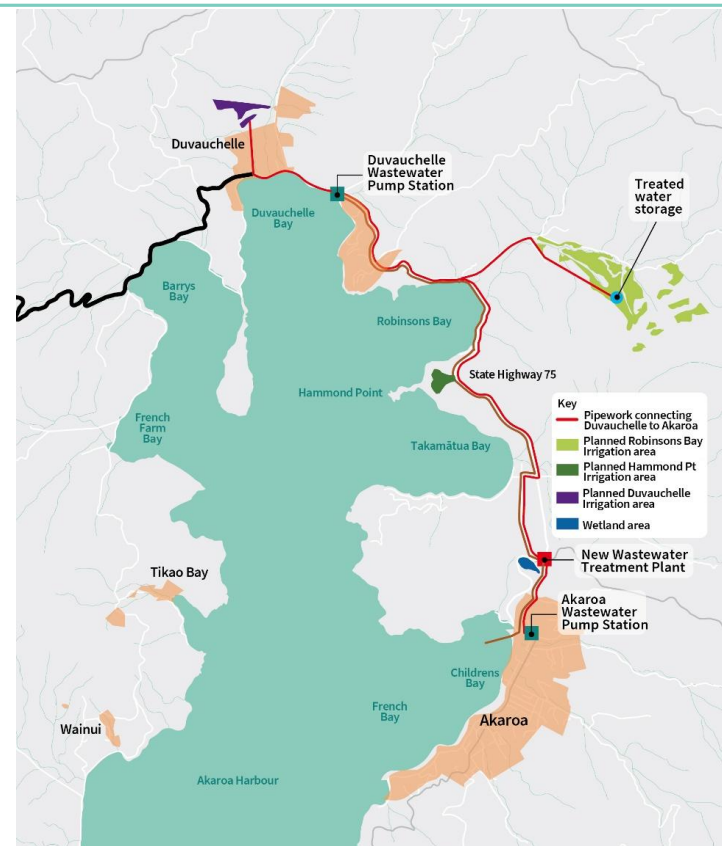
- 2020 Council decision after consultation: irrigation to land at Robinsons Bay, Hammond Point and Takamātua. Treated wastewater storage exceedances to harbour
- Cost increases since the 2020 decision: Capex then: \$45m-\$52m. Now: \$175m
- If Council wants to save costs, what the reasonably practicable options are
- Must choose the most cost-effective option. That doesn't mean cheapest. It can include social, environmental and cultural outcomes.
- LGA requires decisions on options that involve *“a significant decision in relation to land or a body of water, take into account the relationship of Māori and their culture and traditions with their ancestral land, water, sites, waahi tapu, valued flora and fauna, and other taonga”*

What the report describes cont.

- Staff considered 13 options (p280) - most are NOT reasonably practicable options and not cost-effective
- Four reasonably practicable options for saving costs: three variations on the current irrigation to land proposal, or discharge into Akaroa Harbour
- Community views and preferences expressed in the 2020 consultation, submissions on the 2023 resource consent application, in deputations, and in future notified resource consent applications
- Recommendation: Reduce costs by selecting Option 1: irrigation to land with the changes described in resolution 4, and look for other cost savings provided these do not increase frequency of discharges to harbour
- Next step: change resource consent applications.
- Report back on other cost savings within the recommended option 1, including advice on extending the 300m outfall.

The Current Application

- WWTP at Old Coach Rd
- Irrigation to land at Robinsons Bay, Hammond Point and Duvauchelle
- 84 ha of native planting
- 24,000m³ of storage tanks
- Old Coach Rd wetland before occasional treated storage exceedance discharges (approx. 50 days per 10 yrs)
- Those discharges – 300m pipe in Childrens Bay.



Robinsons Bay and Hammond Point Sites



Indicative Robinsons Bay and Hammond Point site boundaries (red outline) and extent of plantings (green infill), approximately 84 hectares.

Drip Lines Under Trees

- Irrigation via drip lines laid along the ground below the trees (drippers are built into the pipes)
- Undergrowth allowed to grow over the irrigation system
- Approximately 133 irrigation to land schemes in NZ. Many to natives including on sloping ground.
- Operated at Tikao Bay, Wainui, and Duvauchelle study.



Tikao Bay land drip line discharge scheme at commissioning in 2005 and more recently in 2025.

Site Performance in Rain Events

Some submitters are concerned about risk of landslides from soil saturation, getting worse with climate change.

But:

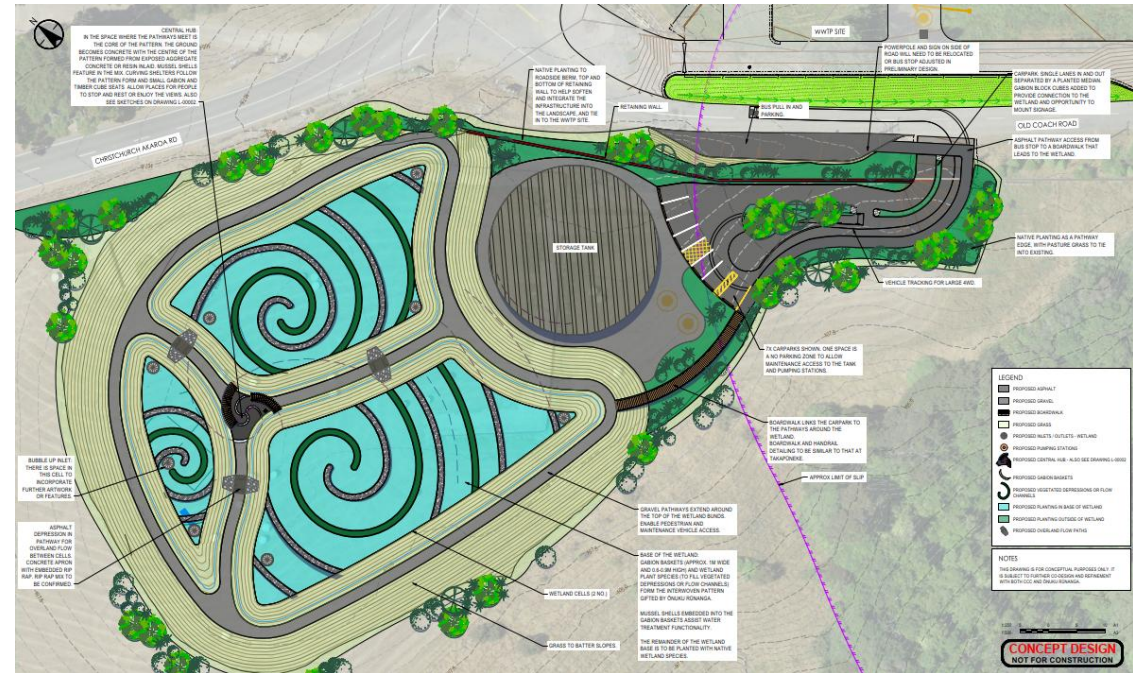
- Modelling irrigation rates accounts for climate change;
- The slope, soils, drainage and other characteristics make these sites suitable;
- Site performance in recent storms of over 200mm rainfall demonstrates this.

Five largest 48 hr rainfall events since July 2017	
Date	Rainfall (mm)
30/05/2021 - 31/05/2021	218
22/07/2023 - 23/07/2023	237.8
30/04/2025 - 1/05/2025	298.6
15/02/2026 - 16/02/2026	248.6
16/02/2026 - 17/02/2026	317

NIWA Akaroa rain gauge data.

Wetland

- 3200m² wetland at hay paddock site to provide restoration of mauri before a harbour discharge.



Wetland concept design

Harbour outfall for storage exceedances (through wetland)

- 300m outfall assessed using a Quantitative Microbial Risk Assessment to ensure public health risks of the harbour discharge are minimised.
- If Council prefers a longer outfall to address community concerns no further expert assessment is needed. This is technically feasible. It simply costs more and has no gain in public health risks and ecological effects.
- The current cost estimate for the outfall is approximately \$16,000 per meter.

Built-in contingencies

Risk: Pumping or treatment breakdowns. Storage tanks unavailable.

- Option has capacity in pumping, treatment, irrigation and storage systems to avoid this.

Risk: Land discharge is not possible due to saturated ground (from rainfall).

- Discharge to land is supplemented with harbour discharge path.

Risk: Localised slips in irrigation areas.

- Irrigation scheme has flexibility to operate with a number of irrigation areas out of service at any one time. Scheme is intended to actively identify any areas that make present a risk and not irrigate those areas until safe to do so.

Risk: Total failure of irrigation system

- WWTP and harbour discharge pipe are designed to take the full flow of the Akaroa and Duvauchelle terminal pump stations. Could be extended to a mid-harbour discharge or ocean outfall.

Independent expert evidence supports Council

Council follows expert advice on irrigation rates, native planting, slope stability, nutrient load, ecological effects, etc ensuring that risks are eliminated or appropriately mitigated.

- Geotechnical stability: Steve Woods (Stantec, 27 years experience)
- Storage and irrigation modelling: Greg Offer (30 years), Dr Zarour (30 years), Dr Dark
- Irrigation design: Ian McIndoe (38 years)
- Contaminants: Charles Mellish (40 years)
- Climate change and population modelling: NIWA, StatisticsNZ
- Soil science and nitrogen uptake: Prof. Robinson, Dr Gutierrez Gines (Uni of Cauty)
- Water ecology: Dr Zoe Dewson, Jesse Burns (EOS Ecology)
- Land ecology: Dr Colin Meurk (40 years)

Ecological benefits

[I]nfrastructure for the betterment of the overall environment and reasonable human amenity and comfort, sensitive to cultural needs and biodiversity values must be invested in from the beginning. This scheme is designed to provide a net benefit across multiple values and be adaptable to future trends in climate, biodiversity and social-cultural conditions....

Overall, there will be a substantial net gain of biodiversity values over the status quo, and an ‘overwhelming positive’ effect on biodiversity and other ecosystem services of the Akaroa Basin...

Dr Colin Meurk

NOT reasonably practicable options

Ocean outfall (refer agenda page 196) :

- Less cost-effective than the irrigation to land and mid-harbour outfall options.
- Construction risks and significant risks of cost escalation.
- Critical consenting risks (sediment and plumes during construction)
- Does not align with mana whenua values.

I&I reduction (refer agenda page 267) :

- Does not change the need for the scheme and a discharge solution.
- Network performed to 21% I&I in 2025.
- Options proposed do not rely on further I&I reduction.
- Costs outweigh benefits: as noted by FOBP the Council has spent many millions of dollars on I&I reduction with no clear drop in the rate of I&I.
- Aligns with mana whenua values.

Options Comparison

	Option 1 Land Based Scheme with increased irrigation rates, 16,000m ³ storage, WWTP moves to hay paddock	Option 2 Land Based Scheme with increased irrigation rates, 4,000m ³ storage, WWTP moves to hay paddock	Option 3 Land Based Scheme with increased irrigation rates, 16,000m ³ storage, WWTP stays on hillside site	Option 4 Land Based Scheme with increased irrigation rates, 4,000m ³ storage, WWTP stays on hillside site	Option 5 2700m Mid-Harbour Outfall	Status quo (Not shortlisted)
Irrigation Sites	Hammond Point Robinsons Bay	Hammond Point Robinsons Bay	Hammond Point Robinsons Bay	Hammond Point Robinsons Bay	Nil	Hammond Point Robinsons Bay Duvauchelle Recreation Reserve
Irrigated Land	28.0 ha	28.0 ha	28.0 ha	28.0 ha	Nil	41.1 ha
Irrigation Storage	16,000m ³	4,000m ³	16,000m ³	4,000m ³	500m ³ (For flush flows)	24,000m ³
WWTP Location	Hay Paddock	Hay Paddock	Hillside	Hillside	Hay Paddock	Hillside
Wetland Size	1000m ²	1000m ²	3200m ²	3200m ²	Nil	3200m ²
Irrigation Rates	3.4 - 6.2 mm/day	3.4 - 6.2 mm/day	3.4 - 6.2 mm/day	3.4 - 6.2 mm/day	Nil	1.7 - 3.1 mm/day
% of days WW discharged to land	99.3%	97.2%	99.4%	97.7%	100%	98.6%
Discharge Months	Apr - Sep	Any month	Apr - Sep	Any month	All months	Apr - Sep
Discharge Days Over 10 years	< 3 days through wetland: 15.9 days ≥ 3 days through wetland: 10.2 days	< 3 days through wetland: 62.5 days ≥ 3 days through wetland: 39.0 days	< 3 days through wetland: 5.0 days ≥ 3 days through wetland: 16.8 days	< 3 days through wetland: 21.3 days ≥ 3 days through wetland: 62.9 days	All days No wetland	< 3 days through wetland: 9.6 days ≥ 3 days through wetland: 40.9 days
Capital Cost	\$150m	\$136m	\$160m	\$146m	\$127m	\$176m
35 yr NPV Cost	\$186m	\$171m	\$196m	\$181m	\$155m	\$215m

Why not recommending harbour discharge

Harbour outfall (refer agenda page 199) :

- Does not achieve the substantial ecological benefits of irrigation to land.
- It does not provide for mana whenua values.
- Option is simpler to operate but more challenging to maintain, repair or monitor for breakages than an irrigation to land system.

Changed Irrigation Rates

- Council experts advise rates in the current application are very low and highly conservative, due to community concerns, not expert advice
- Independent experts support the increase to doubled irrigation rates
- Increased rates are consistent with the new Regulations (WEPS)
- Reduces irrigation to areas less than 17 degrees slope
- Possible further cost savings by increasing irrigation rates to some land and other changes to the scheme (will report in July)
- Intent is not to irrigate to saturation, it does not rely on plant uptake of water.
- Ecologists support the nitrogen load of the current application and this will not be changed

The Recommended Option cost savings

Reduces capital costs by estimated \$25m:

- Duvauchelle irrigation removed.
- Less storage in tanks: down from 24,000m³ to 16,000m³
- Moving the WWTP to other side of Old Coach Rd

Changes to current proposal going hand in hand:

- Removal of irrigation to slopes of 17 degrees or more (Application did include up to 19)
- Increased irrigation rates - supported by experts and compliant with Regulations (WEPS)
- Reduced size of wetland because of moved WWTP - but still achieves
 - (i) 3 days in wetland before discharge on all but 16 days in 10 years;
 - (ii) Discharge to harbour on fewer than 1% of days
- No change to outfall for storage exceedances – 300m into Childrens Bay
- No change to the 84 ha of native regeneration

Questions?

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10 February 2026

Tim Ure
Senior Project Manager - Wastewater
Christchurch City Council

Kia ora Tim,

WASTEWATER ENVIRONMENTAL PERFORMANCE STANDARDS (WEPS) - PART 4 LAND CLASSIFICATIONS ASSESSMENT FOR AKAORA AND DUVAUCHELLE TREATED WASTEWATER DISCHARGES

1.0 Introduction

Christchurch City Council (CCC) have engaged Pattle Delamore Partners Limited (PDP) to undertake an initial review of the Akaroa Treated Wastewater Irrigation Scheme (ATWIS) and Duvauchelle Treated Wastewater Irrigation Scheme (DTWIS) with respect to the new Water Services (Wastewater Environmental Performance Standards) Regulations 2025 (referred to as the 'WEPS'), which came into force on 19 December 2025. The purpose of the review is to assess the proposed irrigation areas to determine the likely land classification for each irrigation site under the WEPS.

The irrigation sites to be assessed are:

- Robinsons Bay;
- Hammond Point; and
- Duvauchelle Showground Recreational Reserve (DSRR).

Additionally, the resulting WEPS land classes and potential associated irrigation loading rates are compared to the existing proposed irrigation system rates at a high level to show an approximation of how the system may change, providing an indication of any associated changes to number of treated wastewater exceedance discharges.

2.0 Background

An application for discharges of treated wastewater to land was lodged for the ATWIS in 2023. This includes irrigation to land in Robinsons Bay and Hammond Point. It was notified in 2024 and hearings commenced in December 2024. As this resource consent application had been publicly notified in 2024, no further updates are required by the introduction of the WEPS.

The DTWIS application was initially drafted in accordance with the Resource Management Act prior to the release of the WEPS. The application planning assessment is now being updated to acknowledge the WEPS.

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Attachment B
Item 10



All three irrigation sites have preliminary irrigation designs in place, supported by technical investigations and assessments of site soils, groundwater, and ecology. These have informed the basis of this initial land classification assessment in accordance with WEPS Part 4 (2025).

The assessment outlined in Part 4 of the WEPS does not yet have accompanying guidance available on how to assign likelihood and severity for each risk associated with this assessment. Therefore, this letter outlines the most likely land classification for each of the assessed irrigation areas in accordance with best available information at the time of writing. There is a risk that the approach used in this assessment may vary from any future guidance released on determining land class and therefore the outcomes of this assessment should be reviewed once guidance is available.

3.0 WEPS Part 4 Categories

Part 4 of the Water Services (Wastewater Environmental Performance Standards) Regulations 2025 sets the national requirements for discharging treated wastewater to land. It applies to publicly owned wastewater treatment plants and mandates that any discharge-to-land activity must operate under a resource consent.

Part 4 requires a site assessment to be completed for each discharge site and defines key discharge types being either slow-infiltration (an annual hydraulic load of less than 6 metres) or rapid-infiltration (an annual hydraulic load of 6 metres or more). This part then sets discharge concentration limits, operations and maintenance manual requirements, and monitoring and record-keeping obligations.

The proposed irrigation systems at the ATWIS and DTWIS are considered to be slow-infiltration discharges as the discharge of treated wastewater to land is anticipated to be at a rate that results in the land receiving an annual hydraulic load of less than 6 metres. To be considered as rapid infiltration it is estimated more than 2 million cubic metres of wastewater would be required to be applied across the application area. Therefore, the regulations relevant to slow-infiltration discharge have been applied for the purposes of this assessment.

3.1 Slow-Infiltration Discharge Methodology

The land classification assessment has been undertaken in accordance with the methodology outlined in the WEPS Part 4 (Discharge from wastewater treatment plants to land) regulation 90 to regulation 93. Each of resultant Land Classes from the assessment have relevant slow infiltration discharge limits under regulation 96. These limits are outlined in Table 1.

Class	Loading Rates
1	Total Nitrogen (TN) - 550 kg/ha/yr Total Phosphorus (TP) – 110 kg/ha/yr If public has access to the site & discharge is above ground, <i>E coli</i> must not exceed 1 cfu/100 mL, measured as a 90th percentile
2	TN - 250 kg/ha/yr

¹

Water Services (Wastewater Environmental Performance Standards) Regulations 2025, <https://www.legislation.govt.nz/regulation/public/2025/0258/latest/whole.html>



Table 1: Slow infiltration discharge limits by land classification ¹	
Class	Loading Rates
	TP – 50 kg/ha/yr if no public access to the site or discharge is underground, <i>E coli</i> must not exceed 10,000 cfu/100 mL, measured as a 90th percentile if public has access to the site & discharge is above ground, <i>E coli</i> must not exceed 1 cfu/100 mL, measured as a 90th percentile
3	TN - 150 kg/ha/yr TP – 30 kg/ha/yr if no public access to the site or discharge is underground, <i>E coli</i> must not exceed 1,000 cfu/100 mL, measured as a 90th percentile if public has access to the site & discharge is above ground, <i>E coli</i> must not exceed 1 cfu/100 mL, measured as a 90th percentile
4	Regulation 87 applies – standards do not apply

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An overview of the methodology to determine the land classification and relevant limits is described in Sections 3.1.1 to 3.1.3.

3.1.1 Risk Assessment Categories

Regulation 92 requires a risk assessment to be undertaken by determining the likelihood and severity of an environmental or public health risk. The risks which must be assessed are listed below:

Environmental risks

- (a) toxicity resulting from nitrogen or nitrogen compounds entering water:
- (b) eutrophication resulting from nitrogen or phosphorus entering water:
- (c) accumulation of phosphorus in the soil:
- (d) the release of nitrogen or phosphorus from the soil:

Public health risks

- (e) a drinking water supply protection area becoming subject to a public health warning due to the presence of a nitrate or pathogen:
- (f) a source of drinking water becoming subject to a public health warning due to the presence of a nitrate or a pathogen:
- (g) the public being exposed to any pathogen as a result of having access to a discharge site:
- (h) illness due to the public being exposed to a pathogen:

Other risks

- (i) any other risk that the person identifies as posing a significant risk to the environment or to public health.

Likelihood and severities are assigned in accordance with the categories outlined in Table 2 and a risk factor is then determined using the matrix shown in Table 3.



Table 2: Likelihood and Severity Assessment Categories

Likelihood Categories	Severity Categories
certain or almost certain:	negligible:
likely:	minor:
possible:	moderate:
unlikely:	significant:
rare:	extreme.
nil.	

