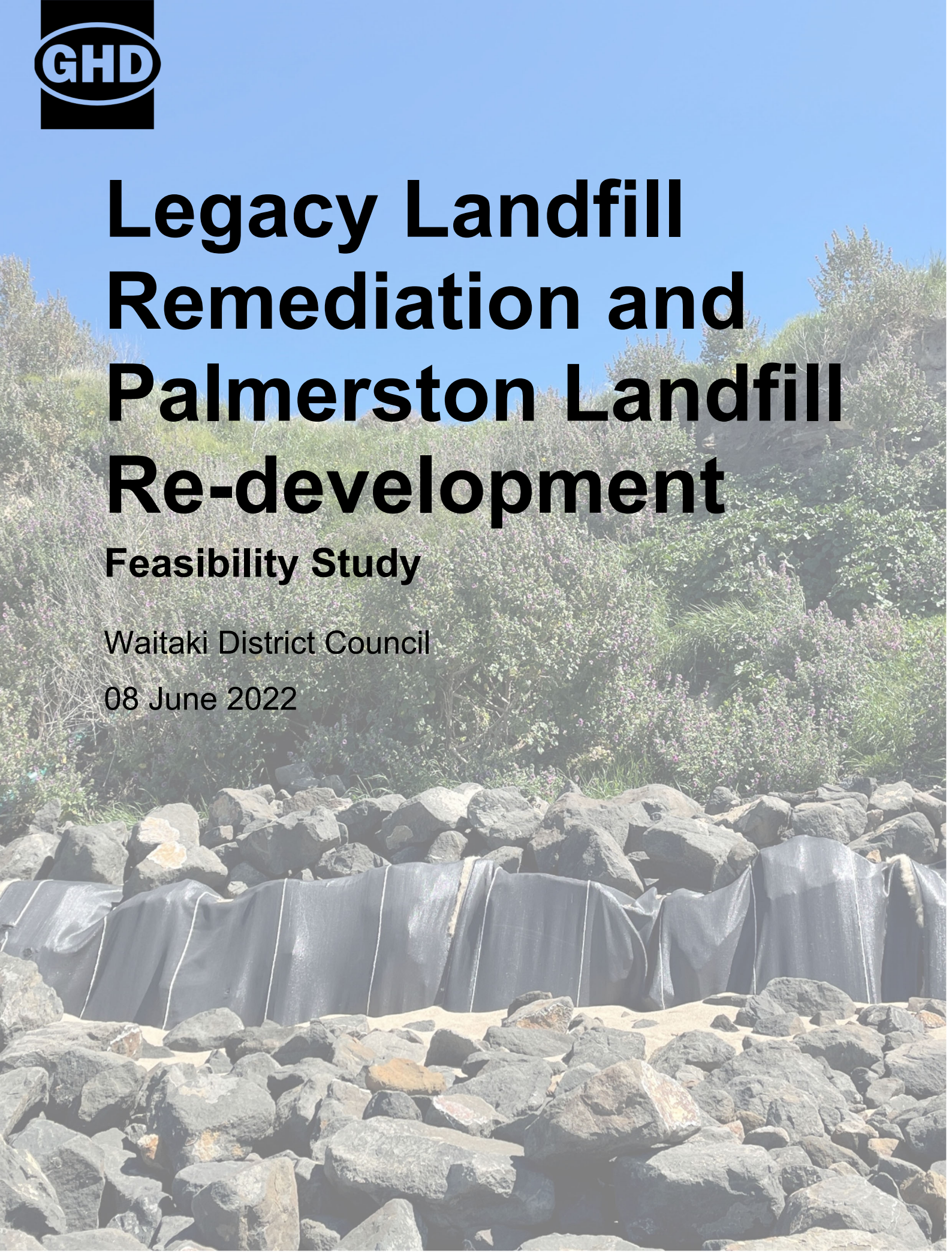
Legacy Landfill Remediation and Palmerston Landfill Re-development

Feasibility Study

Waitaki District Council

08 June 2022



The Power of Commitment

GHD Pty Ltd | ABN 39 008 488 373
27 Napier Street, GHD Centre Level 3
Freemans Bay, Auckland 1010, New Zealand
T +64 9 370 8000 | **F** +64 9 370 8001 | **E** aklmail@ghd.com | **ghd.com**

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Executive summary

Waitaki District Council (Council) wishes to address environmental pollution and amenity value risks associated with three historically unlicensed legacy landfills positioned within beach-cliffs and dune systems of the North Otago coastline. Storms and other erosive activities infrequently result in the spillage of visible waste on the coast and can result in associated public access restrictions. Infrastructure in the form of a local road may also be lost.

The landfills comprise two infilled gullies that are located near the intersection of Beach Road and Awamoa Road and the third former landfill is located at the end of Stafford Street in Hampden. Due to regional shoreline retreat, the three pockets of landfilled waste (and co-mingled contaminated soils) are being increasingly exposed by coastal erosion and released to the near-shore environment.

GHD and Morrison Low have been engaged by Council to prepare a Feasibility Study (this report) to consider the technical and planning requirements associated with remediating the legacy coastal landfills, as well as assessing options to further develop the inland Palmerston Landfill to receive project generated wastes and reduce the costs of remediation. The findings from this Feasibility Study will be used to inform an Outline Business Case for the overall remediation approach for the legacy landfills at Beach Road and Hampden.