Table 3: Risk Factor Matrix

Likelihood	Severity				
	Negligible	Minor	Moderate	Significant	Extreme
Certain or almost certain	Low	Medium	High	Critical	Critical
Likely	Low	Medium	High	Critical	Critical
Possible	Low	Medium	Medium	High	Critical
Unlikely	Low	Low	Medium	Medium	High
Rare	Low	Low	Low	Low	High
Nil	Low	Low	Low	Low	Low

Finally, the number of low, medium, high and critical risk factors assessed for each risk determine an overall risk category as outlined below:

- a) if each risk assessed for the site has a low risk factor, the site is in **risk assessment category 1**:
- b) if 1 risk assessed for the site has a medium risk factor but all other risks have a low risk factor, the site is in **risk assessment category 2**:
- c) if 2 or more risks assessed for the site have a medium risk factor but all other risks have a low risk factor, the site is in **risk assessment category 3**:
- d) if 1 risk assessed for the site has a high-risk factor but all other risks have a medium or low risk factor, the site is in **risk assessment category 3**:
- e) if 2 or more risks assessed for the site have a high-risk factor but all other risks have a medium or low risk factor, the site is in **risk assessment category 4**:
- f) if 1 or more risks assessed for the site have a critical risk factor, the site is in **risk assessment category 4**.

3.1.2 Site Classification Category

Under the WEPS, the proposed irrigation systems are classified as slow infiltration discharges, as their annual hydraulic load will be less than 6 metres. Accordingly, the site classification category is determined in accordance with Regulation 93, based on an assessment of the following characteristics:



- (a) drainage:
- (b) soil type and suitability:
- (c) climate and soil moisture attributes:
- (d) nutrient uptake from land use on the site:
- (e) slope:
- (f) depth to groundwater level.

Slope is determined in accordance with Regulation 93(5) which states the slope must be measured by measuring the average gradient of the slope over a distance of 20 metres.

Table 4 demonstrates how each characteristic is assessed to assign a site classification.

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Table 4: Site Classification Categories by Characteristic						
Site Classification Category	Drainage	Soil type & suitability	Climate & soil moisture attributes	Nutrient uptake from land use on site	Slope	Depth to groundwater level
1	well drained and free of any drainage impediments in an unsaturated zone	fine sand, loamy sand, sandy loam, loam, or silt loam	remains below field capacity year-round with irrigation	nutrient uptake from pasture or crops on the site is 400 kilograms or more per hectare per year	less than 10 degrees	shallowest depth to groundwater level (including groundwater mounding) is 5 metres or more
2	moderately well drained and free of any drainage impediments in an unsaturated zone		irrigation brings the soil above field capacity but the soil never reaches field saturation			shallowest depth to groundwater level (including groundwater mounding) is 3 metres or more but less than 5 metres
3	imperfectly drained and free of any drainage impediments in an unsaturated zone	fine-grained clay loam or silty clay loam	irrigation occasionally brings the soil to field saturation in winter	nutrient uptake from pasture or crops on the site is more than 100 kilograms per hectare per year but less than 400 kilograms per hectare per year	10 degrees or more but less than 17 degrees	shallowest depth to groundwater level (including groundwater mounding) is 1.5 metres or more but less than 3 metres
4	poorly drained or there are minor drainage	coarse granular soil	soil occasionally reaches field saturation in	nutrient uptake from pasture or crops on the site is 100 kilograms		shallowest depth to groundwater level (including groundwater



Table 4: Site Classification Categories by Characteristic

Site Classification Category	Drainage	Soil type & suitability	Climate & soil moisture attributes	Nutrient uptake from land use on site	Slope	Depth to groundwater level
	impediments in an unsaturated zone		winter without irrigation	or less per hectare per year but more than negligible		mounding) is 1 metre or more but less than 1.5 metres
5	very poorly drained or there are extensive drainage impediments in an unsaturated zone	light or heavy clay or peat soil	soil reaches soil saturation for prolonged periods in winter without irrigation	nutrient uptake from pasture or crops on the site is negligible or 0 kilograms per hectare per year	17 degrees or more	shallowest depth to groundwater level (including groundwater mounding) is less than 1 metre

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To assign a land class to a site, the site classification category for the site is the highest classification category determined after assessing all characteristics.

3.1.3 Determination of Land Class

The overall risk assessment category and site classification category is used to determine the land class in regulation 91 as per the matrix outlined in Table 5.

Table 5: Procedure for assigning land class to site

	Site classification category 1	Site classification category 2	Site classification category 3	Site classification category 4	Site classification category 5
Risk assessment category 1	Land class 1	Land class 1	Land class 2	Land class 3	Land class 4
Risk assessment category 2	Land class 1	Land class 2	Land class 2	Land class 3	Land class 4
Risk assessment category 3	Land class 2	Land class 2	Land class 2	Land class 3	Land class 4
Risk assessment category 4	Land class 2	Land class 2	Land class 3	Land class 4	Land class 4

3.2 Workshop – 3 December 2025

An initial assessment of land classes was undertaken by PDP using existing technical reports associated with the ATWIS and DTWIS. A workshop was held between Christchurch City Council (CCC), Aqualinc Research Limited (Aqualinc) and Pattle Delamore Partners (PDP) on 3 December 2025 to discuss and refine each risk assessment topic and site characteristic classification to determine the likely land classes associated with the irrigation sites. These attendees were present due to being part of previous site



assessments and therefore are familiar with site specific characteristics of the proposed Robinsons Bay, Hammond Point or the DSRR irrigation areas.

The key outcomes of this workshop are described in Sections 3.2.1 to 3.2.15 below, which have been refined by further assessment in some limited circumstances.

3.2.1 Toxicity resulting from nitrogen or nitrogen compounds entering water

The Workshop attendees discussed the potential likelihood and severity of ecological impacts, focusing on toxicity from nitrogen or nitrogen compounds entering water. A review of relevant ecological assessments indicated that the likelihood of such toxicity occurring was assessed as unlikely across all locations.

At the DSRR the severity, should this occur, was considered moderate. This was due to high abundance of 'at-risk' species noted in receiving streams² as well as the coastal receiving environment having seagrass present³. The site was therefore assigned a 'medium' risk factor.

At Robinsons Bay, the severity, should this occur, was considered minor. This was due to the main potential effect of this activity being expected to result in a small increase in stream flow, as well as an increase in concentration of nitrate nitrogen in the streams. However, the estimated post irrigation nitrate concentration for the stream would not result in a change of Attribute Band in Robinsons Bay Stream⁴. The site was therefore assigned a 'low' risk factor. Notably, should this severity on the stream be considered moderate instead of minor due to higher loading, this would be assigned a 'medium' risk factor. This higher interpretation of the risk factor, in conjunction with the alternative risk factor described in Section 3.2.2 would not alter the final Land Class determination outlined in Section 3.3.

At Hammond Point the severity, should this occur, was considered negligible. The nitrogen in the treated wastewater applied to the Hammond Point irrigation site was assessed to have a less-than-minor adverse effect on estuary ecology, due to rapid dilution and mixing of residual contaminants within the subtidal harbour waters.⁵ The site was therefore assigned a 'low' risk factor.

3.2.2 Eutrophication resulting from nitrogen or phosphorus entering water

The likelihood of eutrophication, resulting from nitrogen or phosphorus entering water, was assessed as possible by the workshop attendees for the DSRR and Robinsons Bay, as any runoff or leaching may enter freshwater streams.

At both the DSRR and Robinsons Bay, the severity, should this occur, was considered moderate. This was due to an elevated eutrophication risk being noted at Pawsons Stream² and the effects of any eutrophication being noted as likely to be more evident on the more sensitive invertebrate community of Robinsons Bay Stream than they would be on other more impacted waterways⁴. The sites were therefore assigned a 'medium' risk factor. Notably, should this severity on the streams be considered significant instead of moderate due to due final guidance interpretations, this would be assigned a 'high' risk factor. This interpretation of the risk factor, in conjunction with the alternative risk factor described in Section 3.2.1 would not alter the final Land Class determination outlined in Section 3.3.

² Pattle Delamore Partners, *Freshwater and Terrestrial Ecological Impact Assessment – Duvauchelle Treated Wastewater Irrigation Scheme* (October 2025)

³ Pattle Delamore Partners, *Duvauchelle Treated Wastewater Irrigation Scheme (DTWIS): Assessment of Effects on Estuarine Ecology* (October 2025)

⁴ EOS Ecology, *Akaroa Treated Wastewater Irrigation Scheme (ATWIS) Assessment of Environmental Effects on Freshwater Ecology* (December 2022)

⁵ *Summary of Evidence of Jesse Elizabeth Burns on behalf of the Christchurch City Council* (November 2024)



At Hammond Point the severity, should this occur, was considered negligible, assigning a 'low' risk factor due to the nitrogen in the treated wastewater applied to the Hammond Point irrigation site may being expected to have a very low/less than minor level of adverse effect on estuary ecology due to the quick dilution and mixing of residual contaminants in subtidal harbour waters⁶.

3.2.3 Accumulation of phosphorus in the soil

For all sites, the likelihood of accumulation of phosphorus in the soil from irrigation of treated wastewater is certain or almost certain. However, when considering just the severity of phosphorus accumulating in the soil, the workshop considered that severity could be negligible for all sites. This results in a 'low' risk factor. If potential phosphorus runoff during rainfall was considered as part of the severity for this risk, instead of the risk of the release of nitrogen or phosphorus from the soil, then severity may be considered minor, assigning a 'medium' risk factor. However, it has been assumed by the workshop group that this severity is covered off by Section 3.2.4 and therefore the overall risk factor is 'low'.

3.2.4 The release of nitrogen or phosphorus from the soil

The likelihood release of nitrogen or phosphorus from the soil was assessed at the workshop as certain or almost certain along with a minor severity for both DSRR and Robinsons Bay. This results in a 'medium' risk factor for those sites.

Hammond Point was assessed as a likelihood of certain or almost certain for nutrient release from the soil, with a negligible severity, assigning a 'low' risk factor for the site.

The workshop attendees considered release of nitrogen and phosphorus is anticipated at some level for all sites, however at the DSRR and Robinsons Bay there is a risk of low level of release into sensitive waterbodies or bores making severity potentially minor, whereas the receiving environment of Hammond Point is the coastal environment where mixing of any low level nutrients is anticipated to result in negligible severity.

3.2.5 A drinking water supply protection area becoming subject to a public health warning due to the presence of a nitrate or pathogen

There are no drinking water supply protection zones documented nearby any of the irrigation areas⁷. A drinking water supply protection area becoming subject to a public health warning due to the presence of a nitrate or pathogen was assessed at the workshop as nil likelihood and negligible severity, therefore receiving a 'low' risk factor.

3.2.6 A source of drinking water becoming subject to a public health warning due to the presence of a nitrate or a pathogen

Mean treated wastewater quality for total nitrogen is limited to 10 mg/L, which is lower than the nitrate, short-term drinking water standards maximum acceptable value of 11.3 mg/L as NO₃-N. Any total nitrogen remaining in groundwater following application is anticipated to be significantly lower than this, given that further dilution with rainfall and groundwater flows is expected to occur.

Ultraviolet disinfection will reduce human pathogen loads in treated wastewater prior to irrigation and any remaining pathogens would need to travel through strata to a drinking water source.

⁶ Summary of Evidence of Jesse Elizabeth Burns on behalf of the Christchurch City Council (November 2024)

⁷ Environment Canterbury – Canterbury Maps, 'Community Drinking Water Protection Zones', <https://mapviewer.canterburymaps.govt.nz/> (December, 2025).



Bore N36/0005 at the Duvauchelle School is the only bore recorded near the DSRR, this is understood to be unused as Duvauchelle is on a reticulated water supply⁸. CCC have offered to decommission this bore in the current version DTWIS resource consent application⁹. Likelihood of the school extracting water for drinking is therefore considered rare and severity would be considered minor.

There are no known active bores near Hammond Point¹⁰ or any other known drinking water sources downgradient of the irrigation area, therefore, the likelihood of a source of drinking water becoming subject to a public health warning is considered rare and severity would be considered minor.

Two consented water supplies are present at Robinsons Bay as well as other groundwater users for stock supply and domestic drinking water¹⁰. Sources of drinking water are therefore present in this area. The workshop discussions determined that the number of people using these bores is very small. The pathways for a source of drinking water becoming subject to a public health warning due to the presence of a nitrate or a pathogen are limited. Therefore, the workshop determined that the likelihood of a source of drinking water becoming subject to a public health warning is considered rare and severity would be considered minor.

The risk factor for a source of drinking water becoming subject to a public health warning due to the presence of a nitrate or a pathogen has therefore been determined as 'low' for all locations.

3.2.7 The public being exposed to any pathogen as a result of having access to a discharge site

Illness due to the public being exposed to any pathogen as a result of having access to a discharge site was assessed at the workshop as unlikely and minor severity assigning a 'low' risk factor. The irrigation areas are most likely to be restricted access for the public and will have signage. The treated wastewater is proposed to be tertiary treated including ultraviolet filtration to significantly reduce human pathogen sources. On a very rare occasion, a member of the public could attempt to access the irrigation sites for some reason. CCC have indicated future supporting information may allow the site to be used for public access should it be demonstrated risk of being exposed to any pathogen is sufficiently low due to quality of treated wastewater and discharge to land at the surface.

Those present at the workshop interpreted severity as being related to the number of the public being impacted by illness due to exposure. As the exposure pathways are limited and any types of illness that public accessing the site may contract (such as a norovirus virus) have very low probability to kill or spread widely, the severity was considered minor for all sites.

3.2.8 Illness due to the public being exposed to a pathogen

Illness due to the public being exposed to a pathogen was assessed at the workshop as unlikely and minor severity assigning a 'low' risk factor. Given discharge is via drip irrigation along the ground in all locations this risk is considered the same as the above assessment of risk of the public being exposed to any pathogen as a result of having access to a discharge site (instead of spray irrigation, for example, where spray drift may pose risk of illness to public without access to the site).

⁸ Pattle Delamore Partners, *Duvauchelle Treated Wastewater Irrigation Scheme – Discharge to Land Assessment* (October, 2025)

⁹ Pattle Delamore Partners, *Duvauchelle Treated Wastewater Irrigation Scheme – Assessment of Environmental Effects* (December, 2025)

¹⁰ Stantec New Zealand, *Akaroa Treated Wastewater Irrigation Scheme – Application for Resource Consents and Assessment of Environmental Effects* (May 2023)



3.2.9 Any other risk that the person identifies as posing a significant risk to the environment or to public health

No additional risks were identified by those present in the workshop as posing a significant risk to the environment or to public health. This additional risk category has therefore not been utilised for the purposes of this land class assessment.

3.2.10 Drainage

Discussions at the workshop determined the most suitable drainage attribute for all irrigation areas to be imperfectly drained (no impediments). This is based on experience with the sites and existing soil studies^{11 12}.

3.2.11 Soil type and suitability

Areas near the irrigation sites have been documented as Barry soil at Duvauchelle and Pawson silt loam at Robinsons Bay and are therefore classed as silt loam¹¹. Based on soil investigations, Hammond Point is understood to be silt loam also. It is possible a mixture of other soil types may be present across the sites.

3.2.12 Climate and soil moisture attributes

Discussions at the workshop determined the most suitable climate and soil moisture attribute for all irrigation areas is to assume soil occasionally reaches field saturation in winter without irrigation. This is based on experience with the sites and known behaviour during heavy rainfall.

3.2.13 Nutrient uptake from land use on the site

13.5 kg N/ha/yr of applied nitrogen is estimated to be lost via denitrification, either directly from the soil or indirectly from decomposing leaf litter¹³. This value has been adopted for all irrigation areas to be consistent with irrigation modelling assumptions undertaken to date.

3.2.14 Slope

The workshop agreed to divide the irrigation areas into slope categories as this determines whether the irrigation areas would be site category 3 or 5 and therefore land class 3 or 4.

A geospatial review of each irrigation area determined the spatial distribution by slope presented in Table 6.

Table 6: Irrigation Areas by Slope Category			
Slope	Robinsons Bay	Hammond Point	DSRR
< 10 degrees	10.2 ha	1.3 ha	1.4 ha
≥ 10 but < 17 degrees	16.9 ha	2.5 ha	3.8 ha
≥ 17 degrees	4.8 ha	0 ha	0.4 ha

¹¹ Brett Robinson, Department of soil science, Lincoln University (School of Physical and Chemical Sciences), *Final report (June 2017): A lysimeter experiment and field trial to determine options for the beneficial reuse of wastewater from Duvauchelle and Akaroa, Banks Peninsula* (June, 2017).

¹² Pattle Delamore Partners, *Duvauchelle Treated Wastewater Irrigation System - Discharge to Land Assessment* (2025).

¹³ Pattle Delamore Partners, *Combined Akaroa and Duvauchelle Modelling – Inputs and Assumptions* Letter (October, 2025).



Maps of the 20 m grid average slope distribution across each irrigation area are shown in Attachment A.

3.2.15 Depth to groundwater level

The minimum depth to groundwater at the DSRR between the upper irrigation area and the groundwater table has been measured at 12.41 m below ground level based off existing assessments¹⁴ (not including mounding). Shallower groundwater measurements have been taken downhill and downgradient of the irrigation areas, closer to the streams which indicates depth groundwater may decrease in the downhill portions of the irrigation field. The mounding assessment indicated that the predicted groundwater mounding could be between 0.34 to 0.70 m after one year in some locations, and 0.15 to 0.37 m in others¹⁴. Drainage is proposed to mitigate mounding impacts to the groundwater table in the lower sections of the irrigation area. Therefore, shallowest depth to groundwater level (including groundwater mounding) is estimated as 1 metre or more at the irrigation site.

No shallow groundwater monitoring (it is understood that the depth of closest monitoring bores is 10 m and no groundwater has been observed in these bores, therefore groundwater is expected to be > 10 m below ground level) has been observed at the Hammond Point Road site¹⁵. Therefore, shallowest depth to groundwater level (including groundwater mounding) is estimated as likely to be 5 metres or more at Hammond Point.

Groundwater monitoring at Robinsons Bay indicated shallowest groundwater may be below 1 metre at GW105 (inside the proposed irrigation areas) and GW3 (downstream of the irrigation areas). These monitoring bores are close to Robinsons Bay Stream and are likely to be hydraulically connected. Bores further upslope and next to small tributaries (such as GW104 and GW1) do not appear to have the same hydraulic connection resulting in depths from ground level to groundwater of less than 1 m. The statistics of the groundwater monitoring are shown in Table 7.

Table 7: Statistics for groundwater levels in monitoring bores at the site (m bgl)

Site	Minimum	Mean	Maximum
GW1 ¹	2.305	2.912	3.100
GW3 ¹	0.869	2.563	2.660
GW101 ¹	2.029	6.041 ³	> 9.393 (Dry)
GW104 ²	1.30	7.122 ³	> 8.874 (Dry)
GW105	0.114	1.563	1.871
GW106	1.229	2.504	2.770

Notes:

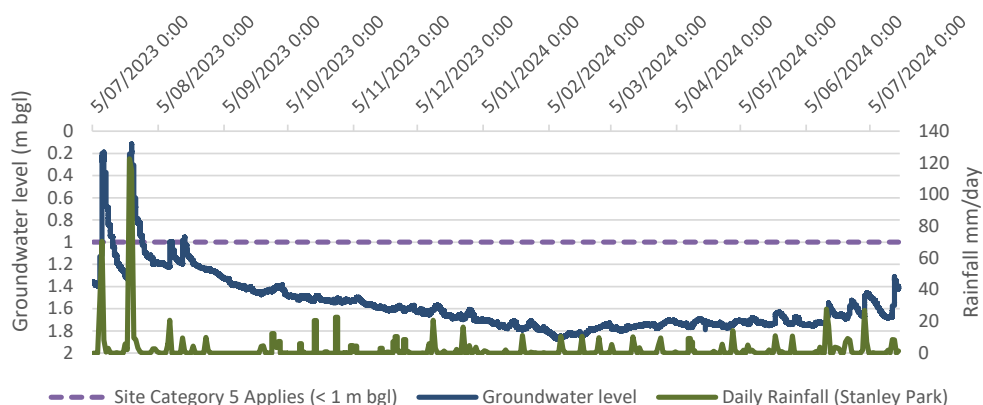
1. Groundwater levels were affected by drawdown during the sampling process and are not entirely representative of natural groundwater conditions. Where bores were quick to recover (< 48 hours), that drawdown data was excluded from the analysis.
2. The pressure transducer in bore GW104 experienced a manufacturing defect and therefore there is no electronic data available for the period 5/07/2023 to 20/12/2023. Minimum value is the manual measurement undertaken on 5 June 2023. Mean and maximum statistics for this bore are calculated from the electronic record only and as such may be skewed.
3. Mean values for these bores exclude the period where the bores were dry.

¹⁴ Pattle Delamore Partners, *Groundwater Mounding and Mitigation Assessment – Duvauchelle Showground Recreational Reserve* (October, 2025).

¹⁵ Aqualinc Research Limited, *Aqualinc Research Limited Report - Irrigation Assessment* (October, 2022).



Comparison of bore GW105 against rainfall in **Figure 1** shows that high groundwater levels are associated with heavy rainfall. Two large rainfall events are noted to have triggered groundwater levels at bore GW105 to rise for the winter period such that levels were frequently less than 1 m bgl.



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Figure 1: Groundwater levels recorded at bore GW105 and corresponding rainfall measured

The definition of shallowest depth to groundwater in the WEPS is not fully defined. It is not clear whether there must be consideration of monitored groundwater level cutoffs, and seasonal shutdowns of irrigation areas, where groundwater is known to rise (such in winter). This would allow risk categories to be managed and influence the assessment of a site. For example, a site assessed as Site Classification Category 5, due to the shallowest depth to groundwater, could have this risk category managed by adding consent conditions to cease irrigation when groundwater is high and result in a Site Classification Category 4. If this is possible, the area of Robinsons Bay Irrigation Site close to Robinsons Bay Stream may be able to be assessed as land class 3 outside of winter and potentially early autumn periods.

In lieu of guidance from the regulator, this assessment has conservatively assumed that the seasonal high groundwater level reflects the shallowest depth to groundwater level. Therefore, for the purposes of this assessment, a 50 m buffer zone from Robinsons Bay Stream has been used as an approximation of shallowest groundwater levels that may result in less than 1 m bgl when river levels rise. This 50 m buffer has been used as an indicator for groundwater levels potentially less than 1 m bgl as GW3, which is 30 m from the stream, indicates lowest groundwater levels of 0.869 m in winter. Any irrigation areas within this setback of the stream have been conservatively assigned site class 5.

Notably, an elevated terrace does run along the southern side of the stream. This may provide justification that areas which are currently indicated as site class 5, within the 50 m buffer, could be considered site class 4. This is because the elevation of the terrace may add more separation than 1 m to groundwater, provided any mounding assessments are shown to maintain this separation also. Figure 2 shows terraced areas which should be further assessed as potentially being land class 3 under the hydraulic loading and mounding scenario relevant to any potential WEPS application.

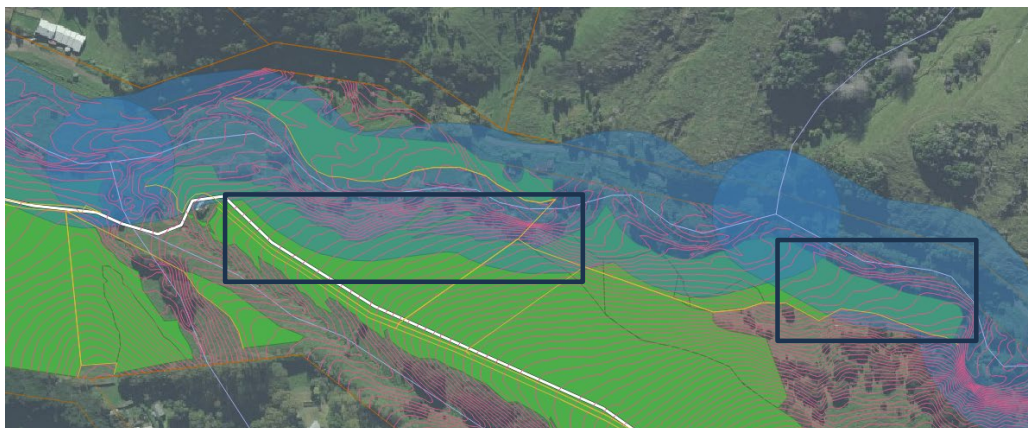


Figure 2: Irrigation area (green) and survey contours showing elevated southern terraces (boxed)

Table 8 shows the distribution of Robinsons Bay irrigation area by slope and potential groundwater levels.

Table 8: Areas outside of and within 50 m of Robinsons Bay Stream at Robinsons Bay

Slope	River 50m Buffer (groundwater potentially < 1 m bgl in winter)	Outside River 50m Buffer
< 10 Degrees	1.7 ha	8.5 ha
10 - 17 Degrees	0.9 ha	16.0 ha
17 + Degrees	0.1 ha	4.7 ha

Further assessment in the future may further refine this approach and the areas where groundwater is site classification category 5. Additional groundwater mounding impacts will need to be further considered in refinement of these areas. A map of slopes, monitoring bores and the 50 m stream buffer zone for the whole site is shown in Attachment A.

3.3 Results

Using PDPs land class assessment tool which has been built to tally risk scores and assign appropriate categories in accordance with the WEPS, the irrigation areas have been determined as either land class 3 or 4. The difference between land classes for this assessment was influenced by the areas of the irrigation sites at higher slopes (≥ 17 degrees) and locations with shallowest groundwater, potentially less than 1 metre. Areas which overlap one of both of these indicators were assigned site classification category 5 and are subsequently considered to be land class 4. All remaining irrigation areas were determined as most likely to be land class 3. Land class 3 and 4 areas are summarised in Table 9.



Irrigation Site	Area (ha)	Land Class
Duvauchelle Showground Recreational Reserve	5.2	3
	0.4	4
Hammond Point	3.8	3
	0	4
Robinsons Bay	24.5	3
	7.4	4

Based on the initial assessment of Robinsons Bay, Hammond Point and DSRR against the WEPS land classes, it is estimated that 33.5 ha may be land class 3 and 7.8 ha may be land class 4. These results inform updated irrigation hydraulic rates for different land class areas modelled in section 4 onwards.

3.4 Sensitivity of Assessment

This assessment has been undertaken prior to guidance being released. Therefore, some categories identified in this assessment may vary with release of written guidance from Taumata Arowai. For the areas which have been assessed as land class 3, two risk factors would need to change from the currently assessed low and medium factors to high factors in order for the irrigation area to change from land class 3 to land class 4.

4.0 Comparison of Potential Land Classification Rates to Existing Proposed System

4.1 Overview

Five modelling scenarios have been prepared for the purposes of indicating how the irrigation system may vary under different scenarios potentially available under the WEPS for comparative purposes.

At the request of CCC, the model comparisons also show the change in the irrigation system operation with different overall wastewater treatment quality. This is because CCC have indicated progression in the wastewater treatment plant design indicates that improved average total nitrogen and total phosphorus concentrations may be able to be achieved compared to what is in the current consent application. This improvement is anticipated as a total phosphorous (TP) concentration of 3 mg/L¹⁶ and total nitrogen (TN) concentrations of 7 mg/L¹⁷. Thereby potentially enabling additional irrigation depth to be applied without increasing the previously assessed nutrient loads being irrigated. The current proposed treatment quality used to date has been a mean TP concentration of 7 mg/L and TN concentrations of 10 mg/L.

Irrigation rates in each scenario are also adjusted to demonstrate what may occur if irrigation applications rates were able to be increased. The alternative scenarios look at two different sets of increased rates: theoretically what could be applied if rates were doubled in Land Class 3 areas; and then what may occur if Wainui irrigation system rates could be applied to Land Class 3 areas. Previous high-level infiltration testing studies indicated Wainui rates may be able to be facilitated on the land at Robinsons Bay¹⁸, however any increased application rates would need to be reviewed in terms of soil capacity and geotechnical stability prior to adoption in system changes.

¹⁶ CCC indicated this value is more representative of sampled influent untreated wastewater concentrations prior to treatment, therefore TP is unlikely to increase after treatment.

¹⁷ CCC indicated that the wastewater design may more likely meet this value as a mean annual concentration



Five scenarios have been modelled as outlined in Table 10.

Table 10: Scenarios used for Comparison		
Scenario	Type	Description
1	Baseline	the system irrigation application rates and treated wastewater quality are modelled as presently proposed for the resource consent applications ¹⁸
2a	Increased application on Land Class 3	the system irrigation application rates are doubled for Land Class 3 areas and maintained as per 'Baseline' scenario 1 for Land Class 4 areas, treated wastewater quality is as presently proposed
2b	Increased application on Land Class 3	the system irrigation application rates are doubled for Land Class 3 areas and maintained as per 'Baseline' scenario 1 for Land Class 4 areas, treated wastewater quality is improved
3	Increased application on Land Class 3	the system irrigation application rates are the same as Wainui irrigation sites¹⁹ for Land Class 3 areas and maintained as per 'Baseline' scenario 1 for Land Class 4 areas, treated wastewater quality is improved
4	Increased application on Land Class 3 and removal of Land Class 4 irrigation	the system irrigation application rates are the same as Wainui irrigation sites¹⁸ for Land Class 3 areas and Land Class 4 areas are removed from the system, treated wastewater quality is improved

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4.2 Soil Moisture Balance Model

PDP developed a soil moisture balance (SMB) model for irrigation of treated wastewater to land²⁰. This was previously applied to the DTWIS to estimate potential land irrigation loading rates and included the ATWIS to provide outputs to estimate treated wastewater storage exceedances for resource consent application. The model uses a daily time step to estimate irrigation applied, soil moisture, and nitrogen retention within the soil profile.

The same model has been used to undertake this comparison of different hydraulic loading and potential revised treated wastewater quality. Section 4.2.1 outlines fixed variables for the purposes of this assessment and Section 4.2.2 details how each scenario varies in terms of model inputs.

¹⁸ Currently submitted consent application annual means are 7 mg/L TP and 10 mg/L TN

¹⁹ 'Infiltration testing results for Akaroa treated wastewater disposal via irrigation – Robinsons Bay and Pompeys Pillar', Pattle Delamore Partners 2016

²⁰ 'Combined Akaroa and Duvauchelle Modelling – Inputs and Assumptions', Pattle Delamore Partners 2025



4.2.1 Fixed Model Inputs and Assumptions

The following model inputs that were retained from previous modelling, and remained constant across all new modelled scenarios, are summarised below:

- ✦ Treated wastewater flow series (1972 - 2023²¹)
- ✦ Daily rainfall depth (1972 – 2022)
- ✦ Daily potential evapotranspiration (1971 – 2022)
- ✦ Irrigation storage volume (28,208 m³)
- ✦ Drip irrigation application method – 100 % efficiency
- ✦ Land use – Trees
- ✦ Nitrogen uptake 0.04 kg TN/ha/day (13.5 kg TN/ha/year)¹³
- ✦ Daily rainfall interception coefficient by land use type
- ✦ Surface run-off based on monthly rainfall depth
- ✦ Soil and land properties: Plant rooting depth, permanent wilting point, field capacity, saturation, plant available water, and saturation capacity (mm)
- ✦ Saturated drainage rate (mm/day)
- ✦ ET crop factor and curve number
- ✦ Irrigation start and stop triggers
- ✦ Minimum rest period (days) was set to 0
- ✦ Rainfall cut off limits (30 mm/d for Duvauchelle, 50 mm/d for Akaroa)

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4.2.2 Irrigation Areas and Nutrient Concentrations Compared

The comparative scenarios model nutrient loading and leaching rates for seasonal irrigation patterns that vary for different estimated land class areas (section 3.3), compared to the baseline ('status quo') scenario.

The currently proposed wastewater treatment plant quality submitted for consent²² has been modelled in Scenarios 1 and 2a. CCC's indicative improved treated wastewater concentrations for TP and TN (3 mg/L and 7 mg/L respectively) have been modelled across scenarios 2b - 4. The irrigation areas for modelled scenarios 2b - 4 were also divided into the different land class areas identified in Section 3.3. Scenario 4 demonstrates a scenario where only land class 3 areas are used.

Table 15 in Attachment 2 shows the different land areas and associated treated wastewater quality compared for each scenario and hydraulic loading rates were adjusted by each land class area, as described in section 4.2.3.

4.2.3 Hydraulic Loading Rates Compared

The current irrigation hydraulic loading rates used in the resource consent applications vary by season to account for rainfall patterns and the unique soil properties of Duvauchelle Showground,

²¹ Input data from 2023 does not contain an entire year of data and therefore statistical analysis of model results to inform annual averages presented in Section 4.4 have not taken into account 2023.

²² Akaroa treated Wastewater irrigation Scheme – Application for Resource Consents and Assessment of Environmental Effects, May 2023



Duvauchelle Pawson's' and Akaroa catchments. Different irrigation application rates have been modelled for comparison for each scenario, as listed below:

- ✧ Scenario 1: baseline seasonal irrigation patterns are used:
 - Baseline for Duvauchelle Showground Catchment (based on matching N uptake)¹³
 - Baseline for Duvauchelle Pawson's Catchment (based on previous modelling work)¹³
 - Baseline for Akaroa (as per Aqualinc recommendations²³)
- ✧ Scenario 2a & b:
 - Land class 4 areas are irrigated with the seasonal irrigation patterns from scenario 1.
 - Increases the volume of treated wastewater irrigated by doubling the seasonal irrigation rates from scenario 1 in Land class 3 areas as follows:
 - 2 x Baseline for Duvauchelle Showground Catchment
 - 2 x Baseline for Duvauchelle Pawson's Catchment
 - 2 x Baseline for Akaroa (Robinsons Bay and Hammond Point)
- ✧ Scenario 3:
 - Land class 4 areas are irrigated with the seasonal irrigation patterns from scenario 1.
 - Applied hydraulic irrigation rates to Land class 3 areas based on soil investigations for Robinsons Bay by PDP in 2016 for all irrigation areas^{Error! Bookmark not defined.}. This investigation recommended irrigating up to a maximum of 37.5 mm/week to trees in summer, and 17.5 mm/week in winter, similar to Wainui irrigation system rates. The average of these two values were used for Spring and Autumn seasons.
- ✧ Scenario 4:
 - Land class 4 areas are not irrigated.
 - Land class 3 areas were irrigated with the rates adapted from recommendations by PDP in 2016.

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Irrigation rates used across the four modelled scenarios are summarised Table 16 in Attachment 3.

4.3 Treated Wastewater Storage Exceedances Model

The outputs of the soil moisture balance modelled scenarios were also used to estimate potential changes to the number of treated wastewater storage exceedance discharges to harbour. The size of areas irrigated and varying hydraulic loading rates across scenarios will yield different volumes of treated wastewater able to be irrigated. This then influences the potential occurrence of treated wastewater exceedances from the storage, which has been modelled as 28,208 m³ for all scenarios²⁴.

The treated wastewater storage exceedances model has been updated using the outputs of each irrigation scenario from the soil moisture balance model outlined in Section 4.2. The updated model incorporates treated wastewater flows from the wastewater treatment plant (WWTP), the total irrigated volumes, available storage, rainfall and evaporation data to assess how the frequency of treated wastewater exceedance discharges may change.

²³ Aqualinc Research Limited, *Aqualinc Research Limited Report - Irrigation Assessment* (October, 2022).

²⁴ 'Combined Model Run Outputs for Storage Exceedances', PDP, 2025



4.4 Results

4.4.1 Nutrient Loading

The model results for annual average and maximum total treated wastewater volumes for all areas are presented by scenario in Table 11. Annual average and annual maximum volume irrigated to land, nitrogen and phosphorus loading for the DSRR and Akaroa (Robinsons Bay and Hammond Point) irrigated areas are shown in Table 12 and Table 13.

The comparative results indicate the following for all irrigation areas:

- ∴ The current baseline scenario 1 (with higher modelled treated wastewater concentrations) is anticipated to meet the WEPS land class 3 limits for TN (150 kg TN/ha/year), but may exceed land class 3 limits for TP (30 kg TP/ha/year)²⁵;
- ∴ Scenario 2a which models doubled application rates with the same with higher modelled treated wastewater concentrations as Scenario 1 is also anticipated to meet the WEPS land class 3 limits for TN (150 kg TN/ha/year), but will exceed land class 3 limits for TP (30 kg TP/ha/year);
- ∴ All other comparative modelled scenarios (2b to 4) with reduced TN and TP concentrations and higher hydraulic loads are anticipated to meet the land class 3 limits for TN and TP;
- ∴ Overall, scenario 2a and 2b results in the greatest volume of treated wastewater being irrigated to land. However, it is important to note that the comparative modelling assumes the same irrigation application rates as Wainui for all Land Class 3 areas in Scenarios 3 and 4, including the Showground catchment at the DSRR. As a result, higher wastewater volumes are applied to the DSRR in scenarios 3 and 4 than were modelled in scenarios 1 and 2a and 2b, where significantly lower rates are applied to 1.1 ha in the Showground catchment (refer to Attachment 3).

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²⁵ Untreated wastewater sampling shows that TP concentrations in Akaroa are typically lower than the current proposed treated wastewater consent limit of 7 mg/L. Therefore scenario 1 'baseline' TP loading is highly conservative.



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Table 11: Annual Average and Annual Maximum Treated Wastewater Volumes Irrigated (Whole System) ²⁶										
Model Outputs	Average					Maximum				
	Scenario 1	Scenario 2a	Scenario 2b	Scenario 3	Scenario 4	Scenario 1	Scenario 2a	Scenario 2b	Scenario 3	Scenario 4
Total Annual Treated Wastewater Applied (m ³)	267,219	271,538	271,538	271,294	270,599	298,343	325,985	325,985	322,158	314,847

Table 12: Annual Average and Annual Maximum Model Outputs for the DSRR										
Model Outputs	Average					Maximum				
	Scenario 1	Scenario 2a	Scenario 2b	Scenario 3	Scenario 4	Scenario 1	Scenario 2a	Scenario 2b	Scenario 3	Scenario 4
Total Annual Treated Wastewater Applied (m ³)	20,931	22,479	22,479	29,758	28,033	27,407	33,060	33,060	41,692	41,941
N Applied (kg/ha/year)	37	40	28	37	38	49	69	41	51	51
P Applied (kg/ha/year)	26	28	11	15	15	34	48	17	17	21

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²⁶ Volumes are estimated using the 51-year synthetic flow series and will differ to recent CCC flow monitoring data



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Table 13: Annual Average and Annual Maximum Model Outputs for Akaroa										
Model Outputs	Average					Maximum				
	Scenario 1	Scenario 2a	Scenario 2b	Scenario 3	Scenario 4	Scenario 1	Scenario 2a	Scenario 2b	Scenario 3	Scenario 4
Total Annual Treated Wastewater Applied (m ³)	246,288	249,058	249,058	241,535	242,566	271,750	293,595	293,595	282,285	272,906
N Applied (kg/ha/year)	69	58	48	47	59	75	81	57	55	67
P Applied (kg/ha/year)	48	41	20	19	24	53	57	23	22	27

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4.4.2 Treated Wastewater Storage Exceedance Discharges

The modelled total treated wastewater storage exceedance events and seasons are presented in Table 14.

A modelled storage 'exceedance event' is considered to be a single instance of when treated wastewater continuously discharges to harbour. Exceedance seasons are counted when in any given year out of the 51-year model is estimated to have one or more exceedance event. In some seasons, it is possible there would be shorter exceedance events with days on which there are no storage exceedances between events.

Scenario	1	2a & b	3	4
Total Exceedance Events	37	1	5	8
Total Exceedance Seasons (out of 51)	18	1	3	6

Due to higher volumes of wastewater irrigated across both Duvauchelle and Akaroa in scenarios 2 to 4, when compared to scenario 1, the number of treated wastewater storage exceedance discharges decrease significantly for all scenarios (2 – 4).

5.0 Conclusions and Recommendations

5.1 Site Land Classes

An initial review of the likely land class areas for the DSRR, Robinsons Bay and Hammond Point irrigation areas show that most areas of the DSRR and Robinsons Bay irrigation areas are likely to be considered Land Class 3. Smaller areas with slopes above 17 degrees and potential groundwater above one metre are likely to be considered Land Class 4. Hammond Point irrigation area is anticipated to be considered Land Class 3.

This high-level assessment has been undertaken prior to guidance documents for discharges to land becoming available for use. It is possible that further assessment, following release of guidance documentation, may vary the interpretations of assigned likelihood and severity any scores assigned in Section 3.0. CCC are therefore recommended to confirm risk category and site class assessments with relevant subject matter specialists (i.e. ecology, groundwater and soil science) prior to relying on any land classes indicated in this assessment.

Further topographical and groundwater analysis is recommended to refine the land classes of the irrigation areas near Robinsons Bay Stream noting that an elevated terrace does run on the southern side of the river which may constitute some areas which are currently indicated as land class 4 to be justified as land class 3 due to groundwater being further below ground level than currently accounted for.

5.2 Comparative Modelling

The results of the comparative modelling scenarios show that improved treated wastewater quality and increased hydraulic loading could be accommodated under the WEPS. Improved treated wastewater quality (as modelled) could maintain similar or lower nutrient loading to the current proposed activity (scenario 1 'baseline'). The modelled increases in hydraulic loading are anticipated to reduce the modelled frequency of treated wastewater storage exceedance discharges.



The model results are indicative and should be used for comparative purposes only to demonstrate how increased irrigation under the WEPS may change overall system performance. Should CCC progress irrigation scheme changes, any changes to irrigation rates and treated wastewater quality would require individual sites to be further assessed in terms of impacts to the risk assessments and site categories (where input parameters are varied) to confirm land class categorisation would remain unchanged and these rates could be accommodated.

Geotechnical constraints of the irrigation areas have also not been considered in this assessment where scenarios with increased hydraulic application rates on slopes within the 10-to-17-degree category have been modelled. A geotechnical review of increased rates to the irrigation sites is recommended prior to any increased rates being incorporated into the irrigation system design or consent application. Hydraulic capacity of the soil should also be considered should system changes with increased rates be progressed.

Further refinement of modelled values in this letter report with technical investigations would be required prior to being used for informing any technical assessments used for resource consent or design.