Council has undertaken various phases of remedial maintenance and waste removal to minimise the effects of coastal erosion since 2007. However, the risk of historically landfilled wastes being exposed and released from all three coastal fill sites remains. The core remediation solution being tested in this feasibility study is the transfer of all 'at-risk' wastes from the Hampden and Beach Road coastal sites to the more secure Palmerston Landfill. This solution is assessed against the status-quo practices of managing coastal waste deposits in-situ, which implicate long-term reactive remediation efforts and costs.

Palmerston Landfill is owned by Council and is a Class B landfill, operated by contractors engaged by Council. The facility receives low volumes of municipal waste (typically less than 500 tonnes per annum) from Palmerston township and the surrounding Waihemo rural area. The opportunity to upgrade Palmerston Landfill to receive additional regional waste and generate revenues to offset the costs of legacy landfill remediation is developed in this Feasibility Study for further consideration in the Outline Business Case.

Waste quantities

Based on an assumed aged-waste density of 1.5 t/m^3, the mass of waste within Hampden Landfill may be estimated as 31,500 tonnes (21,000 m^3). Based on GHD's review of the available information for Beach Road, our opinion is that previous waste volume estimates may be too low and should be revised upwards to 4,000 m^3 for each site (8,000 m^3 in total), translating to 12,000 tonnes. The overall waste quantity involved is therefore expected to be approximately 29,000 m^3 and is likely to represent a waste mass of 40,000 – 45,000 tonnes.

Waste character

Previous site investigations at Hampden Landfill have indicated that a variable thickness of waste-contaminated capping materials lies over the main waste mass that is estimated to be 3 m deep on average but ranges from 0.4 m to more than 5 m in thickness. It was further estimated that actual refuse represents only 5% to 30% of the overall waste profile and that most waste (50-90%) occurs in relatively thin beds.

Prior site investigations at Beach Road have encountered glass, plastics, ceramic, fabric, metal, concrete, brick, ash and tar. Asbestos containing materials (ACM) have also been documented. Contaminant concentrations detected in the Beach Road landfills are greater than those documented in the Hampden Landfill. Multiple samples, collected from both Beach Road fill areas, exceed Class A landfill acceptance criteria for heavy metals including arsenic, cadmium, chromium, copper, lead, nickel and zinc. Of seven samples submitted for leaching (TCLP) analysis, four returned lead and zinc concentrations greater than Class A landfill TCLP acceptance criteria.

Remediation options

Remediation options for all three legacy landfill sites are based around gradually increasing amounts of waste extraction, from status-quo options (that involve only maintenance and no active remediation), partial-remediation (involving the removal of the most at-risk or problematic waste mass) and full remediation (involving the complete removal of all waste materials).

Various degrees of site reinstatement and/or ongoing liability management are implicated by the removal of varying proportions of waste. Key considerations in remediation decision-making must include that:

– Partial waste removal options can only delay the inevitable requirement to completely relocate all legacy coastal waste deposits at some future date
– Complete waste removal options are initially costly, but negate ongoing monitoring and maintenance costs and reduce overall liabilities associated with managing legacy waste deposits within a retreating coastline
– Where site reinstatement options are aligned to managed coastal retreat policies (and asset abandonment), site reinstatement costs will decrease
– Where site reinstatement options are aligned to retaining Council assets (such as Beach Road), site reinstatement costs may significantly increase (irrespective of the proportion of waste removed)

Based on our review of available information, the technical viability, planning requirements and projected costs of the following site management or remediation approaches has been provided.

Table ES.1 Hampden Landfill – ongoing management or remediation options

H1	Status Quo	Reactive repairs and ongoing maintenance
H2	Do minimum	Additional capping improvements and erosion protection repairs
H3	Do more	Remove the next 10 m strip of landfill and relocate coastal protection measures inland (long-term incremental landfill remediation permitted under current Resource Consent)
H4	Complete solution	Remove all legacy landfill material and reprofile site for managed coastal retreat

Table ES.2 Beach Road Landfills – ongoing management or remediation options

B1	Status Quo	Reactive repairs and ongoing maintenance
B2	Do minimum	Partial (minimum) remediation to allow improved and stabilised capping profile and improved coastal protection measures
B3-1	Do more	Remove all legacy landfill material and reinstate Beach Road to pre-1972 alignment (at northern landfill)
B3-2		Remove all legacy landfill material, reinstate current alignment of Beach Road and provide improved coastal protection along 2.4 kilometre stretch of erosion-prone road
B4	Complete solution	Remove all legacy landfill material, abandon Beach Road and reprofile site for managed coastal retreat

Coastal erosion treatment

Based on predicted rates and extents of coastal retreat along the Waitaki District coastline and specifically coastal stretches at the Hampden (0.2 m/year) and Beach Road (0.3 – 0.5 m/year) sites, it is evident that no readily viable coastal protection measures will be capable of retaining wastes indefinitely and that eventually all wastes will require relocation to a more secure disposal location.

Except for Option B3-2, coastal erosion protection measures are based on maintaining those currently installed at Hampden Landfill and improving protection measures at the Beach Road sites to design levels adopted by Council for the protection of other nearby sections of Beach Road.

The scale and cost of works associated with providing improved protection for a fuller 2.4 km stretch of Beach Road (Option B3-2) have been extrapolated from recent New Zealand Transport Authority works to protect sections of State Highway 1 involving 10 sites to the north of Katiki Beach. The extrapolated costs are considered prohibitive and should only be considered further in the context of wider Council policies for coastal asset abandonment and regional strategies relating to managing coastal retreat.

Planning requirements

A high-level planning assessment has been undertaken considering planning rules and consents that may be required.

In terms of Regional Council consents, the various remedial options being considered that involve soil disturbance at Beach Road and/or Hampden are outside of the scope of existing consents and will therefore require resource consents in some form under Rule 5.6.1 of the Waste Plan, this consent application would include post remediation verification or reporting. Consents for works within the Coastal Marine Area will be required where

options are associated with relocation of defences. Consents from territorial authorities are likely required for earthworks and for disturbing a contaminated site under the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NESCS) and the Waitaki District Plan. The likelihood of NESCS consents being required depends on the remedial option involved, however for the 'do minimum' and 'do more' options, these will exceed permitted activity volumes under the NESCS and consent will be required. For the Beach Road sites further consideration of interaction of the NESCS and the designation will need to be considered under Section 43D of the RMA and this will be a decision for the local authority.

Given the nature of the waste and the low contaminant concentrations observed at Hampden, it was concluded from 2019 site investigations that a Category E (normal) waste classification is considered valid (under the prior SWBL) and via direct consultation Otago Regional Council (ORC) have recently confirmed the remaining Hampden waste would meet Palmerston Landfill waste acceptance criteria (December 2021). However, ORC also stated that "*contaminated soil would be considered special waste, so it would only be acceptable if the volume of contaminated soil and concentrations were such that the mixed soil met cleanfill criteria".*

Beach Road materials exhibit notably higher contaminant concentrations and would be classified as Category C (controlled) waste under the prior SWBL. Further discussion with ORC and additional waste delineation and characterisation testing are recommended for the Beach Road landfills.

Solutions to address the technical and regulatory viability of disposing the more problematic Beach Road wastes to Palmerston Landfill include:

– Undertaking additional waste characterisation studies, in combination with waste blending and chemical stabilisation trials, to provide more waste characterisation certainty and to define waste treatments necessary to achieve landfill waste acceptance
– Confirming whether out-of-district Class A landfills (AB Lime and Kate Valley) will accept Beach Road waste materials without pre-treatment (and at what cost)
– Development of a project specific containment cell at Palmerston Landfill for the receipt of legacy landfill wastes, including by beneficial extension, the development of Stage 3 of Palmerston Landfill to Class A landfill standards

From a planning perspective, some portions of the waste mass of all three landfills will be classified as prohibited under definitions of the Council's previous (now expired) Solid Waste By-Law (SWBL). This report assumes waste classification definitions of the expired SWBL will prevail in the interim, as these are referenced in the Palmerston Landfill Management Plan for the purposes of defining waste acceptance criteria for the facility.

The ORC resource consent application for redeveloping Palmerston would need to consider several matters including the appropriate management of the landfill, the capturing and treatment of leachate and the effects on the groundwater environment. The application will also need to address the ability of the site's discharge quality to meet the National Policy Statement for Freshwater Management (2020) environmental bottom lines. If the volume and/or waste acceptance criteria changes are minimal, ORC may allow for a change of conditions to occur to allow for additional waste to be accepted.

As these consents expire in 2027, during the renewal of these applications the Council may wish to seek a change in the waste acceptance criteria authorised by the replacement consents, however, the process will still be required to address effects on the wider environment and the new environmental bottom lines at this point.

In terms of local council consents Palmerston is designated under the District Plan as a Landfill (I.D 70), as the site is an active landfill its continued operation can be managed under this designation. However, under the (now expired) SWBL, the Palmerston Landfill is limited in what types of material may be disposed to this facility. Several portions of the waste within all three landfills will be classified as prohibited under the (expired) SWBL. For the Palmerston Landfill to accept this material, current references to the now expired SWBL will need to be updated and a new basis for re-establishing waste acceptance criteria for Palmerston Landfill will be needed.

Rationalised development of Palmerston Landfill

Palmerston Landfill is the logical disposal site for legacy coastal landfill wastes, as it is located within-district, is owned by Council, is close to the legacy landfill sites and has sufficient capacity to receive the waste.

Waste transport and landfill gate fees represent the most significant cost components of remediation. Based on comparative remediation option cost estimates, the waste disposal cost (cartage and gate fee) savings of using Palmerston Landfill rather than AB Lime (the next cheapest disposal solution) are significant:

– Disposal of 21,000 m^3 of waste from Hampden (option H4) to Palmerston Landfill rather than AB Lime provides a potential remediation project cost saving of approximately $6.54 M
– Disposal of 8,000 m^3 of waste from Beach Road landfills (options B3-1, B3-2 or B4) to Palmerston Landfill rather than AB Lime provides a remediation project cost saving of approximately $1.93 M

Challenges in respect of transferring legacy coastal wastes to Palmerston Landfill are associated with its Class B Landfill status and uncertainties around its ability to provide sufficiently long-term secure storage for wastes that are not classed as normal waste or inert waste.