6.0 Limitations

This report has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Christchurch City Council and others (not directly contracted by PDP for the work), including Aqualinc Research Limited (Aqualinc). PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

This report has been prepared by PDP on the specific instructions of Christchurch City Council for the limited purposes described in the report. PDP accepts no liability if the report is used for a different purpose or if it is used or relied on by any other person. Any such use or reliance will be solely at their own risk.

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Yours faithfully,

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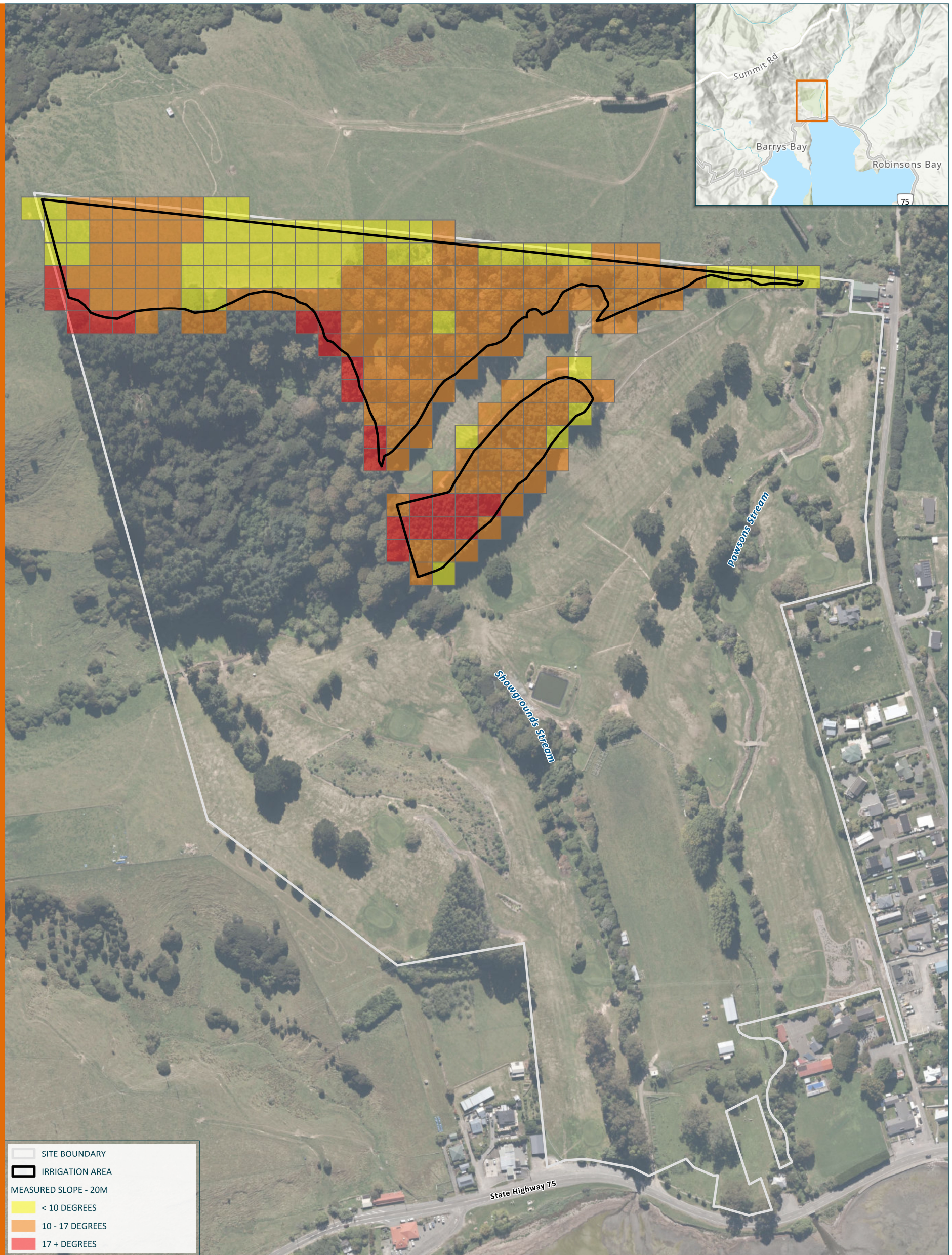


CHRISTCHURCH CITY COUNCIL - WASTEWATER ENVIRONMENTAL PERFORMANCE STANDARDS (WEPS) - PART 4
LAND CLASSIFICATIONS ASSESSMENT FOR AKAORA AND DUVAUCHELLE TREATED WASTEWATER DISCHARGES

Attachment 1: Slope and groundwater category maps

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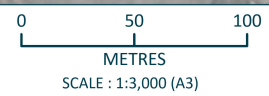
SITE BOUNDARY
 IRRIGATION AREA
 MEASURED SLOPE - 20M
 < 10 DEGREES
 10 - 17 DEGREES
 17 + DEGREES



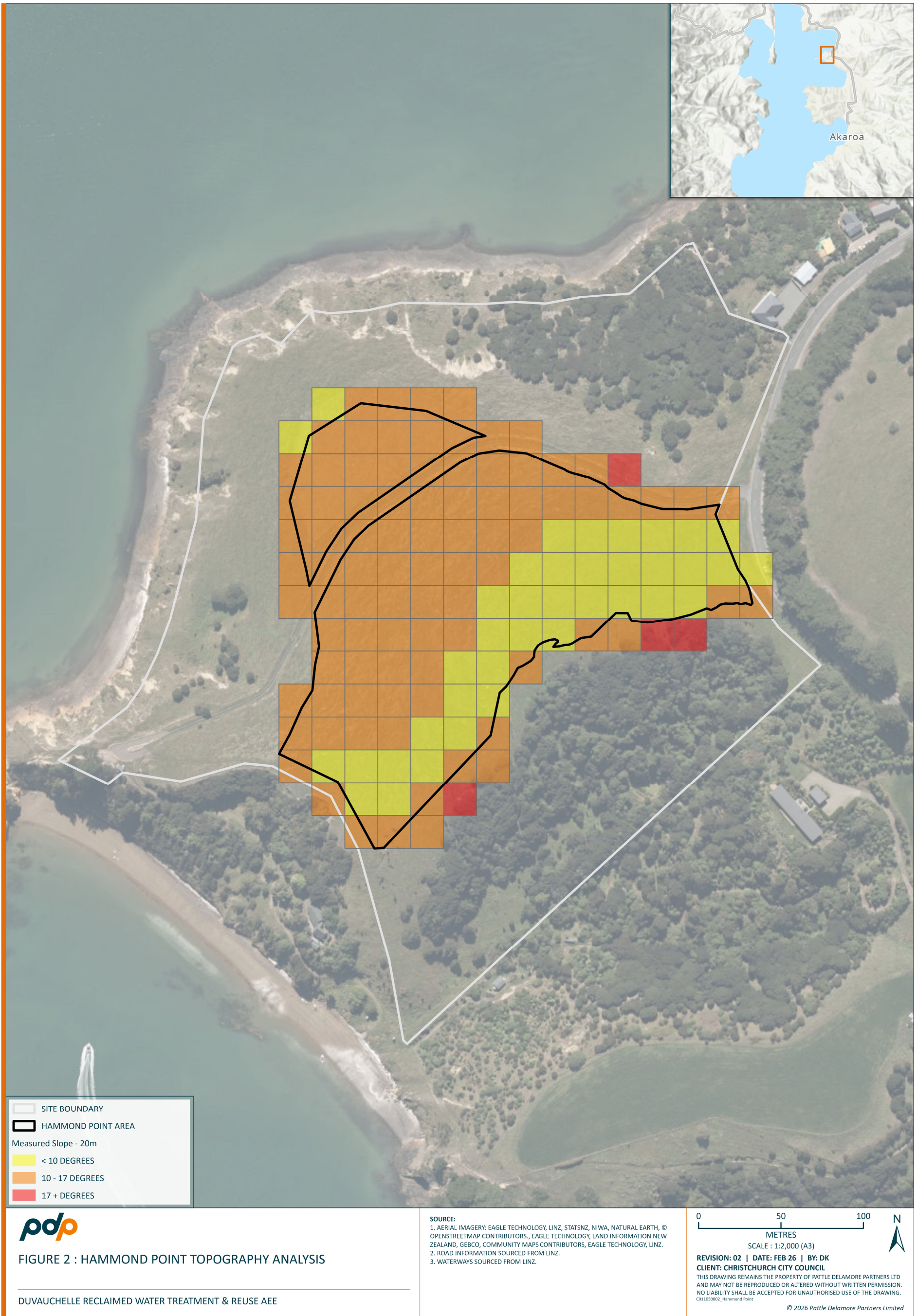
FIGURE 1: DUVAUCHELLE SHOWGROUND RECREATIONAL RESERVE TOPOGRAPHY ANALYSIS

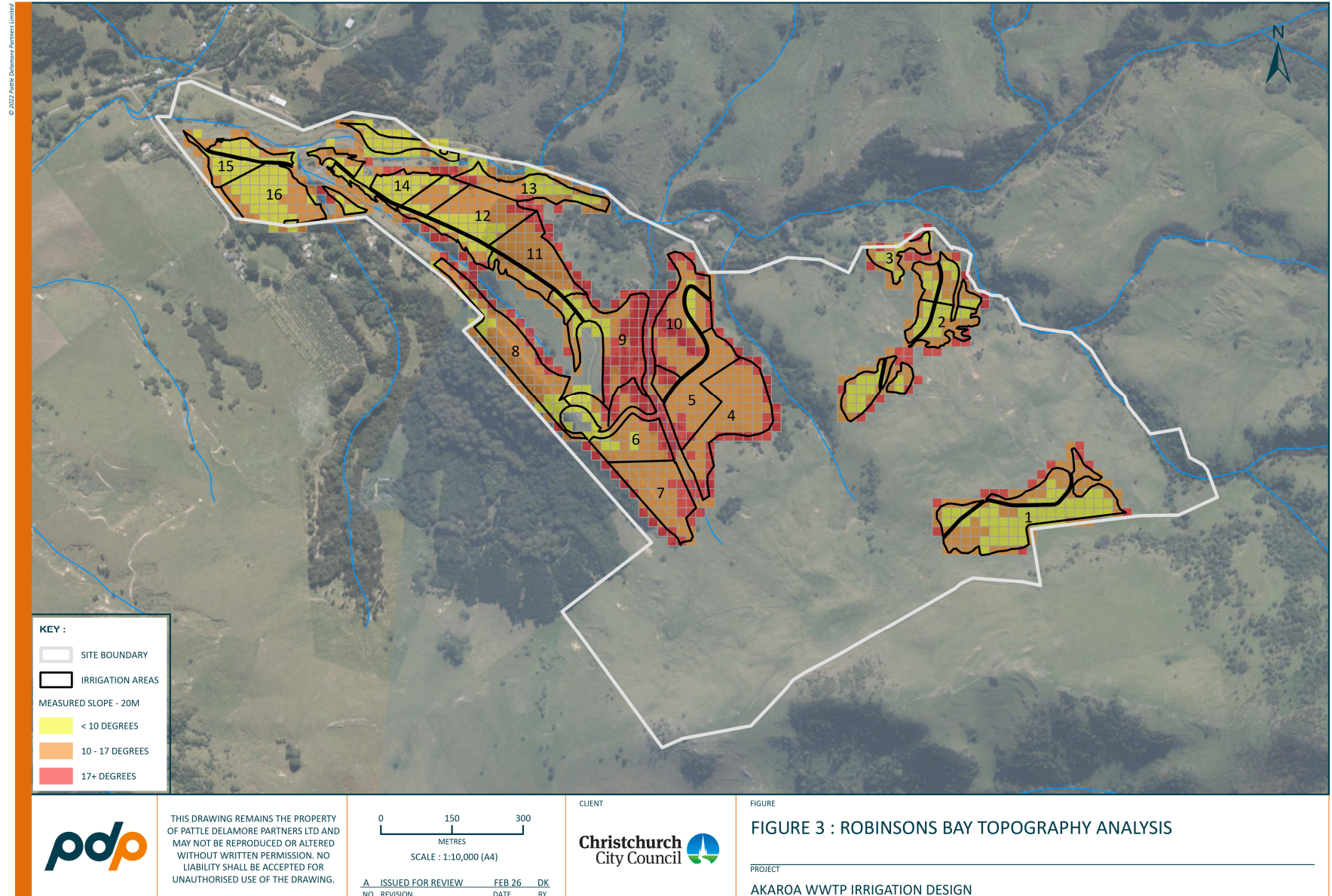
DUVAUCHELLE RECLAIMED WATER TREATMENT & REUSE AEE

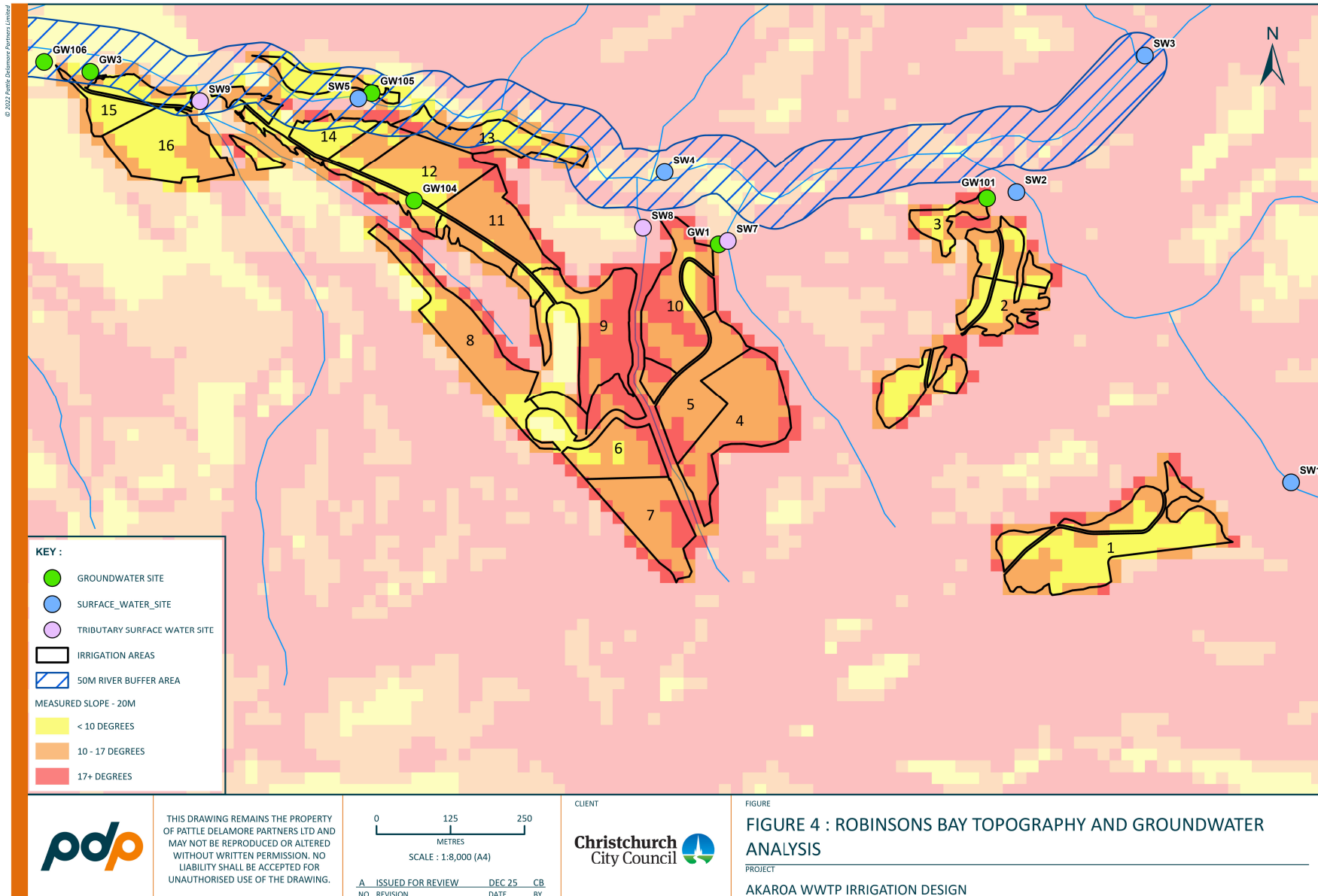
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Attachment 2: Soil Moisture Balance Model Inputs

Table 15: Summary of Modelling Inputs (Areas and Treated Wastewater Quality) by Scenario

Inputs	Duvauchelle (DSRR)					Akaroa (Robinsons Bay and Hammond Point)				
	1	2a	2b	3	4	1	2a	2b	3	4
Total Area (ha)	5.6	5.6	5.6	5.6	5.6	35.7	35.7	35.7	35.7	35.7
WEPS Land Class 3 Area (ha)	N/A	5.2	5.2	5.2	5.2	N/A	28.3	28.3	28.3	28.3
WEPS Land Class 4 Area (ha)	N/A	0.4	0.4	0.4	0	N/A	7.4	7.4	7.4	0
Total Nitrogen in Treated Wastewater (mg/L)	10	10	7	7	7	10	10	7	7	7
Total Phosphorus in Treated Wastewater (mg/L)	7	7	3	3	3	7	7	3	3	3

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Attachment 3: Soil Moisture Balance Hydraulic Loading Rates

Table 16: Irrigation Hydraulic Loading Modelling Inputs considered for Each Scenario

Scenario	1			2a & b						3			4	
Land Class (WEPS)	NA			3			4			3	4		3	
Description	Baseline			2 x Baseline			Baseline			(PDP, 2016)	Baseline		(PDP, 2016)	
Area	Show	Paw	Aka	Show	Paw	Aka	Show	Paw	Aka	Show, Paw & Aka	Show	Paw	Aka	Show, Paw & Aka
Winter (mm/d)	0.37	1.25	1.68	0.74	2.50	3.36	0.37	1.25	1.68	2.50	0.37	1.25	1.68	2.50
Spring (mm/d)	0.37	2.10	2.41	0.74	4.20	4.82	0.37	2.10	2.41	3.90	0.37	2.10	2.41	3.90
Summer (mm/d)	0.37	2.80	3.08	0.74	5.60	6.16	0.37	2.80	3.08	5.40	0.37	2.80	3.08	5.40
Autumn(mm/d)	0.37	2.10	2.41	0.74	4.20	4.82	0.37	2.10	2.41	3.90	0.37	2.10	2.41	3.90

Note:
1. Show = Showground catchment, Paw = Pawsons catchment and Aka = Robinsons Bay & Hammond Point

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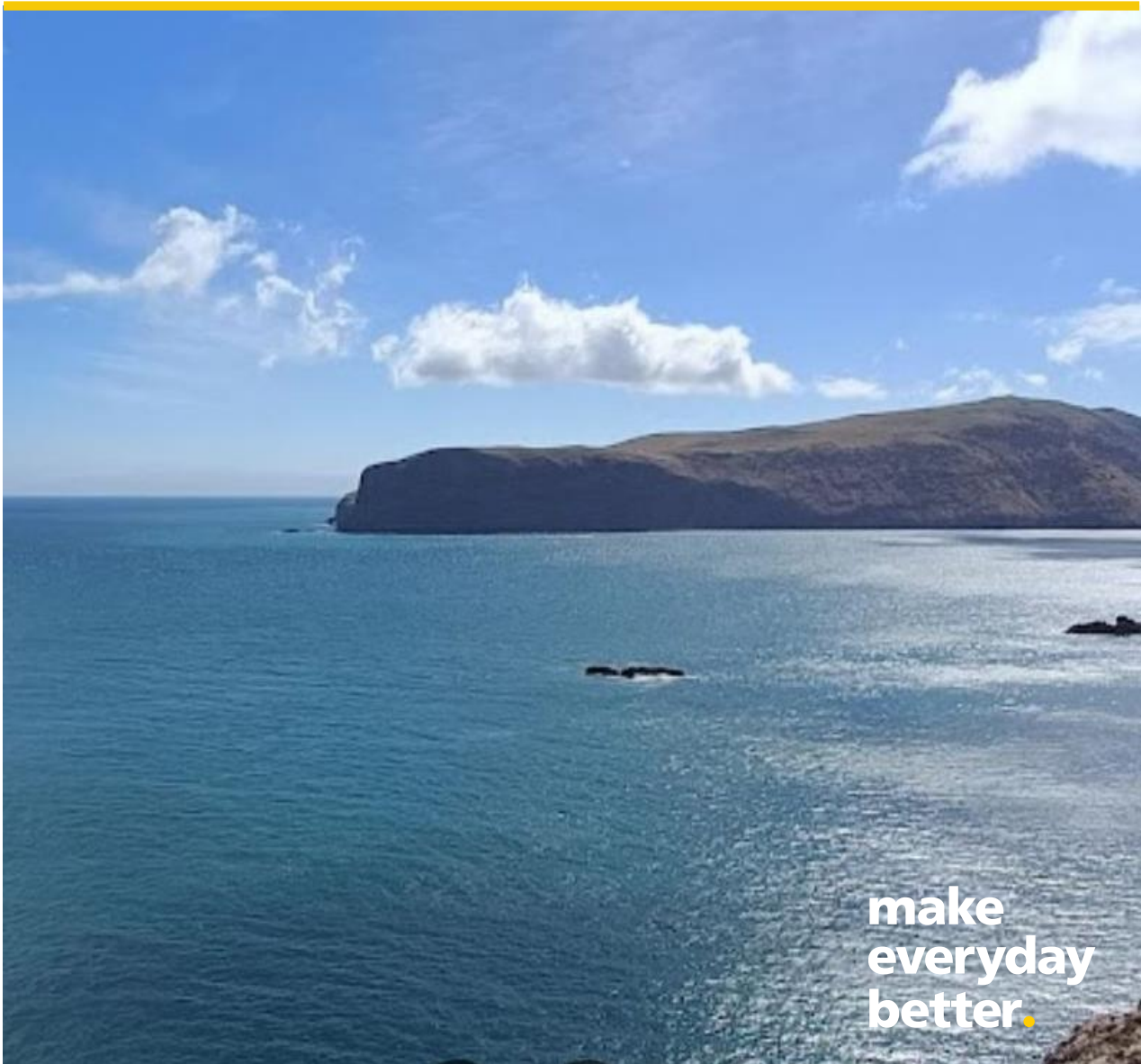


Akaroa Wastewater Scheme

Ocean Outfall Feasibility Assessment Report

Prepared for Christchurch City Council
Prepared by Beca Limited

18 June 2025



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Appendices

- Appendix A – Akaroa Ocean Outfall Concept Plan
- Appendix B – Duvauchelle Marine Pipe Concept Plan
- Appendix C – VISJET Dilution Modelling
- Appendix D – MCD Budget Estimate Report
- Appendix E – Outfall Scheme Cost Estimate

Revision History

Revision N°	Prepared By	Description	Date
1	Innes Duncan, Ian Goss, Graeme Jenner, Rudy Verbeek	Issued to Council	18/06/2025

Document Acceptance

Action	Name	Signed	Date
Prepared by	Innes Duncan Ian Goss Graeme Jenner Rudy Verbeek		18/06/2025
Reviewed by	Greg Offer	P.P. 	18/06/2025
Approved by	David Heiler		18/06/2025
on behalf of	Beca Limited		

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Executive Summary

The report sets out a feasibility assessment of a long ocean outfall option for disposal of treated wastewater from Akaroa. The long outfall proposed would discharge at a point beyond the Akaroa Harbour heads. It has been prepared as a response to an alternative proposal for disposal of Akaroa wastewater involving an outfall put forward by stakeholders to the current wastewater scheme hearing process.