In tandem with the consideration of legacy landfill remediation options, the opportunity to leverage additional development upgrades to Palmerston Landfill have been considered in this Feasibility Study. The overall combined remediation project cost saving achieved in using Palmerston Landfill ($8.47 M) mostly offsets the capital expenditure (CAPEX) estimate ($9.27 M) associated with upgrading Stage 3 of Palmerston Landfill to a Class A landfill facility (option P4). Furthermore,

– Following the receipt of legacy landfill waste, the P4 development option for Palmerston Landfill results in spare Class A landfill capacity of around 50,000 tonnes, which would enable commercial waste management revenues to be generated, hypothetically modelled as 12,000 tonnes per annum over a further 4-year operational period
– CAPEX estimates for P4 include a provisional sum of $1 M for the installation of landfill gas controls, which are unlikely to be necessary for the management of aged and de-gassed legacy wastes, or for the relatively low rates and volumes of waste that could subsequently be received into Palmerston Landfill.

Overall cost estimates

The preliminary remediation project cost estimates for all remediation options provided in this report are summarised in the following two tables.

Table ES.3 Hampden Landfill management and remediation option cost estimates

Option	H1 Status Quo	H2 Do minimum	H3 Do more	H4 Complete solution
Summary description	Reactive repairs and ongoing maintenance	Improve capping and erosion protection repairs	Remove landfill incrementally over the long term (per current Resource Consent)	Remove all legacy waste and reprofile site for managed coastal retreat
Ongoing monitoring & maintenance (10-yr OPEX)	$ 252,000 [A]	$ 1,112,000 [A]	$ 932,000 [B]	$ 41,000 [B]
Remediation - Palmerston disposal (CAPEX)	-	-	$ 1,733,000 [C]	$ 6,480,000
Remediation - AB Lime disposal (CAPEX)	-	-	$ 3,290,000 [C]	$ 13,019,000
Remediation - Kate Valley disposal (CAPEX)	-	-	$ 4,373,000 [C]	$ 17,568,000

A – based on current maintenance budget allocations for Hampden Landfill aftercare, forecasted for 10-years without allowance for the inevitable future requirement to relocate the entire landfill. When waste relocation is required, CAPEX reflected under H3 (partial removal) or H4 (complete removal) will be incurred in addition to annual OPEX in the interim.

B – estimates reflect a reduced 10-year OPEX following partial (H3) or complete (H4) waste removal.

C –estimates include the removal of a single (10-m width; 5,000 m^3) increment of the landfill, without allowance for the inevitable future requirement to relocate the remainder of the landfill (21,000 m^3 in total).

Table ES.4 Beach Road Landfill management and remediation option cost estimates

Option	B1 Status Quo	B2 Do minimum	B3-1 Do more	B3-2 Do more	B4 Complete solution
Summary description	Reactive repairs and ongoing maintenance	Partial waste removal to improve capping profile & coastal protection measures	Full waste removal, reinstate Beach Rd to pre-1972 alignment (north landfill)	Full waste removal, reinstate Beach Rd to current alignment & provide coastal protection to 2.4 km of erosion-prone road.	Full waste removal, abandon Beach Road and reprofile cliffs for managed coastal retreat.
Ongoing monitoring & maintenance (10-yr OPEX)	$ 763,000 [A]	$ 1,401,000	$ 1,295,000	$ 1,614,000	$ 21,000 [B]
Remediation (CAPEX) - Palmerston disposal	-	$ 1,245,000 [C]	$ 3,912,000 [C]	$ 13,887,000 [C]	$ 3,712,000
Remediation (CAPEX)- AB Lime disposal	-	$ 1,891,000 [C]	$ 5,843,000 [C]	$ 15,818,000 [C]	$ 5,643,000
Remediation (CAPEX)- Kate Valley disposal	-	$ 2,250,000 [C]	$ 6,990,000 [C]	$ 16,965,000 [C]	$ 6,790,000

A – based on current monitoring and maintenance allocations, forecasted for 10-years without allowance for inevitable future requirements to relocate wastes. When waste relocation is required, CAPEX reflected under B4 will be incurred in addition to annual OPEX in the interim.

B – estimates reflect a reduced 10-year OPEX following complete waste removal.

C –estimates are for the removal of varying proportions of the landfill only, without allowance for the inevitable future requirement to relocate the remainder of the landfill.

Palmerston Landfill development options and cost estimates provided by this report are summarised in Table ES.5 below. Palmerston Landfill development options variously align with and enable different legacy landfill remediation options (as noted in the Table). Remediation approaches for Hampden Landfill and the Beach Road gullies that involve waste disposal to Palmerston Landfill must therefore also consider the associated cost of the relevant Palmerston Landfill upgrade option.

Table ES.5 Palmerston Landfill management and remediation option cost estimates

Option	P1 Status Quo	P2 Do minimum	P3 Do more	P4 Complete solution
Summary description	Continued operation for local waste only, remediation project waste disposed to out-of-district landfill(s)	Accept remediation material from Hampden only	Accept remediation material from Hampden and Beach Rd (pre-treated waste)	Upgrade Landfill Stage 3 to Class A standards to accept remediation wastes and additional regional wastes for commercial benefit
Legacy coastal landfill remediation option(s) enabled	Out of district disposal	H3/H4	H3/H4 and B2/B3/B4	H3/H4 + B2/B3/B4 and 12,000 t/yr other waste
Operational and monitoring costs (in year of remediation project)	$ 99,000	$ 248,000	$ 297,500	$ 567,000
Operational and monitoring costs (annual thereafter)	$ 99,000	$ 163,000	$ 170,000	$ 397,000
Landfill Upgrades (CAPEX) for landfill development prior to receipt of legacy wastes	$ -	$ 626,000	$ 757,000	$ 9,267,000

This report is subject to, and must be read in conjunction with, the limitations set out in section 1.4 and the assumptions and qualifications contained throughout the Report.

Contents

Table index

1. Introduction

1.1 Project context

Waitaki District Council (Council) wishes to address environmental pollution and amenity risks associated with three historically unlicensed legacy landfills, positioned within beach-cliffs and dune systems of the North Otago coastline. Council has undertaken various phases of remedial maintenance and waste removal to minimise the effects of coastal erosion since 2007. However, the risk of historically landfilled wastes being exposed and released from all three locations remains.

Due to regional shoreline retreat, the three pockets of landfilled waste (and co-mingled contaminated soils) are being increasingly exposed by coastal erosion. The wastes pose direct pollution risks to nearby beaches, require management in the form of public access restrictions and present an ongoing cost liability to Council. Ongoing costs are associated with the maintenance of coastal erosion protection measures, capping materials and stormwater diversions, which can only delay the release of waste materials to the environment.

The three coastal landfill sites considered in this Feasibility Study include:

– Hampden Landfill, located at the end of Stafford Street, Hampden, approximately 2 kilometres north of Moeraki Boulders Beach (approximately 27 kilometres south of Oamaru)
– Two infilled gullies in the beach-cliffs beneath or adjacent to Beach Road, approximately 4.5 kilometres south of Oamaru

The locations of the coastal landfills are shown in Figure 1 (overleaf).

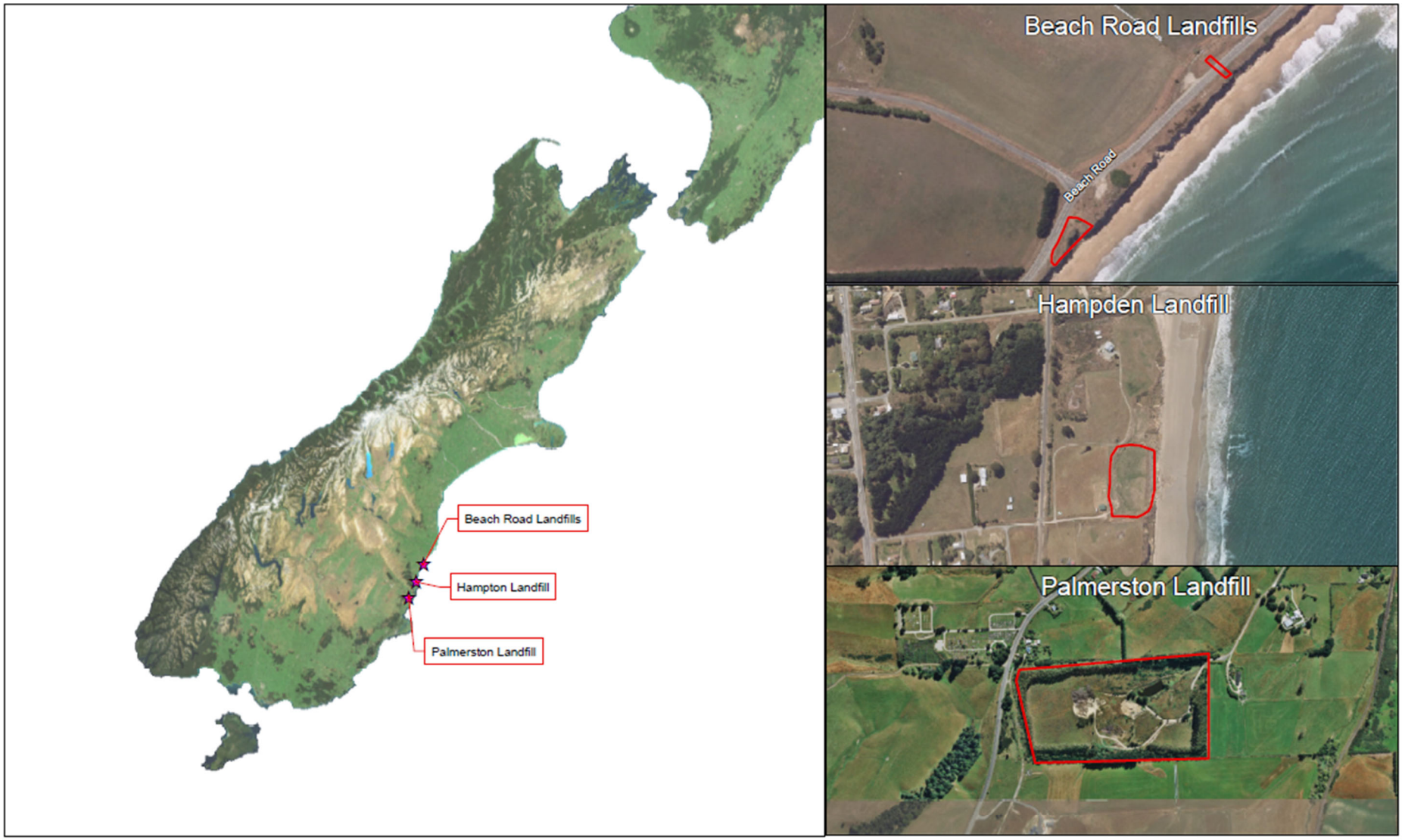
The viability of reinstating Beach Road itself is implicated in assessing remediation and site reinstatement options for the Beach Road landfills, as increasing rates of coastal erosion also threaten the road infrastructure itself.