The scope for the feasibility investigation includes concept design of the outfall pipeline and diffuser arrangement, selection of a discharge point, dilution modelling and performance assessment, and preparation of a feasibility level cost estimate.

The proposed Outfall Scheme would convey wastewater from the proposed new Akaroa Wastewater Treatment Plant (WWTP) at Old Coach Road that treats wastewater from Akaroa, Duvauchelle and Takamatua. The outfall pipeline would run down the harbour, crossing from the eastern side to the western side as it traverses the harbour length, and would discharge at a point beyond the heads at a water depth of more than 30m. The discharge point would be a minimum of 300m away from sensitive receptors including the Akaroa Harbour Taiapure and Akaroa Harbour Marine Reserve area boundaries.

A second marine pipeline could be constructed to convey raw sewage from Duvauchelle to the Akaroa Terminal Pump Station (Akaroa). This would be instead of a pipeline along SH75 (Christchurch Akaroa Rd) from Duvauchelle to the WWTP.

Construction and operation of a wastewater outfall pipeline or marine pipeline within a harbour that is extensively used for recreational fishing and water sports, marine farming, and is accessed by large ships poses significant risks, during both construction and operation. There are also natural hazards to consider in the design including earthquake and tsunami. To start to address these risks it is proposed to bury the pipeline along its full length and to provide rock overprotection in the zone where the pipeline crosses the mid-harbour shipping lane.

Discussions with McConnell Dowell Constructors Ltd (MCD) have led to a construction concept based on a dig-and-lay method. This would utilise a long reach excavator to trench the seabed for water depths up to 10m and use of a towed plough for trenching at depths greater than 10m. The initial diffuser design is a simple four port horizontal diffuser mounted on a single riser pipe, achieving a calculated dilution of 385:1 by the time the buoyant wastewater plume reaches the sea surface.

High-level CAPEX and OPEX cost estimates have been developed for the proposed Akaroa Outfall Scheme and Duvauchelle marine pipeline. These cost estimates are shown below.

Element		Cost Estimate
Akaroa Outfall Scheme ²	CAPEX ^{1,3}	\$37 to \$48 million
	OPEX ⁴	\$170 k
Duvauchelle Marine Pipeline ⁵	CAPEX ^{1,3}	\$16 to \$17 million
	OPEX ⁴	\$70 k

Note 1. The outfall cost estimates are to AACE Class 5 (- 30% +50%).

Note 2. Costs are specific to outfall disposal infrastructure and do not include network reticulation, terminal pump station or treatment plant costs

Note 3. CAPEX costs include project costs (consenting, consultants and council costs)

Note 4. OPEX estimates have been averaged annually over the life of the scheme

Note 5. Duvauchelle Marine Pipeline costs include for a new pump station

Note 6. Other scheme costs such as maintenance and renewal of the reticulation network are not included in these estimates.

1 Introduction

1.1 Background and Scope

Christchurch City Council (Council) has been working on a major upgrade to the Akaroa Wastewater Scheme since 2009. The work has been driven by performance issues and cultural concerns relating to the historical discharge of treated wastewater to Akaroa Harbour, and also by a desire to relocate the treatment plant away from its current site at Takapūneke, which is wāhi tapu (a sacred site).

Over time, Council has looked at a broad range of alternatives for wastewater treatment and disposal. Those options included an early review of a long outfall discharging beyond the Akaroa Harbour heads. The long outfall option was not taken forward at that time, and disposal to land was subsequently adopted as the preferred option in 2020.

Submitters to the current Akaroa wastewater consent hearing for the disposal to land scheme have raised the long outfall as a potential alternative once again. The scope of this report is to reconsider the long outfall option and provide an initial concept design and cost estimate to inform the wastewater hearing process.

1.2 Purpose

The purpose of this report is to present a high-level feasibility assessment for constructing and operating an ocean outfall for disposal of treated wastewater, as part of the proposed Akaroa Wastewater Scheme.

1.3 Limitations

The initial feasibility study has made a number of assumptions about wastewater flows and loads, treatment plant design configuration, pipeline alignments, marine seabed conditions and marine construction methodology, including a range of environmental factors such as wave climate. All of these factors will require further consideration if the Outfall Scheme is taken forward.

Beca has also had to make an initial selection of outfall discharge locations. This may change once cultural considerations and other factors are brought into the analysis during the next stage. Changing the discharge location will change the scheme cost.

Cost estimates are to concept screening level (AACE level 5) and include contingency costs to deal with the various unknowns including the items listed above. These costs can be refined over time through development of design and construction methodology.

2 Outfall Concept Design

2.1 Overview of Outfall Scheme

The proposal involves conveying Akaroa, Duvauchelle and Takamatua raw wastewater to the new Akaroa Wastewater Treatment Plant (WWTP). Treated wastewater would then be conveyed under gravity through a new marine pipeline to an ocean diffuser located beyond the heads of the Akaroa Harbour. Refer to *Appendix A* for an overview map of this arrangement.

This scheme would also include a new Duvauchelle marine pipeline to pump raw wastewater to the Akaroa Terminal Pump Station. There would be significant project and cost efficiencies installing this marine pipeline given the other marine works required for the Outfall Scheme. Refer to *Appendix B* for an overview map of this arrangement.

Table 1 below summarises the differences between the current land-based scheme and alternative Outfall Scheme (with key differences highlighted in **bold**).

Table 1 - Comparison of Akaroa Land Irrigation and Outfall Schemes

Element	Land Irrigation Scheme	Ocean Outfall Scheme
Akaroa Catchment	Gravity network to new Terminal Pump Station (TPS). TPS pumped discharge to new Akaroa WWTP	Same as land scheme
Duvauchelle Catchment	Pumped from Duvauchelle to new Akaroa WWTP along SH75 Christchurch Akaroa Rd.	Pumped to TPS via new 7.5km marine pipe.
Takamatua Catchment	Pressure sewer reticulation to new Akaroa WWTP	Same as land scheme
Terminal Pump Station	86L/s duty flow to new Akaroa WWTP	97L/s duty flow to new Akaroa WWTP (accounts for added Duvauchelle flows)
Akaroa WWTP	Sized for total combined catchment flows	Same as land scheme
Treated wastewater disposal	Treated wastewater pumped from WWTP back to Irrigation sites at Robinson's Bay, Duvauchelle and Hammond Point. Treated wastewater disposal at land irrigation sites and stored during wet weather at storage facility	Treated effluent discharge under gravity through outfall pipe and ocean diffuser past Akaroa Harbour Heads

The conceptualised outfall pipeline is a 14km long 400OD Polyethylene (PE) PN12.5 buried pipe that discharges under gravity from the new WWTP, down through Children's Bay, and runs along the length of the harbour for 13km extending out past the heads to a discharge location. The diffuser for the outfall would comprise of a single piled riser, with four horizontal duck-bill diffuser ports discharging immediately above the seabed. This diffuser concept has been chosen for simple installation and allowing that predicted dilution efficiency is excellent (385:1). In other words, a more sophisticated diffuser design is not justified.

Due to the elevation of the WWTP site, there is sufficient head for the outfall system to operate under gravity (no pumping required). Given the steep downward gradient at the start of the outfall pipe, air will accumulate at the point where the partial pipe flow hits the full flow point (a hydraulic jump). A de-aeration device has been included in the concept design to remove air at this point.

The assumed design basis for this feasibility assessment is summarised below:

- Design/flow horizon: 2053 (updated modelling by Beca and PDP, 2024)
- Outfall capacity to match peak incoming wet weather flow to WWTP
- Dry weather operation to achieve slime-stripping velocities on a sub-weekly basis
- Outfall discharge not permitted within Akaroa Harbour Taiapure area, or Marine Reserve Area
- Water quality and treatment requirements discussed further in report.

2.2 Design Basis Flows

Projected 2053 flows for the scheme are tabled below and have been adopted from the recent flow modelling work undertaken by Beca and PDP¹².

- Akaroa flows are of higher resolution as they have been adopted from recently calibrated ICM network modelling and include instantaneous flows.
- Duvauchelle flows have been developed using a much coarser daily volume correlation approach. Instantaneous flows have been approximated based on a similar peaking behaviour as observed from the Akaroa network modelling.
- Takamatua flows have not been modelled and are based on the CCC IDS dry and wet peaking based on per capita demand.

2053 average and peak dry weather catchment flows are shown in Table 2. Note these flows are off-peak (i.e. outside of the peak summer period) as this is critical for assessing typical outfall operation and maintenance requirements throughout the year.

Table 2 - Assumed dry weather flows for concept outfall design

Catchment	Average Daily Flow (m ³ /day)	Peak Dry Weather Flow ¹ (L/s)
Akaroa	626	11.8
Duvauchelle	82	1.7
Takamatua	24	0.5
Combined	732	14

Note 1 – Duvauchelle and Takamatua peak flows have been scaled from average daily flows (PDWF = 1.8 x ADWF)

Based on design work currently in progress (by others), the new Duvauchelle terminal pump station duty has been assumed as 11L/s.

It is understood that the current design duty flow for the new Akaroa TPS (receiving Akaroa catchment flows only) has been set at 86L/s – which is based on a modelled 1 in 5-year wet weather overflow occurrence. It has been assumed that the TPS capacity would need to be increased to also accommodate the Duvauchelle flow. The assumed ‘combined’ TPS duty flow for this feasibility assessment has been set at 97L/s.

Including peak wet weather flow from the Takamatua catchment (5L/s conveyed directly to the WWTP), the peak incoming wet weather flow to the WWTP (and therefore outfall PWWF design flow) has been assumed as 102L/s.

While the WWTP design includes provision for both dry and wet weather buffering tanks, this feasibility assessment has conservatively been based on the new outfall system having capacity to discharge the full incoming peak wet weather flow from the plant.

We understand the current design throughput capacities for the new Akaroa WWTP are >100L/s for primary and secondary treatment but capped at 49L/s through the tertiary filters and UV treatment. Modifications required for the treatment train for the Outfall Scheme are discussed further below.

¹ Akaroa Wastewater Scheme Design Basis[5].pdf (Beca, 2024)

² Duvauchelle Wastewater Scheme Design Basis[4].pdf (Beca, 2024)

2.2.1 Tidal Levels

Hydraulic sizing for the Outfall Scheme has been based on a Mean High-Water Springs (MHWS) level of 2.70m (chart datum) / 4.0mRL (NZVD2016).

2.3 Proposed Alignment and Discharge Location

Refer to *Appendix A* for an overview plan of the proposed outfall alignment.

The marine pipeline alignment and discharge location have been considered against a range of drivers including cultural and environmental impacts, constructability, cost, resilience and how it may impact (or be impacted by) harbour users. Sensitive receiving environment features that have been considered in the alignment and discharge point selection are the Akaroa Harbour Taiapure Area and the Akaroa Harbour Marine Reserve. The proposed pipeline alignment avoids passing through the marine reserve and discharges at a minimum separation distance from the boundary of both the marine reserve and the Taiapure area.

The proposed alignment has also been reviewed and optimised with McConnell Dowell – a major civil contractor with significant experience installing marine outfalls around New Zealand.

The alignment has been set against the eastern edge of the Harbour for as long as possible, to remain within shallow waters that allow a more cost-effective trench and bury installation method (<15m water depth). The downstream portion of the alignment then swings over to the western edge of the Harbour, to remain as far as practicable separated from the Marine Reserve Area. The section of the alignment that crosses the harbour is at higher risk of anchor-drag and other impacts – mitigation measures for this risk are discussed further below.

The outfall discharge location has been carefully considered with regard to operational performance, as well as the various project drivers/constraints discussed in Section 2. Two discharge locations, both extending beyond the Harbour heads, were considered – refer to plan in *Appendix A*.

- **Discharge location #1:** this position is considered the minimum requirement to achieve a discharge “beyond the harbour heads”. Set at a 300m offset from the edge of the Taiapure zone and 900m from the edge of the Marine Reserve. Water depth is approximately 30m. Initial dilution³ modelling has been carried out using the model VISJET and a mixing zone of 50-100m around the diffuser has been assumed to meet general guidance requirements eg Ministry for Environment (1994)⁴. Refer to *Appendix C* for a summary of the VISJET modelling.
- **Discharge location #2:** Extended discharge beyond the reach of the Marine Reserve area. Set at a 1km offset from the edge of the Taiapure zone, >1km from the edge of the Marine Reserve. Water depth approximately 40-45m. A similar mixing zone to #1 is assumed. Location #2 has been considered (and provided for costing) to understand incremental cost increases, if project drivers require the discharge to be extended further out beyond the heads.

2.4 Anchorage & Navigational Zones

Visits from cruise ships have been a regular feature over recent years and anchorage locations are identified on marine charts. Recreational and commercial boat operators also make use of moorings in the harbour.

³ Initial dilution is achieved after discharge by buoyancy and shear forces as the lighter freshwater based wastewater rises to the surface and mixes with marine waters

⁴ Ministry for Environment (1994) *Resource Management Ideas No. 10: A Discussion on Reasonable Mixing in Water Quality Management*

This level of usage and the existing constraints related to mooring locations, manoeuvring requirements, and consideration of maritime safety suggest that it may be difficult to establish pipeline exclusion zones within the harbour, despite this approach being applied elsewhere to protect wastewater outfalls from potential fishing and mooring damage. The Canterbury Regional Harbour Master has confirmed this opinion.

For the feasibility assessment it is proposed that the outfall pipeline should be buried in the seabed to a practically achievable nominal depth (1m cover). This depth of cover will provide protection from recreational users but not from heavy ship anchors. Additional rock protection has been allowed for in the main shipping channel within the harbour. Further assessment of the risks related to this exposure is required.

2.5 Outfall Operating Regime

It is proposed, at this initial stage, to operate the outfall on a continuous basis. Operating the outfall system on an ebb tidal regime (i.e. tidal discharge regime) would require significant on-site buffering storage at the WWTP to store maximum wet weather flows (~6000m³/day) during incoming tides. Up-sizing of the outfall pipe to discharge wet weather flows, during low-tide only, would result in significantly low dry weather pipe velocities and added cost for the installation of a larger pipe.

Tidal fluxes at the entrance of the harbour and the risk of diluted wastewater being drawn back into the harbour on incoming tides requires further investigation. The extent to which the diluted plume is re-entrained within the harbour has not been modelled and is unknown. Hence any potential benefits of a tidal discharge cannot be defined at this stage. Ebb tide discharges are typically used when there is significant drainage of the water body over each tidal cycle (e.g. estuaries). This is not the case with harbours such as Akaroa where hydraulic residence time is ~3-4 days.

The outfall has been sized to discharge peak wet weather operating flow from the WWTP (102L/s). As discussed above, this conservatively excludes any buffering available within the WWTP infrastructure. Treated wastewater will drain freely through the gravity outfall system and discharge through the diffusers. Operating velocities in the 400OD outfall pipe are ~1.1m/s (with full-pipe flow for the majority of the pipe). However, a conservative (Colebrook-white) pipe roughness of 1.5mm has been modelled, as typical dry weather operation may result in sedimentation, slime-growth and trapped air within the pipe that may restrict flow and increase headloss – see below for dry weather operation and purge cycle options.

A sensitivity check has also been carried out with a 3mm roughness to reflect severe pipe wall roughness, which may reflect conditions on start-up prior to scouring. Under these worst-case operating conditions, the selected pipe size would still be able to discharge under gravity (i.e. freeboard remains at the WWTP inlet).

Under typical dry weather conditions, treated wastewater from the WWTP would be released under gravity into the outfall pipe and discharge through the diffusers. Typical daily flows are expected to be low; ~8L/s on average with up to ~13L/s during diurnal peaks (note during peak summer these flows would increase). Typical dry weather flows will only generate velocities of 0.15 - 0.2m/s, through the majority of the marine pipeline where full-pipe flow occurs. Operating velocities will be much higher in the initial 1km of the pipe, where it grades steeply down into Children's Bay and where partial flow occurs.

Residence times during dry weather operation are expected to be significant - between 1 to 2 days. While the outfall is discharging a well-treated effluent, sedimentation and slime-growth should still be considered as a risk given the flat gradient of the marine pipe and expected residence times. Air entrainment along the outfall pipeline is also likely to increase pipe roughness and head losses. Maintaining a uniform grade (avoiding localised high points) when installing the outfall pipeline is important to minimise the likelihood of air-pockets being trapped along it.

A daily or sub-weekly purge flow is recommended to mitigate the risk of sedimentation, slime accumulation and air-entrainment. Slime stripping velocity has been calculated based on guidance from the *Sewage Pumping Station Code of Australia (WSAA04)*; $V_{slime-control} = 1.1m/s$ to develop wall shear stress = 3.85Pa.

Technical guidance developed as part of the Stronger Christchurch Infrastructure Rebuilt Team (SCIRT) around air movement suggests a 350mm internal diameter pipe (assuming on average flat to negligible gradient) requires 1.2-1.3m/s to mobilise trapped pockets of air down the pipeline. Purge flows could be achieved by holding back treated effluent in the buffer tank at the WWTP for a 12 - 24 hour period, and then releasing this over a 3-4 hour period at full discharge (100-110L/s). Approximately 500-1000m³ of treated effluent storage would be required to purge the outfall pipe over its entire length - noting the entire outfall pipeline doesn't necessarily need to be purged at once.

A pigging/cleaning mechanism could also be considered for the Outfall Scheme – this has not been investigated as part of this feasibility work.

2.6 Outfall De-aeration System

As discussed above, the initial steeply grading down-ward leg of the outfall pipe will accumulate air given partial flow conditions. It is important to provide a mechanism to remove as much of this air as possible before it discharges through the flat 13km marine pipe. A hydraulic jump will form during low dry weather flows around the Children's Bay area where incoming effluent meets the tidal level. A de-aeration chamber based on an over-sized section of pipe is proposed at this hydraulic jump location with air-release valves to promote removal of air from the system. This will reduce the flow velocity and allow entrained air to escape through three offtakes on the soffit of the chamber leading to two air release valves on the edge of Children's Bay Road. The chamber will be buried below low tide so that it is permanently submerged.

Odour generation from the de-aeration system air valves is expected to be low given the treatment level of the WWTP discharge. However, provisions could be made for activated carbon treatment from these air-valves if required in the future.

2.7 Inclusion of Duvauchelle Marine Pipe

The Duvauchelle pump station and marine pipe have been sized based on a 11L/s duty/stand-by arrangement. A 160OD PE PN12.5 rising main has been selected which gives an operating velocity of 0.7m/s and pumping head of 35m. The proposed pump station would comprise of 2x 10kW submersible Flygt pumps in a pre-fabricated GRP wet well and valve chamber. The new pump station is proposed within the vicinity of the treatment plant location, to where the two Duvauchelle pump stations currently discharge.

3 Outfall Constructability

3.1 Seabed Geotechnical Conditions

Marine seabed geotechnical conditions are an important consideration in outfall design and constructability. Relevant information on seabed conditions on the proposed pipeline route includes the bathymetry presented in the current Marine Chart (NZ6324), and seabed texture characteristics also presented on the marine chart and resulting from a limited number of seabed bed surface grab samples at widely spaced intervals from beyond the harbour entrance and the harbour channel. Several academic papers present more detailed bed characteristics in the shallow northern bays and intertidal areas, but these are generally to the north of the pipeline alignment.

It is noted that Environment Canterbury has advised that the fieldwork for an update of the Marine Chart bathymetry is complete, but still in the post-processing phase. It is expected that this work, when completed will provide the data to allow a closely contoured presentation of the seabed topography and a more comprehensive description of bed surface characteristics. The equipment used for the survey may also allow for the interpretation of density changes below the seabed surface and thus provide some information to help establish sediment thickness.

While detailed information is not yet available, it has been assumed for this preliminary study that bed conditions on the selected route comprise fine sand, silt, mud, and clay to a thickness that will allow pipe installation to 1m depth of cover. Clearly this will need confirmation.

3.2 Marine Pipeline Installation

Installation methods for the marine works have been discussed with McConnell Dowell with respect to their recent Lyttelton harbour experiences and wider experiences installing outfalls around New Zealand. The initial construction methodology (from which initial costing is based) is as follows:

- Godley Quay / Naval Point in Lyttelton Harbour would be used to fabricate and test the HDPE pipe strings before towing bundles to Akaroa Harbour temporary storage and ballast block assembly prior to installation. Assumption made that water-side access is not available in Akaroa Harbour and to avoid transporting all materials to site via road.
- Trench excavation to facilitate pipe burying with use a long reach excavator to -10m Chart Datum. Beyond -10m depth the pipeline would likely be installed using a purpose-built jetting sled towed by marine vessel – this has been included as a contingency item at this feasibility stage.
- De-aeration chamber and multiport diffuser can be detailed for installation with their respective pipe strings and therefore not require discrete operations or additional connections.

Refer to *Appendix D: MCD Akaroa Outfall Budget Estimate Report* for discussion around proposed installation methodology. Cost estimates for the above installation works are provided in Section 9, including allowance for P&G, design & investigations and contingency.

3.3 Outfall Resilience

In conjunction with the confirmation of seabed material characteristics, it is recommended the modelling of the effects of design swell conditions and tsunami events is undertaken to confirm that the nominated cover to the pipeline is adequate to resist scouring and potential exposure of the pipe over its length and the gradually reducing water depths up the harbour.

The ductile nature of the PE pipeline is such that it is unlikely to suffer physical damage in a seismic event. However, adequate pipeline relative density in the buried condition is important to resist flotation to the bed surface in the event of liquefaction of the seabed. This issue should be considered in the design of the pipeline ballast, along with the requirements of the installation procedure.

Ships anchors are designed to bury themselves to provide optimum holding power. Based on the size of the anchors and chains used, it is unlikely that 1m of cover to the pipeline would reliably ensure the avoidance of damage. While the preliminary pipe route has been presented with this exposure in mind, the requirement to allow anchoring in an emergency within the harbour means that such damage cannot be ruled out. It may be required to install additional protection (rock armouring or equivalent) over the ~1.5km section of the Akaroa marine pipe that cross the navigational zone of the harbour. Rock armouring has been included as a contingency item in the outfall cost estimate.

A risk analysis based on expected vessel occupancy and type and frequency is proposed to assess the security of the pipeline.

Detection of damage to the marine pipeline would primarily be through hydraulic monitoring of head and flow. For example, crushing of the pipe would restrict flow and increase head, or conversely, complete rupture of the pipe (dependent on location) would likely increase flow and reduce operating head. A provision for dye release into the outfall system (with appropriate environmental considerations) could be used to monitor for partial ruptures/leaks that may not be obvious from changes in hydraulic performance, or to locate leaks indicated by performance changes.

Repairs to the marine pipeline (in the event of crushing, leaks or full rupture) would typically involve a dive team removing the damaged section and inserting a new short section of PE pipe using mechanical couplers to join to the existing pipeline.

4 Description of Receiving Environment

The Akaroa Harbour environment features high ecological values, outstanding natural features and sub-areas of significant natural value, as well as protected areas, wetlands, estuaries, and coastal lagoons, marine mammals and birds, ecosystems, flora and fauna habitats and scenic sites⁵. Akaroa Harbour is also culturally and historically significant for mana whenua, is an important source of mahinga kai and is a valued area for recreation, tourism, and marine industries.

Construction of a wastewater ocean outfall along the full length of the harbour will require careful consideration including developing a design, alignment and construction method that mitigates or avoids potential environmental and cultural effects. Key background information on the receiving environment is described further below.

4.1 Cultural Values

The harbour is significant to Onuku Runanga in respect of wahi tapu and waahi taonga and the collection of mahinga kai and kai moana. Any proposed wastewater ocean outfall should be designed and operated in order to minimise or avoid cultural impacts. Specific responses to cultural concerns that are reflected in the feasibility stage design include the following:

- Wastewater would be treated to a high level and discharged at a depth of over 30m and at a minimum distance (300m) away from sensitive receptors including the Taiapure area and marine reserve
- Wastewater would be diluted at least 385 times before it hits the sea surface in the zone of initial dilution (ZID) around the diffuser (typically 50 to 100m radius around the discharge point).
- The outfall diffuser location should be such that diluted wastewater is not significantly entrained and recirculated within the harbour. Further hydrodynamic modelling is recommended to gain an understanding of tidally influenced currents near the harbour entrance and to characterise near and far-field dispersion of the wastewater plume.

4.2 Harbour Taiapure Area

Akaroa Harbour Taiapure as shown in Map 9.6 of the Canterbury Regional Coastal Environment Plan (RCEP) 2005. Taiapure means local fishery and identifies an area that has customarily been of special significance to an iwi or hapu as a source of food or for spiritual or cultural reasons. Taiapure are legally recognised under the Maori Fisheries Act 1989.

The Akaroa Harbour Taiapure encompasses the entire Akaroa Harbour (except for those areas covered by existing marine farms and the Akaroa Marine Reserve) which classifies it as “*significant for food, spiritual, or cultural reasons*”. To avoid or minimise cultural impacts, the outfall diffuser would be located past the heads at a minimum 300m separation distance to the boundary of the Taiapure zone.

⁵ Akaroa Harbour Cruise Ship Visits: Preliminary Ecological Risk Assessment, Cawthron Institute 2019.

4.3 Akaroa Harbour Marine Reserve Area

A 512 hectare area, stretching over 4km along the south-eastern coast of the opening of the harbour to the ocean, was designated as a Marine Reserve in 2014. The reserve status means that all marine life is protected and that fishing and the removal of both living and non-living marine resources is prohibited. The pipe alignment and diffuser location for the outfall would be designed to avoid the Marine Reserve Area, to minimise both construction and operational impacts on this sensitive area.

4.4 Banks Peninsula Marine Mammal Sanctuary

The Banks Peninsula Marine Mammal Sanctuary (which includes Akaroa Harbour) was created in 1988 to protect Hector's dolphin from by-catch in set nets. It also recognises the importance of other marine mammals in the area including the endangered yellow eyed penguin and white flippered penguin, as well as the NZ fur seal.

4.5 Recreational and Commercial Use

There are a variety of recreational and commercial activities that take place in Akaroa Harbour, notably⁵:

- a prosperous tourism industry, e.g. charter fishing trip, dolphin watching/swimming, sightseeing etc.
- considerable recreational activities: boating, diving, snorkelling, kayaking, swimming
- recreational fishing, spearfishing and gathering of shellfish (mussels, crayfish and paua)
- aquaculture (salmon and shellfish farming)
- commercial fishing
- giant kelp harvesting

Recreational and commercial use patterns will need to be taken into account in the ocean Outfall Scheme. The operation of the wastewater outfall should avoid or minimise any potential impacts on recreational and commercial users. The nearest commercial salmon farm is located in Lucas Bay, within the harbour, which lies more than 5km from the proposed outfall site.

5 Wastewater Discharge Quality and Treatment Standards

Taumata Arowai has issued proposed new standards for wastewater disposal to land and water. These standards will supersede previous methods for assessing required wastewater discharge quality that involved deriving discharge quality taking into account receiving environment water quality standards, reasonable mixing as defined under the Resource Management Act, and other factors. The assessment set out below is primarily focussed on the new standards, but also provides background information on relevant and current water quality standards and mixing and dilution performance.

5.1 Proposed National Wastewater Standards

Taumata Arowai has recently released proposed national standards for wastewater treatment for public consultation. The proposed standards will apply to new or renewed resource consents for publicly operated wastewater treatment plants. The standards are for freshwater, estuarine and ocean receiving environment types, and are based on an assessment of end of pipe mixing.

An outfall at the proposed location would discharge into an open ocean receiving environment which is determined by the draft standards as further than 500m from mean high water springs (MHWS), or is covered by a minimum of 10m of water depth through the tidal cycle. The outfall is required to meet a minimum centreline dilution of the plume of 1:100 at 100m from the diffuser (as modelled), at nominal slack water conditions (depth averaged velocity of 0.02m/s or the current velocity which is exceeded 90% of the time).

The proposed standards assume two population size scenarios (<1000 and >1000 population). The proposed open ocean discharge standards for >1000 population is as follows (noting that not all the parameters considered by Taumata Arowai apply to ocean outfalls and that the standards for <1000 person plants are the same):

Table 3 - Proposed Open Ocean Wastewater Discharge Standards

Category	cBOD (g/m3)	Total suspended solids (g/m3)	Ammoniacal nitrogen (g/m3)	Total nitrogen (g/m3)	Total phosphorus (g/m3)	E. coli (cfu/100mls)	Enterococci (cfu/100mls)
Statistic used	Annual median	Annual median	Annual 90%ile	Annual median	Annual median	Annual 90%ile	Annual 90%ile
Proposed Standard	N/R	N/R	50	N/R	N/R	N/R	40,000

Note: N/R means no standard recommended, as parameter considered not relevant to potential effects

Data presented in Table 3 shows that there are no requirements to meet a standard for BOD, Total Suspended Solids, Total Nitrogen, Total Phosphorus or E.Coli. The discharge standard set for enterococci is 40,000 cfu/100ml.

5.2 Outfall Discharge Quality

We have compared the calculated required effluent quality with the RCEP shellfish standard and the proposed new enterococci national standard. We have used the Regional Coastal Environmental Plan (RCEP) shellfish gathering standard, given shellfish are gathered in the locality and the harbour water classification is for shellfish gathering. This standard, which applies after reasonable mixing (50-100m mixing zone has been assumed), requires that:

“The median faecal coliform concentration of not less than 5 samples taken within any 30-day period, shall not exceed 14 colony forming units per 100mls and no more than 10% of samples taken within any consecutive 30-day period shall exceed 43 colony forming units as a result of any discharge of a contaminant or water”⁶.

To provide inputs to this calculation, dilution modelling was carried out by Beca⁷ for a number of effluent flow scenarios and diffuser arrangements, including a single vertical or horizontal pipe and multi-port diffusers. The preferred option, at this initial stage, is a multiple port design with four opposing horizontal ports mounted on a single vertical riser, each fitted with a duckbill valve. The modelled dilution at the surface for a worst-case peak wet weather flow (PWWF) of 102L/s for the preferred diffuser option and assumed water depth of 30m is 385:1 (refer to *Appendix C*). The calculation of required wastewater quality to meet the current RCEP shellfish standard and the proposed national standard, using this dilution factor, is shown in Table 4.

⁶ RCEP standard based on MfE/MoH *Microbiological Water Quality Standards for Marine and Freshwater Recreational Areas*, 2004

⁷ Outfall dilution modelling was undertaken using VISJET, developed by the University of Hong Kong. VISJET predicts the impact of an effluent discharge into an unbounded receiving environment. Refer to Appendix C

Table 4 – Required Wastewater discharge quality for RCEP and Proposed 2025 Wastewater Standard

Factor	Calculated Discharge for RCEP Standard	Discharge Proposed National Standard
Discharge flow	102 L/s	
RCEP Shellfish gathering standard	14 cfu/100mls Faecal coliforms)	
Dilution (from model)	1:385	
Required Discharge quality from WWTP to meet standard	5,400 cfu/100ml Faecal coliforms	40,000 cfu/100ml Enterococci

Based on an assumed wastewater quality post biological treatment of 10^6 - 10^7 fcs, a log reduction of at least 3 will be required across the proposed tertiary treatment steps downstream of the biological process to meet the proposed national standard.

As there is shellfish gathering near the Akaroa wastewater discharge point in coastal waters, a Quantitative Microbial Risk Assessment (QMRA) will also be required by the proposed new standards. This may determine revised treatment/upgrading requirements. Note QMRAs are typically carried out using viruses (e.g. norovirus) as the modelled pathogen. Viruses can survive for relatively long periods in ocean waters and can be carried on surface plumes by winds and currents to nearby shorelines. Previous monitoring of norovirus levels in Akaroa wastewater identified large fluctuations in concentration which, at the time, was considered due to varying community infection rates.

While far-field dispersion modelling has not yet been carried out for the proposed outfall, it is assumed that once the effluent plume reaches the surface (freshwater is less dense than seawater), the plume could be quickly transported to nearby shorelines, under strong wind conditions. On this basis, the required wastewater quality has been based on the initial dilutions achieved by the outfall, with no account taken of any subsequent dilution or die-off of micro-organisms during surface dispersion.

It is intended that the proposed standards will be formalized by the current Water Services Bill before Parliament with public submissions now closed. Amongst other things, the Bill will simplify the resource consenting process under the Resource Management Act for treated wastewater discharges. All new municipal discharges that meet the standards will be issued with a 35-year consent. It is expected that this bill will become law in late 2025.

5.3 Proposed WWTP Discharge Quality

5.3.1 Typical Dry Weather Water Quality

From reviewing the current Akaroa WWTP wastewater quality standard (provided by Stantec) we understand post-treatment (prior to irrigation) E.coli and Enterococci concentration will be less than 10 cfu/100ml. Based on the predicted dilution available in the open ocean receiving environment beyond the heads, the WWTP Faecal coliform discharge quality (noting that E. coli is a subset of Faecal coliforms), is expected to be several orders of magnitude better than either of the standard(s) shown in Table 4 and would likely not be detectable after reasonable mixing.

5.3.2 Peak Wet Weather Flow Water Quality

As per the current WWTP design process flow diagram (provided by Stantec), we understand that tertiary treatment throughput capacity is limited to 49L/s and therefore, would require buffering at peak wet weather flows (~100L/s). The outfall system would likely be sized for full peak flow capacity and therefore tertiary treatment throughput and treatment levels at these higher (infrequent) wet weather flows would need to be considered.

6 Cost Estimates

6.1 Overview

High-level capital (CAPEX) and operational (OPEX) cost estimates have been developed for the proposed Akaroa Outfall Scheme and Duvauchelle marine pipeline.

6.2 Basis of Costs

Estimates for the marine works costs such as the marine pipe installation, discharge diffuser and deaeration chamber have been provided by McConnell Dowell Constructors Ltd. Estimates for land-based works such as the Duvauchelle pump station and 400OD discharge pipe from the Akaroa WWTP has been provided by Beca. Additional project costs such as consenting, advisors/consultants, and council project costs have been estimated by Beca. Other scheme costs such as maintenance and renewal of the reticulation network are not included in these estimates. Table 5 summarises the basis of costs (sources) for the Outfall Scheme.

Table 5 Legend

Council provided costs	Beca provided costs	McConnell Dowell provided costs
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Table 5 - Basis of Cost Estimates

Element	Ocean Outfall Scheme
Duvauchelle raw wastewater conveyance to Akaroa scheme	Beca provided cost estimates for Duvauchelle PS
	McConnell Dowell provided cost estimates for 7.5km 160OD marine pipeline (CAPEX only)
Treated effluent disposal (Akaroa Outfall)	Beca provided cost estimates for 1km 400OD PE land outfall pipe
	McConnell Dowell provided cost estimates for 13km 400OD PE marine outfall pipeline, deaeration works and diffuser installation (CAPEX only)
	Beca provided estimates for outfall OPEX costs
Other Costs / Savings	Expected land sale revenue for Robinson's bay & Hammond Point Irrigation sites.

6.3 Cost Estimate Limitations

- All cost estimate values presented in this report are in NZD \$, rounded, and exclusive of GST.
- All of the estimates are high-level estimates only and based on limited information, including initial costs estimates for marine works provided by a contractor.
- The ocean outfall estimates are deemed to be Class 5 or Class 4 estimates in terms of the AACE Cost Estimate Classification System guidelines. The probable accuracy range of the estimates is likely to be no better than -30% to +50%.
- These estimates are solely for our Client's use for the purpose for which they were intended in accordance with the agreed scope of work. They may not be disclosed to any person other than those stated above and any use or reliance by any person contrary to the above, to which Beca has not given its prior written consent, is at their own risk.
- While Beca believes that the use of the assumptions, as set out elsewhere in this report, are reasonable for the purposes of this study, Beca makes no assurances with respect to the accuracy of such assumptions, and some may vary significantly due to unforeseen events and circumstances. To the

extent that the conditions differ from those assumed in this report, the opinions expressed by Beca in this report may no longer be valid and should be reviewed.

- In preparing this estimate, Beca has relied on the accuracy, completeness and currency of the information provided by others. Beca is not responsible for information provided by others and has not sought to independently verify it. To the extent that the information is inaccurate or incomplete, the opinions expressed by Beca may no longer be valid and should be reviewed.
- The high-level cost estimates presented in this section are typically developed based on extrapolation of recent similar project pricing, industry unit rates and the general experience of Beca. The estimates are based on incomplete design and other information and are not warranted or guaranteed by Beca.

6.4 Outfall Scheme CAPEX Costs

6.4.1 Land-based CAPEX Costs

Table 6 provides a summary of the CAPEX estimates provided by Beca for the land-based elements of the Outfall Scheme. Refer to *Appendix E* for a further breakdown of the Outfall Scheme cost estimate.

Table 6 - Land-based CAPEX Outfall Scheme Cost Estimates (provided by Beca)

Element	Estimated Cost (\$M)
Duvauchelle Pump Station (for pumping via sub-marine pipeline to the Terminal Pump Station)	\$2.1
Akaroa Outfall Overland Pipe (400OD PE 1km from the WWTP down to Children's Bay)	\$3.6

It is worth noting that there is a potential CAPEX saving from significantly reducing the size of the 2,000m³ wet weather buffer tank currently proposed at the WWTP. It is understood there are significant costs associated with the wet weather buffer tank foundation. While some on-site storage is likely required for holding of flow for periodic flushing of the marine pipe, Outfall capacity will cater for peak wet weather flow and is therefore expected to require less on-site storage compared with the land irrigation scheme.

6.4.2 Marine Works CAPEX Costs

Marine works CAPEX cost estimates have been provided by McConnell Dowell (MCD) – a major contractor with significant experience installing marine outfalls around New Zealand. Beca provided a technical brief to MCD that set out the core requirements for the marine installation works (alignment, size, material, burial depth, diffuser arrangement etc.). The estimate is based on a recommended installation methodology provided by MCD (discussed above in Section 3.2).

The CAPEX cost estimate for the Akaroa Outfall marine works ranges from **\$34 to 45 million**, and the estimate for the Duvauchelle marine works ranges from **\$14 to 15 million**. The cost estimate range of values reflect different contingency allowances included for the four risk items identified below.

The estimates **include** allowances for the following items:

- P&G costs
- Design & Investigations
- Yards, facilities & material delivery
- Akaroa outfall system (marine pipe, de-aeration chamber & diffuser)
- Contingency allowances for cost risk around:
 - Delay costs due to adverse weather
 - Extent of rock armouring of marine pipeline crossing rock outcrop
 - Alternate installation methodology required in deeper waters
 - General design & construction risk

Cost estimate clarifications:

- The construction methodology used to inform this high-level estimate is based on several assumptions that require validation through site investigations and subsequent assessment and design.
- As discussed in Section 3.2, pipe burial beyond 10m water depth will likely require jetting (or other method) as depths are beyond backhoe dredging limits. MCD were unable to provide an estimate for this given limited information and time and therefore the base price excludes trenching and burial beyond this depth). Self-burying methods may be effective but this is unable to be determined at this stage. Beca have had further discussions with MCD, who have specified an extra contingency allowance for a jetting sled installation (beyond 10m water depth) which would move along the pipe jetting and burying it below the surface (likely requiring multiple passes).
- As discussed in Section 3.3, additional protection (rock armouring or equivalent) may be required over the 1.5km section of the Akaroa marine pipe that crosses navigational routes. This has been included in the above estimate.
- Contingency has been allowed for the risk of encountering rock in the seabed and attaching the marine pipe over top with rock armouring (300m extent).
- This estimate allows for McConnell Dowell to undertake detailed design but does not include concept and preliminary design required to support a consent application – assumed to be completed by others.
- This estimate (provided by MCD) does not include consenting costs and associated technical studies / assessments and consultation required to support an Assessment of Environmental Effects (AEE).
- The estimate is based on discharge location #2 (Refer to Appendix 1 layout ~700m further beyond the harbour heads). Feedback from MCD suggests that installation works in water depths >30m are unlikely to incur significant (stepped) costs compared with discharge location #1.