Palmerston Landfill is owned by Council and is located on Falcon Street, Palmerston. Palmerston Landfill is a Class B landfill, operated by contractors engaged by Council. Class B landfills have limited or no engineered systems for leachate collection or gases and are consented to accept general domestic and commercial waste. The Palmerston facility receives low volumes of municipal waste (typically less than 500 tonnes per annum) from Palmerston township and the surrounding Waihemo rural area.

The core solution being tested in this feasibility study is the transferral of all ‘at-risk’ wastes from the Hampden and Beach Road sites to the more secure disposal location of Palmerston Landfill.

Council requires this core solution be evaluated against all available waste disposal options, including out-of-district landfill disposal, as well as viable alternative or in-situ remediation options. Such alternatives include the status-quo scenario, of maintaining existing erosion protection measures to manage the coastal waste deposits in-situ; and improving protection measures to defend against increasing rates of coastal erosion.

Council also wishes to evaluate the viability (regulatory, technical and commercial aspects) of upgrading Palmerston Landfill to allow it to accept additional volumes of waste on an ongoing basis. It is envisaged that further development of Palmerston Landfill may generate revenues that could offset legacy landfill remediation costs over time.



Paper Size A3

0 45 90 180 270 360

Metres

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

LEGEND

Site Location

Approximate Site Boundary

Waitaki District Council
Waitaki DC Closed Landfills FS

Job Number 12566144
Revision A
Date 13 Dec 2021

Landfill Site Locations

Figure 1

138 Victoria Street, Christchurch Central 8141 T 64 3 378 0900 E chcmail@ghd.com W www.ghd.com

1.2 Project objectives

The key objective(s) of this Morrison Low and GHD commission are to:

1. Prepare a Feasibility Study (this report) to consider the technical and planning requirements associated with:
    - Remediating the identified legacy coastal landfills
    - Extending and accelerating current filling operations at Palmerston Landfill
2. Use findings from this Feasibility Study to inform an Outline Business Case.

More broadly, the coastal waste deposit management and remediation options developed in this study are inherently aimed towards achieving outcomes of:

– Reducing the environmental impacts posed by the uncontrolled release of waste
– Reducing potential hazards and risks posed to the public by waste pollution of beaches and reserves
– Improving the amenity value of the coastal reserve
– Mitigating ongoing costs and liabilities associated with managing waste deposits within a retreating shoreline

1.3 Purpose of this report

As a precursor to developing the Outline Business Case, the purpose of this Feasibility Study is to:

1. Review, confirm and shortlist viable options for the ongoing management or remediation of:
    - Hampden Landfill, containing approximately 21,000 m^3 of waste
    - Beach Road infilled gullies, containing a combined volume of approximately 8,000 m^3 waste
2. Assess and confirm the feasibility of waste disposal to Palmerston Landfill from engineering, planning, and regulatory perspectives.
3. Assess the feasibility of installing fuller coastal erosion protection measures along some greater extent of Beach Road.
4. Document the outcomes of initial project-related consultation with:
    a. Otago Regional Council (ORC), specific to:
        i. Regional policies and strategies associated with managing coastal retreat
        ii. Regional waste (and legacy contamination liability) management strategies
        iii. Regulatory requirements for the favoured remediation options
        iv. Regulatory requirements for upscaling Palmerston Landfill operations
    b. The Ministry for the Environment, in relation to the potential applicability of:
        i. Contaminated Sites Remediation Fund (CSRF) availability for legacy landfill remediation
5. Develop comparative costs for the identified options, incorporating transport and landfill gate costs, planning, approval, and implementation costs. These costs will form the basis for additional financial modelling within the separate Outline Business Case.

1.4 Scope and limitations

This report: has been prepared by GHD (and Morrison Low) for Waitaki District Council and may only be used and relied on by Waitaki District Council for the purpose agreed between GHD, Morrison Low and Waitaki District Council as set out in section 1.3 of this report.

GHD otherwise disclaims responsibility to any person other than Waitaki District Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of its preparation. GHD has no responsibility or obligation to update this report to account for events or changes occurring after the date the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described throughout this report. GHD disclaims liability arising from any of those assumptions being incorrect.

Where this GHD document is included in another document, the entirety of GHD's report must be used (including the disclaimers contained herein), as opposed to reproductions or inclusions solely of sections of GHD's report.

GHD has prepared preliminary comparative cost estimates for remediation options, as set out in section 7 and associated cost estimate tables in the appendices of this report ("Cost Estimate") using information reasonably available to the authors of this report; and based on assumptions and judgments made by GHD.

The Cost Estimate has been prepared for the purpose of comparing remediation options and for providing the required base-case cost estimates that will be further developed in the Outline Business Case (prepared by Morrison Low) and must not be used for any other purpose.

The Cost Estimate is a preliminary estimate only. Actual prices, costs and other variables may be different to those used to prepare the Cost Estimate and may change. No detailed quotation has been obtained for actions identified in this report. GHD does not represent, warrant or guarantee that the works can or will be undertaken at a cost which is the same or less than the Cost Estimate.