A more detailed estimate breakdown has been provided by MCD, however has not been included in this report due to commercial sensitivity.

6.4.3 Other Outfall Scheme Project Costs

The following additional Outfall Scheme project costs have been estimated.

Table 7 - Outfall Scheme Project Costs (provided by Beca)

Description	Estimate (\$M)
Consenting Costs	\$2.0
Principle Advisory / Consultant Costs	\$0.4
Council Costs	\$0.7

Note consenting costs include concept/preliminary design, dispersion modelling, technical studies/assessments, preparation of AEE, consultation.

6.4.4 Land Sale Revenue

An ocean Outfall Scheme would no longer require Council to own the proposed land irrigation sites. Table 8 shows an estimate of potential revenue (based on rateable value - RV) from irrigation site land sales.

Table 8 – Estimated Land Sale Revenue from Irrigation Sites

Site	Estimate / RV (\$M)
Robinson's Bay Site	\$1.7
Hammond Point Site	\$2.1
Total	\$3.8

Please note that this potential revenue from sale of surplus land has not been included in the Outfall Scheme cost estimates.

6.5 Outfall Scheme OPEX Costs

OPEX costs specific to the Outfall Scheme have been estimated by Beca and are summarised in Table 9. Please note the OPEX costs below exclude operating and maintenance costs associated with the Wastewater Treatment Plant and Terminal Pump Station.

Table 9 - Outfall Scheme OPEX Costs (provided by Beca)

OPEX element	Description	OPEX Cost (\$/yr)
Duvauchelle Pump Station	Power usage, maintenance, labour	\$50,000
Duvauchelle Marine Pipe	General maintenance, dive surveys	\$20,000
Akaroa Outfall Pipe	General maintenance and inspections, dive surveys and water quality sampling, ARV maintenance	\$170,000
Outfall Scheme OPEX Estimate (rounded)		\$240,000

The total OPEX cost above represents the new scheme elements only and does not capture complete OPEX costs for managing the wider Akaroa wastewater network. No allowance for reactive maintenance in case of the submarine pipelines being damaged or leaking.

6.6 Overall CAPEX and OPEX Cost Estimates

Overall CAPEX and OPEX cost estimates for the proposed Akaroa Outfall Scheme and Duvauchelle marine pipeline are shown in Table 10.

Table 10 - Overall CAPEX and OPEX Cost Estimates

Element		Cost Estimate
Akaroa Outfall Scheme ²	CAPEX ^{1,3}	\$37 to \$48 million
	OPEX ⁴	\$170 k
Duvauchelle Marine Pipeline ⁵	CAPEX ^{1,3}	\$16 to \$17 million
	OPEX ⁴	\$70 k

Note 1. The outfall cost estimates are to AACE Class 5 (- 30% +50%).

Note 2. Costs are specific to outfall disposal infrastructure and do not include network reticulation, terminal pump station or treatment plant costs

Note 3. CAPEX costs include project costs (consenting, consultants and council costs)

Note 4. OPEX estimates have been averaged annually over the life of the scheme

Note 5. Duvauchelle Marine Pipeline costs include a new pump station

Note 6. Other scheme costs such as maintenance and renewal of the reticulation network are not included in these estimate

7 Further Work

This feasibility stage assessment of an ocean outfall disposal option for Akaroa wastewater has been prepared to inform the current wastewater consent hearing process. Suggested next steps for Council, if the outfall option is taken further, would include the following:

- Conduct stakeholder engagement over the ocean outfall alternative
- Review the implications of the final national standards for wastewater discharges to both land and water
- Further detail the investment case for the ocean outfall vs the land-based scheme.

If the Outfall Scheme ultimately becomes the preferred option, then the following needs to be progressed:

- Prepare a plan to develop, design and build the outfall option
- Scope up and commission technical and environmental investigations as required
- Continue stakeholder engagement
- Prepare and lodge consent applications for the works
- Once consents have been granted, procure, design, construct and commission the outfall.

7.1 Consent Needs Assessment

The construction of an outfall pipeline within the harbour and beyond the heads will require resource consents (for discretionary activities) from Environment Canterbury, for both the construction and occupation of the structure in the Coastal Marine Area, as well as for the wastewater discharge. Some enabling consents (e.g. for construction activities) may also be required from Christchurch City Council for land-based works.

An Assessment of Environmental Effects (AEE) to support the consents application will be required which meets the requirements of section 88 and Schedule 4 of the Resource Management Act 1991. Technical studies will be required to support the development of a pipeline/outfall concept design and the effects assessment.

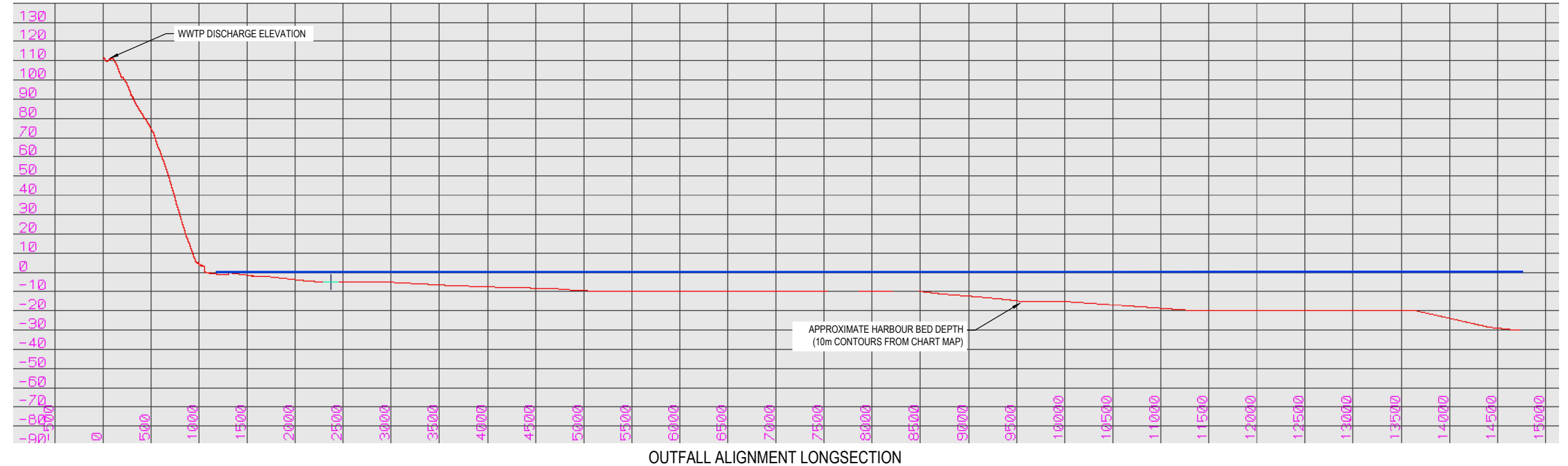
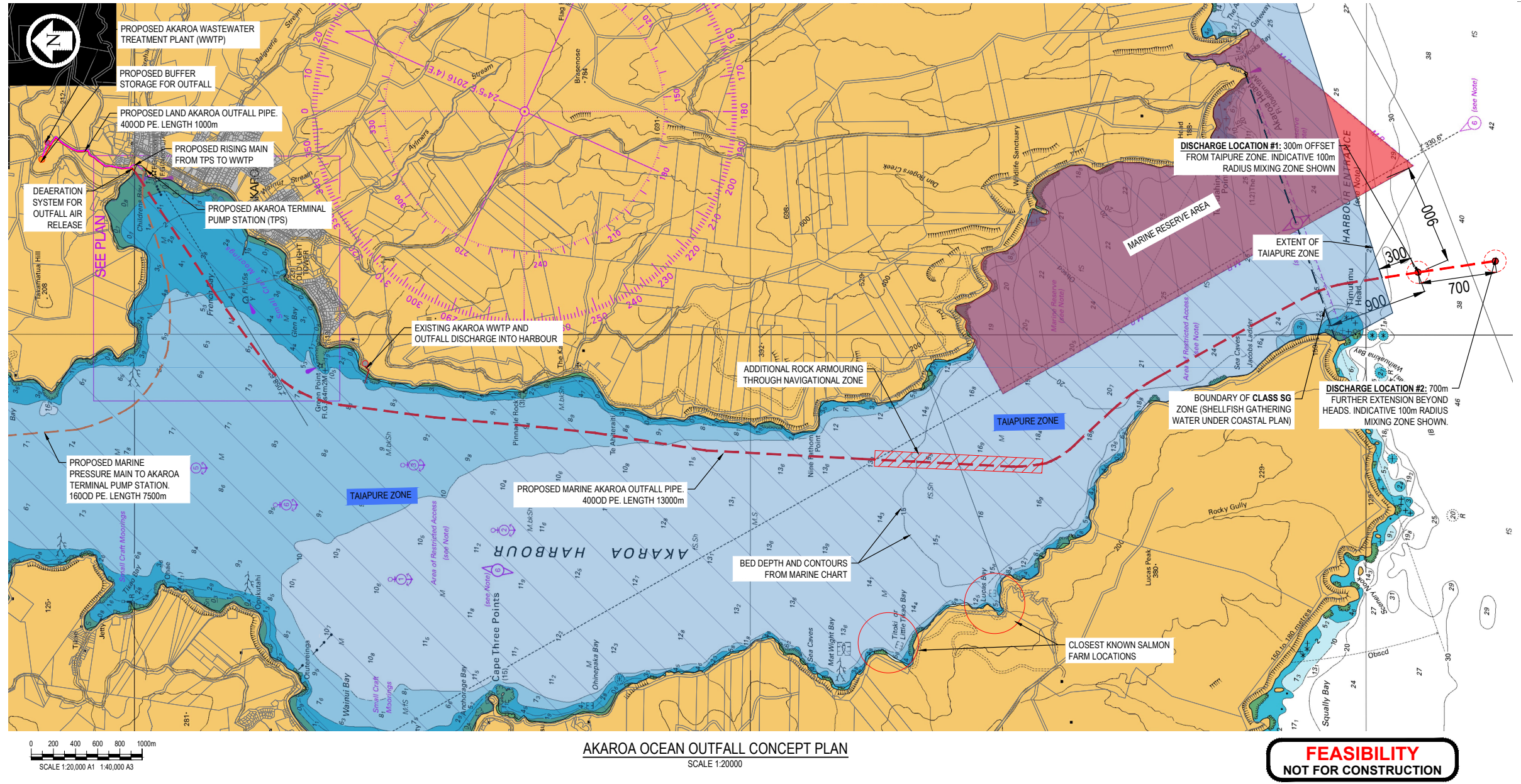
Technical studies are likely to include the following:

- Near-field dispersion modelling
- Far-field hydrodynamic modelling for the proposed discharge to support the development of a public health risk assessment
- Public health risk modelling using Quantitative Microbial Risk Assessment techniques (QMRA) to confirm impacts on sensitive receptors including shellfish gathering areas, and associated risks to public health from shellfish consumption
- Receiving water quality and ecological investigations
- Seabed bathymetry survey
- Marine geotechnical investigation
- Cultural impact assessment
- Recreational impact assessment.

Consultation with key partners (iwi) as well as key stockholders (ie. DoC, Public Health, harbour commercial and recreational users, harbourmaster etc) will also be required.

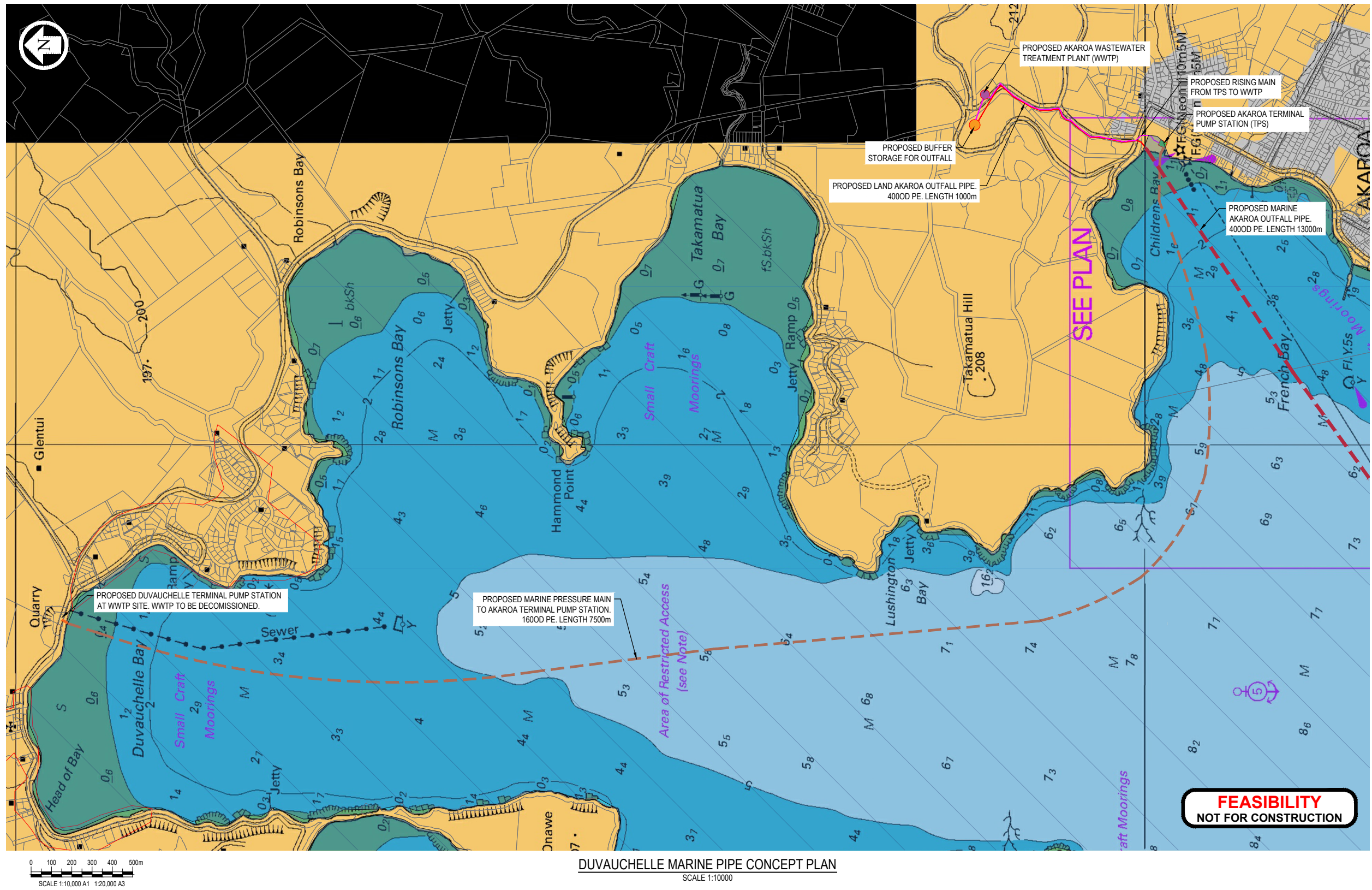
Typically, construction management plans which include mitigating impacts on harbour users, marine mammals etc would be required.





OUTFALL ALIGNMENT LONGSECTION





DUVAUCHELLE MARINE PIPE CONCEPT PLAN
SCALE 1:10000



2 Model Inputs & Assumptions

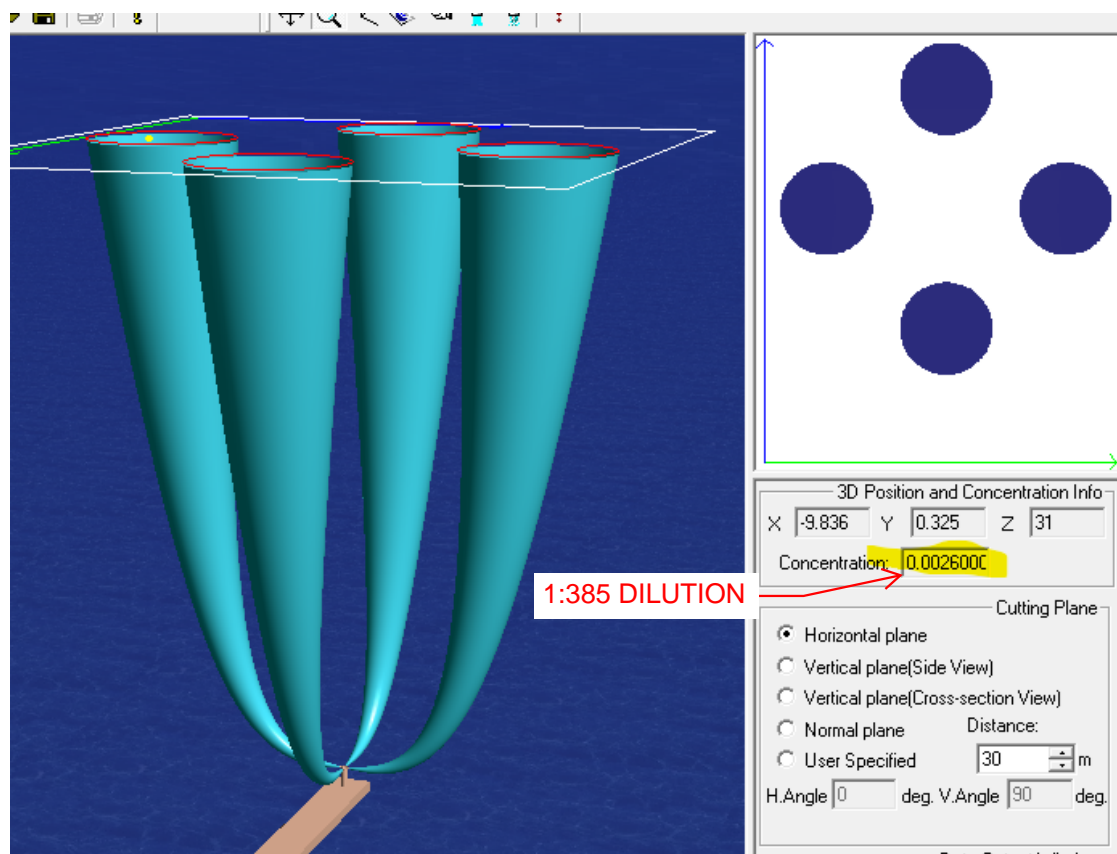
2.1 Modelling Software

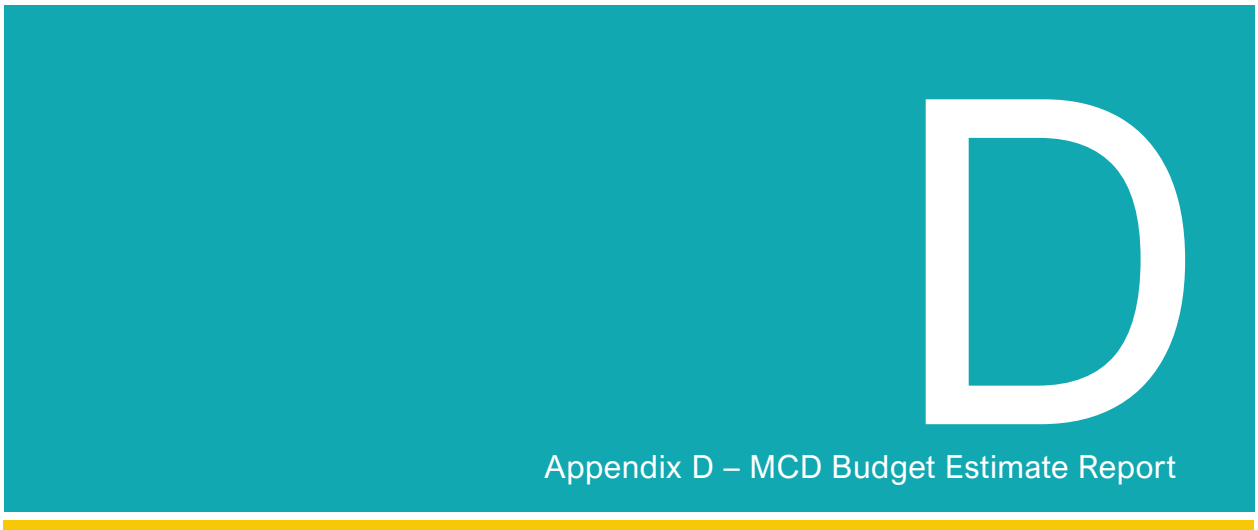
The outfall dilution modelling was undertaken using VISJET, developed by the University of Hong Kong. VISJET predicts the impact of an effluent discharge into an unbounded receiving environment. The model provides 3D flow visualisation of the predicted path and mixing of an arbitrarily inclined buoyant plume in a moving receiving water which may be density stratified. VISJET can be used to study the impact of either a single, or a group of inclined buoyant jets in three-dimensional space. It can be used for outfall design, impact assessment and risk analysis of polluting or natural environmental discharges.