GHD has prepared this report on the basis of information provided by Waitaki District Council and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

1.5 Assumptions

1. This Feasiblity Study has been informed by GHD's review of prior site investigation works undertaken and reported by others. This Study is therefore affected by the limitations applicable to the reliability of information and interpretations provided in those reports. Critically, prior site investigation reports have been used to inform overall waste volume estimates within this Feasibility Study, and a degree of uncertainty will always remain in relation to waste volume estimates. Although the practice of including contingency volumes is commonly introduced in planning remedial earthworks projects, it is not considered beneficial to build contingency volumes into remediation cost estimates at this Feasibility Study stage. Contingencies may be included at detailed planning and budgeting stages, but the decision-making process informed by this Feasibility Study should proceed based on the best current estimates of the overall waste volumes involved.
2. Feasibility considerations and cost estimates in this report are based on an assumed aged-waste density of 1.5 t/m^3. Variability in the weight of waste materials may significantly affect waste disposal costs, as landfill charges are by weight and because safe-load restrictions may cause additional transport costs.
3. Under options involving complete waste removal and managed coastal retreat, reinstatement works are assumed to be limited to re-profiling the resulting excavation voids in coastline cliffs and dunes, predominantly using (uncontaminated) site-won materials. Importing cleanfill materials to reconstruct site profiles following the remediation works is considered futile, given the predicted rates of coastal erosion (0.2 m/year at Hampden and 0.3 – 0.5 m/year at Beach Road). However, there are allowances to import capping, rip rap and roading materials to the sites where required in partial remediation scenarios, or in options involving the protection of Beach Road.
4. Palmerston Landfill development options are based on existing Palmerston Landfill expansion designs and geometries, as provided by WDC and developed by Overview Surveying. Landfill development options proposed in this Feasibility Study involve upgrades to landfill facilities and infrastructure and to the improvement of construction methods, and do not provide any optimised landfill design or any re-calculation of potential landfill void-space.

Further assumptions specific to the development of cost estimates are detailed in Section 7.

2. Landfill remediation drivers

2.1 Hampden Landfill

Hampden Landfill is located at the end of Stafford Street and was an unlicensed waste tip used by residents from the late 1960s. Council later became involved in managing the site and its subsequent closure in 1996/97. The closure works included the removal of car bodies and other bulk surface wastes; before capping the site, to provide an evenly contoured water-shedding surface.

Since closure, the landfill has suffered coastal erosion at its toe and ongoing differential settlement and subsidence at the head of the landfill. The landfill lies within a wider slip-failure mechanism extending further inland than the landfill itself.

Erosion of the landfill toe caused refuse to be released onto Hampden Beach and prompted Council to commission remedial works in 2009. Those works involved the removal of buried waste and the construction of a rock rip-rap structure between the toe of the landfill and the beach. An estimated volume of 5,090 m^3 was removed from an approximate 10-metre strip along the landfill toe. Excavated materials were disposed to the Palmerston Landfill and the excavation was reinstated with large rocks to provide erosion protection.

Differential settlement, slipping and subsidence issues continue to be monitored via (quarterly) surveys of the landfill surface. When required, reactive maintenance of the landfilled area is undertaken, including:

– repair of capping materials (to repair cracks caused by subsidence)
– maintenance of surface water diversions
– installation and maintenance of fencing and access controls

Although maintenance of capping and surface drainage has been undertaken with the intent of reducing surface water infiltration (and thus to reduce leachate generation); lower profiles of the landfill have been shown to extend beneath the groundwater table, which likely fluctuates seasonally and in response to tidal influence.

2.1.1 Hampden regulatory status

The closed Hampden Landfill is now monitored and managed under the Resource Consents listed in Table 2.1.

In combination, these permits allow ongoing passive contaminant discharges and prescribe maintenance and monitoring requirements associated with managing the closed landfill. Consent 2008.431 specifically contains trigger conditions that will prompt future rounds of waste excavation and landward rip-rap relocation, to facilitate ongoing managed retreat of the landfill mass.

Table 2.1 Resource Consents associated with the closed Hampden Landfill

Consent No.	Type	Purpose	Issued	Expires
2008.431	Coastal Permit	To disturb the foreshore within the coastal marine area to allow the placement, removal, alteration and maintenance of a structure for the purpose of allowing managed retreat of a rock protection structure	31 July 2009	30 July 2044
2008.432	Coastal Permit	To occupy the foreshore within the coastal marine area for the purpose of erecting coastal erosion protection	31 July 2009	30 July 2044
RM19.456.01	Discharge Permit	To discharge contaminants to air for the purpose of undertaking remedial and investigative works	1 October 2020	1 October 2027
RM19.456.02	Discharge Permit	To discharge landfill leachate and leachate contaminated stormwater into the ground in circumstances where it may enter water	1 October 2020	1 October 2027
RM19.456.03	Discharge Permit	To disturb a contaminated site for the purpose of undertaking remedial and investigative works	1 October 2020	1 October 2027

2.1.2 Hampden waste character and quantity

Tonkin and Taylor consultants were engaged to undertake a Ground Contamination Assessment in 2019, which included the following site investigation activities:

– 5 test-pits were advanced around the inferred perimeter of the landfill to confirm the extent of buried wastes
– 8 soil-bores were advanced through waste materials within the landfill footprint
– 4 monitoring wells were installed in 4 of the soil-bores, targeting the lower sections of the landfill, to assess groundwater elevations and the nature of leachate at the base of the landfill

The following observations were made:

– Capping or cover materials consist of sandy-silt soils of variable thickness (0.15 - 0.9 m) and include minor fractions of waste (gravel, plastic, glass, brick and wood)
– The thickness of the underlying waste is estimated to be 3 m deep on average, but ranges from 0.4 m (BH02, northwest fill area) to more than 5 m thickness (BH08, southwest fill area).
– The nature of the waste profile varies between locations, with actual waste representing only 5% to 30% of the overall profile. It was further observed that most waste (50-90%) occurs in relatively thin beds. This is typically an indication that inconsistent cover placement and operational practices have occurred.
– Natural soils encountered beneath the landfill mass were stiff to very-stiff orange to blue silts and clays.