2.2 Design Flows

Three design flows have been assessed:

- Maximum Flow = 102L/s – summer peak wet weather flows (PWWF)







Akaroa Outfall

Budget Estimate Report

February 2025

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Document History and Status

Rev	Date	Details	Author	Reviewer	Approver
A	24/02/25	Draft Issue to BECA for review/comment	DP		

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1 Executive Summary

This Report has been prepared for BECA / Christchurch City Council to inform the Akaroa Wastewater Project Resource Consent hearing process.

This Report is based on very limited information, drawing mainly on past experience of similar projects in Canterbury and elsewhere in New Zealand, therefore consideration shall be given to the application of additional contingencies.

McConnell Dowell's non-binding budget estimate for an alternative discharge to ocean for the Akaroa WWTP via a new marine pipe outfall, including all requested contingencies, is \$47,795,351.

DRAFT



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2 Introduction

2.1 Background

The Akaroa Wastewater Project involves conveying Akaroa, Duvauchelle and Takamatua wastewater to a new Akaroa Wastewater Treatment Plant (WWTP). Christchurch City Council (CCC) has applied to Canterbury Regional Council (Environment Canterbury) and CCC for various Resource Consents to establish and operate the new wastewater treatment scheme, which includes discharge to land via a Treated Wastewater Irrigation Scheme. A new Ocean Outfall pipeline is proposed as an alternative to the irrigation scheme, to enable the treated wastewater to be discharge beyond the mouth of the Akaroa Harbour.

2.2 Project Location

Akaroa Harbour, including Childrens, French and Duvauchelle Bays.

2.3 Project Scope

Under the proposed Ocean Outfall concept, the treated wastewater would then be piped under gravity through a new ~13km long (400OD HDPE) marine pipeline for discharge through a diffuser located beyond the Harbour heads.

Taking advantage of the required mobilisation for the marine outfall construction; it is also proposed that wastewater from the Duvauchelle catchment would be conveyed via a new 7.5km long (160OD HDPE) marine pipeline laid from Duvauchelle Bay to Childrens Bay. This will provide an alternative to eliminate disruption and risk associated with a conventional trenched pipeline in the road reserve. This pipeline would discharge into the new Terminal Pump Station (TPS) for subsequent treatment at the new WWTP and disposal through the marine outfall.

2.4 Purpose of Report

The purpose of this report is to provide preliminary budget and non-binding advice to BECA / CCC to inform the current Resource Consent process.

This report does not provide exhaustive optioneering and evaluation, and is instead based on McConnell Dowell's (MCD) experience in marine and outfall pipeline construction across New Zealand, including in the Canterbury region.

2.5 References

- BECA Letter dated 7 February 2025, subject: Akaroa Outfall Preliminary Pricing RFQ – CONFIDENTIAL [REV_3]
- McConnell Dowell track record projects, including:
 - Lyttelton Wastewater WP2 – HDPE submarine pipeline construction between Governors Bay and Diamond Harbour to Lyttelton by bottom pull with a temporary site establishment at Godley Quay / Naval Point, completed for Christchurch City Council in 2019
 - St Marys St Marys Bay & Masefield Beach Water Quality Improvement – HDPE submarine pipeline ballast assembly on water via construction barge and 'float and sink' installation, completed for Auckland City Council in 2019.
 - Christchurch Ocean Outfall – HDPE submarine pipeline construction by 'float and sink' with a temporary site establishment at Godley Quay, completed for Christchurch City Council in 2010.



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3 Methodology

For the purposes of this Budget Estimate, assumptions relating to methodology and plant selection are summarised in the following subsections.

3.1 Site Establishment

Godley Quay / Naval Point in Lyttelton Harbour will be established for the marine pipe string fabrication – per Lyttelton WP2 and Christchurch Ocean Outfall. Refer to Appendix A. Godley Quay / Naval Point site establishment for marine pipe fabrication

Activities required to create nominally 600m pipe string lengths, 13 off DN160 SDR13.6 PE100 HDPE and 22 off DN400 SDR13.6 PE100 HDPE, are:

- butt fusion welding,
- weld bend testing (to simulate pipe string installation stresses) and
- hydrostatic pressure testing.

Pipe strings will be capped, launched and bundled together before being towed to Akaroa Harbour for assembly on water via construction barge and installation – similar to St Marys Bay Outfall.

Assume bundles of five will be towed to Akaroa, therefore seven return voyages are required. Nominally 48Nm @ 4kts = 12hr one way completed as voyage of convenience as weather allows by tug in attendance with the pipe string assembly barge (see below). Refer to Appendix B.

Review of publicly available sea state data from the NIWA Le Bons Wave Buoy suggest suitable weather windows will occur at regular intervals. Refer to Appendix C.

Bare pipe strings to be stored floating at temporary anchorage in sheltered location within Akaroa Harbour.

3.2 Element 1: Akaroa Marine Pipe

Submarine pipeline trenches will be excavated and side cast by backhoe dredger barge, supplemented by amphibious excavator in shallow tidal sections – per Lyttelton WP2. To allow for tidal range and efficient dredging, assume the pipeline is only buried to the 10m depth contour ~ 46% (6km) of the Akaroa marine pipe. Refer to Appendix D.

Burial to the 20m depth contour ~38% (5km) has been considered as a contingency only, assuming multiple passes with a purpose-built jetting sled towed by marine vessel.

Pipe string assembly will be completed on a construction barge in Akaroa Harbour – per St Mary's Bay Outfall.

Vessels in attendance to include tug, crew transfer boat, hydrographic survey boat and line handling boat / small tug.

Buried marine pipe (both backhoe dredge and jetting sled):

- Annular ballast weight system for buried pipelines is 'overweighted', so negatively buoyant when air filled and providing an SG \approx 1.4 when filled with effluent – similar to Lyttelton WP2.
- This system will be deployed from the barge to the seabed via a stinger to control installation stresses and bottom pulled / progressively laid into the pre-dug trench.
- Diving resources in attendance to include dive boat (including SSBA, decompression chamber and compressor), dive tender and typical crew of supervisor plus four divers.

Seabed marine pipe:

- Trapezoidal ballast weight system designed to self-bury, with a ballast ratio that enables incremental float & sink installations, with bolted flange connections completed in-water – similar to Snells-Algies Outfall.



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- Diving resources in attendance to include dive boat (including SSBA, decompression chamber and compressor), dive tender and typical crew of 1) supervisor plus six divers for 10m < Depth < 15m and 2) supervisor plus nine divers for 15m < Depth < 50m.

Backhoe dredger barge and amphibious excavator will recover side cast spoil to backfill trench. Backhoe dredger barge will also place armour rock over ~1,500m Akaroa Outfall crossing the harbour (assume 3,000m³ of 100/200 river stone delivered by hopper barge ex. Lyttelton, requiring four return voyages).

3.3 Element 2: Multi-port Diffuser

Diffuser is designed as part of, and laid with, the final Akaroa marine pipe string. Duckbill riser and valve to be rubber construction to be resilient and shed snags, detailed to work with self-burying pipe.

Additional temporary buoyancy would likely be required during installation.

3.4 Element 3: Marine Pipeline Extension

Extra-over costs to extend marine pipe and diffuser 700m further beyond the heads of the Harbour on the same basis as 3.2 above.

3.5 Element 4: De-aeration chamber at Childrens Bay

De-aeration chamber is designed as part of, and laid with, the first Akaroa marine pipe string.

3.6 Element 5: Duvauchelle Marine Pipe

Submarine pipeline trenches to be excavated and side cast by backhoe dredger barge, supplemented by amphibious excavator in shallow tidal sections – per Lyttelton WP2. As water depths in the upper Akaroa Harbour are all within efficient dredging range, 100% (7.5km) of the Duvauchelle marine pipeline will be buried. Refer to Appendix D.

Pipe string assembly will be completed on a construction barge in Akaroa Harbour – per St Mary's Bay Outfall.

Vessels in attendance to include tug, crew transfer boat, hydrographic survey boat and line handling boat / small tug.

Annular ballast weight system for buried pipelines is 'overweighted', so negatively buoyant when air filled and providing an SG \approx 1.4 when filled with effluent – similar to Lyttelton WP2.

This system will be deployed from the barge to the seabed via a stinger to control installation stresses and bottom pulled / progressively laid into the pre-dug trench.

Diving resources in attendance to include dive boat (including SSBA, decompression chamber and compressor), dive tender and typical crew of supervisor plus four divers.

Backhoe dredger barge and amphibious excavator will recover side cast spoil to backfill trench.



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4 Budget Estimate

Initial budget estimate is summarised as follows:

Bill description	Amount
Preliminary and general	
Design & investigations	
Yards and facilities	
HDPE pipe delivery	
ELEMENT 1: Akaroa marine pipeline (13km), buried to the 10m depth contour	
ELEMENT 2: Multiport diffuser	
ELEMENT 3: Akaroa marine pipeline extension (700m)	
ELEMENT 4: De-aeration chamber at Childrens Bay	
ELEMENT 5: Duvauchelle Marine Pipe	
Contingency – adverse weather EOT	
Contingency – Akaroa marine pipeline, additional burial to 20m contour (5km)	
Contingency – rock armouring of marine pipeline crossing rock outcrop (300m)	
Contingency – general design & construction risk	
TOTAL	\$47,795,351

5 Appendices

Appendix A – Godley Quay / Naval Point site establishment for marine pipe fabrication

Appendix B – Potential HDPE pipe string tow

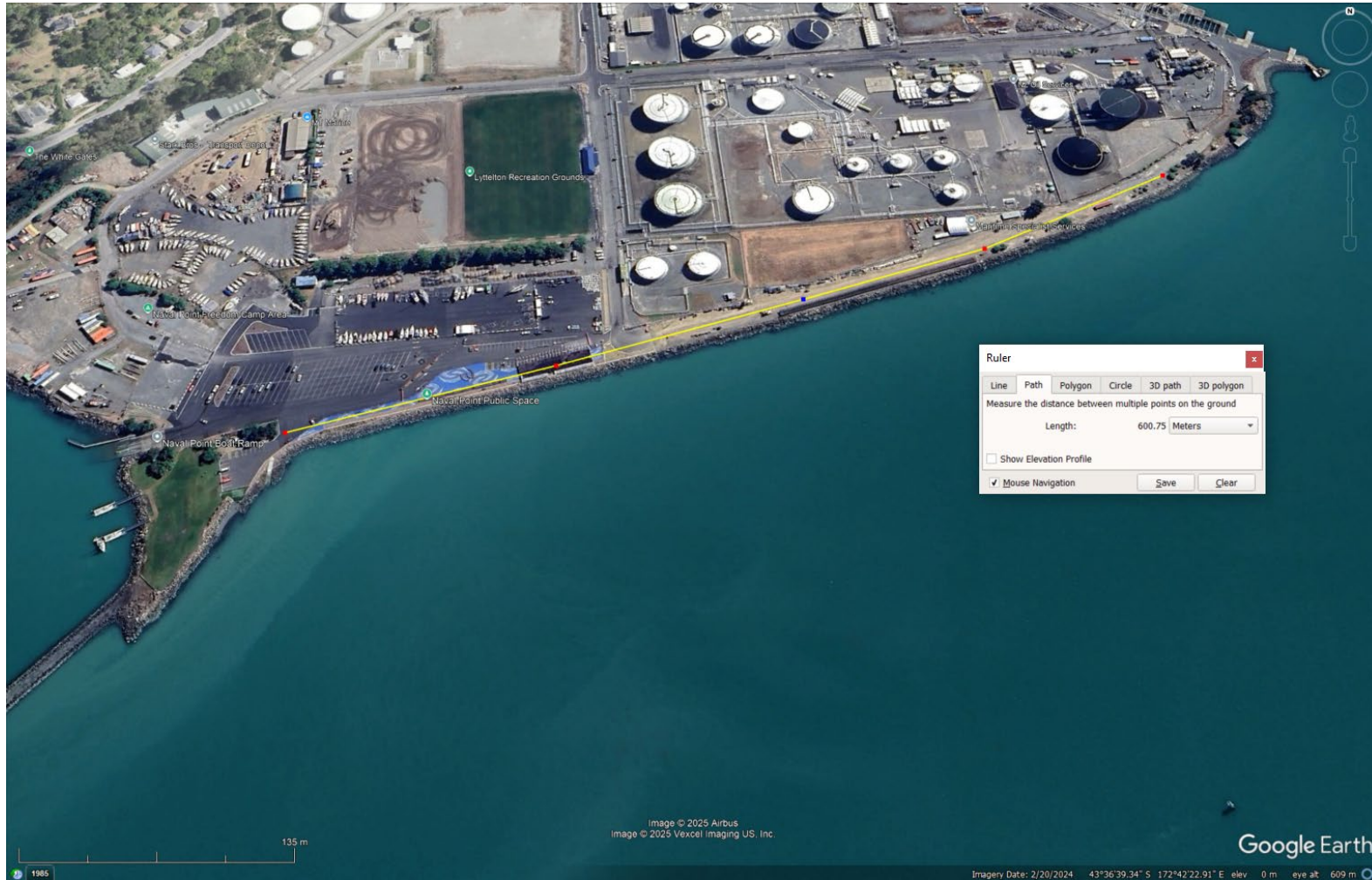
Appendix C – NIWA Le Bons wave buoy data

Appendix D – Akaroa Upper and Outer Harbour Chart snips



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Appendix A Godley Quay / Naval Point site establishment for marine pipe fabrication

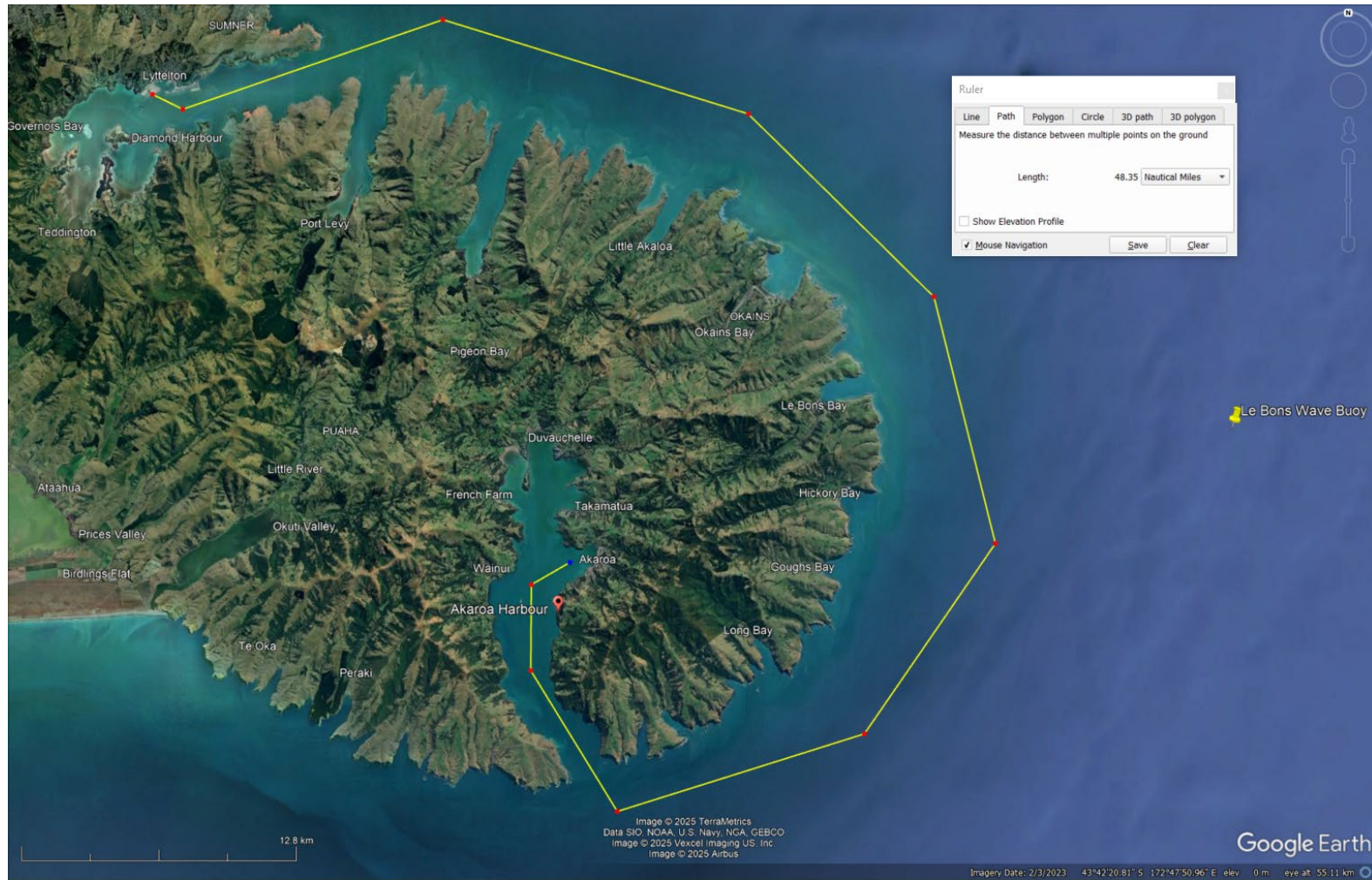


Attachment C Item 10



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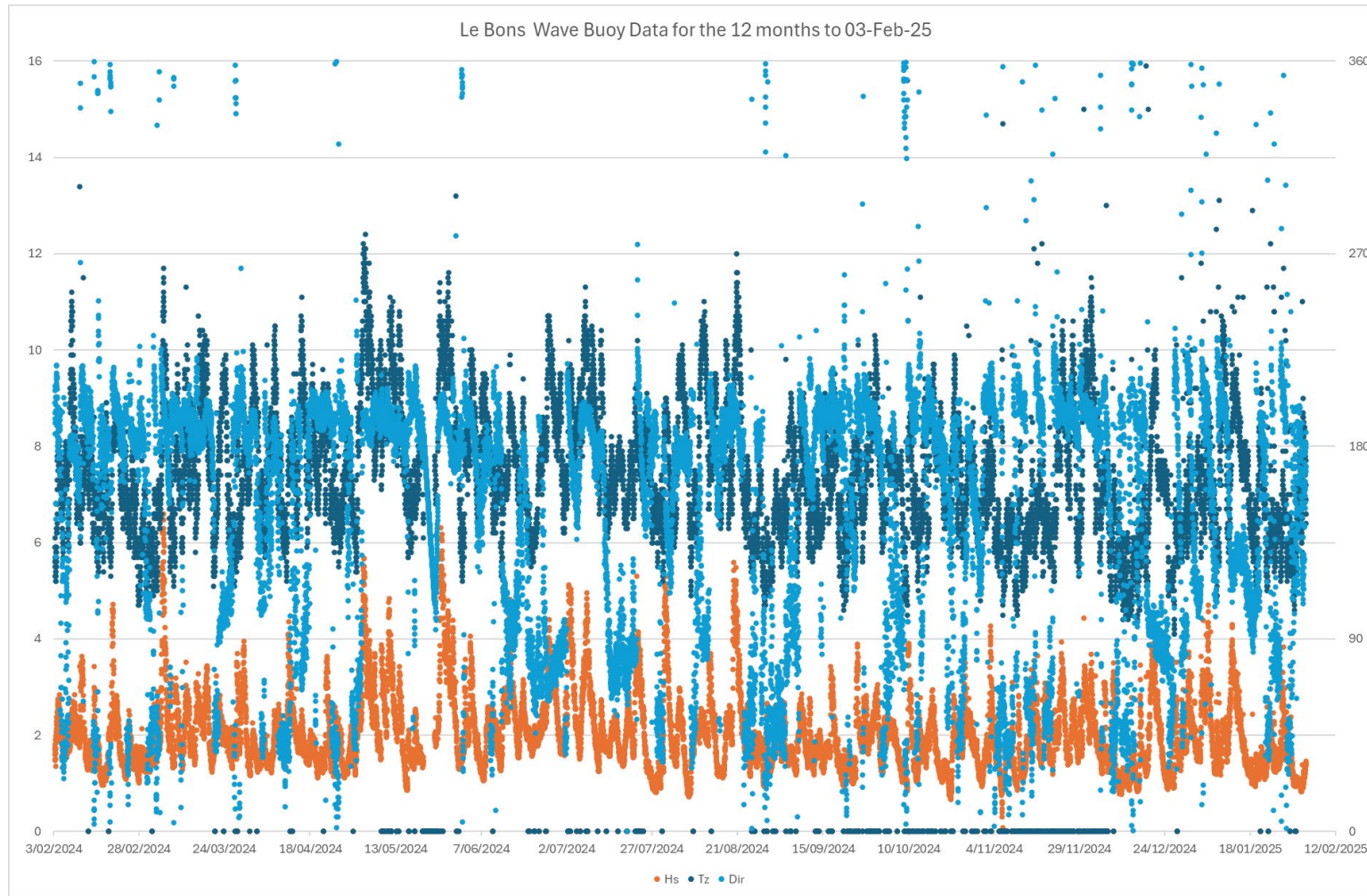
Appendix B Potential HDPE pipe string tow



Attachment C Item 10

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Appendix C NIWA Le Bons wave buoy data



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