Waste quantity

Previous estimates of the volume of waste received into Hampden Landfill have ranged up to 33,000 m^3 (Waugh, 2021). Those estimates may not account for waste removed in the 1997 closure or 2009 remedial works.

The 2019 Tonkin and Taylor delineation work provides an estimated waste volume of 21,000 m^3, based on:

– Approximate landfill footprint of 6,000 m^2
– Average waste profile depth of 3 m
– The inclusion of capping materials as waste (average thickness of 0.5 m)

Based on an assumed aged-waste density of 1.5 t/m^3, the mass of waste within Hampden Landfill may be estimated as 31,500 tonnes. Approximating the density of aged-waste within landfills is problematic (due to waste/soil matrix composition, variable consolidation, moisture content etc.). Appropriate levels of uncertainty or contingency must therefore be applied in using waste tonnage estimates.

Waste character

Twenty-six soil samples were collected during borehole drilling in the 2019 investigations.

– No asbestos was detected (22 samples analysed)
– No (organochlorine) pesticide residues were detected (17 samples analysed)
– Insignificant hydrocarbon compound concentrations were detected (19 samples analysed)
– Various metal concentrations were detected above background levels in all samples, including from the landfill cap, within waste materials and in natural ground profiles beneath the landfill
– Metal concentrations within waste materials were generally higher than in capping and natural soils.
– All soil analytical results met NES Soil Contaminant Standards (SCS)[1] for recreational land use, except for one lead result from within the waste profile (BH07)
– Detected total metal concentrations in all samples exceed screening criteria[2] for Class B landfills
– Lead and zinc concentrations were detected above screening criteria[2] for Class A landfills in most samples collected from within the waste profile
– Leachability analyses were not performed on soil samples. Inference on leachate impacts were instead evaluated through the sampling of groundwater from within the landfill.

[1] Ministry for the Environment. 2012. *Users' Guide: National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health.*

[2] Ministry for the Environment. 2004. *Module 2- Hazardous Waste Guidelines: Landfill Waste Acceptance Criteria and Landfill Classification*

Leachate (groundwater) character

Four groundwater samples were collected and analysed in the 2019 contamination assessment and were considered by Tonkin and Taylor to be representative of landfill leachate.

– Contaminant concentrations in all four groundwater/leachate samples were at least two orders of magnitude less than leachate screening criteria for Class B landfills
– Concentrations of ammonia (as nitrogen), some dissolved metals (copper, lead, nickel and zinc) and some organic compounds (PAH compounds) exceeded typically applicable guidelines for the protection of marine species[3] [4]. However, the coastal zone presents massive dilution and dispersion potential and in considering the comparatively low rate of leachate discharge to the coast, risks posed to the marine environment are considered negligible.
– As a result of the waste not being accessible to the public, low rates of leachate discharge and coastal dilution; leaving the waste in-situ does not constitute an environmental or human health risk in terms of contaminant concentrations. The risk is that a containment failure event occurs (such as from ongoing coastal erosion), causing waste to be exposed and released to the coastline, increasing the likelihood of direct exposure and creating visual amenity (pollution) issues.

Landfill gas

Landfill gas, including methane was detected during 2019 contamination assessment works. Due to the age and nature of the waste; and due to the degree of venting afforded by multiple cracks and openings in the landfill cap, little potential exists for significant landfill gas accumulation within the landfill. Despite this, any excavation into the landfill materials should incorporate appropriate atmosphere monitoring and safe-work controls.

Hampden Waste Conclusions

In 2019, Tonkin and Taylor concluded that the Hampden waste meets the definition of Category E (normal domestic) waste, under the Council Solid Waste By-Law (SWBL) and would therefore be acceptable at Palmerston Landfill. They also considered that the Hampden waste did not meet the definition of 'ecotoxic' and would therefore not be classified as either Category B (restricted) or Category C (controlled) waste. Tonkin and Taylor recommended that WDC consult with ORC to confirm that the material from Hampden Landfill would meet the Palmerston Landfill waste acceptance criteria.

Given the nature of the waste observed at Hampden, the 2019 conclusions supporting Category E waste classifications are considered valid and ORC have recently confirmed remaining Hampden wastes would meet the Palmerston waste acceptance criteria (December 2021). However, ORC also stated that "*contaminated soil would be considered special waste, so it would only be acceptable if the volume of contaminated soil and concentrations were such that the mixed soil met cleanfill criteria".* This means that the much of the soil in its current form will meet the requirement however some soil may require pre-treatment before meeting the cleanfill criteria required by ORC. A more comprehensive waste characterisation assessment would provide greater certainty in this regard – refer to Section 2.2.2.

It should be noted that this report refers to waste classification definitions provided in a now expired Solid Waste By-Law (SWBL) of the Waitaki District. However, this report assumes those waste classification definitions will prevail and remain relevant in the interim, and for the purposes of providing Palmerston Landfill waste acceptance judgements, as the same classification remain referenced in the Landfill Management Plan for the facility.

The acceptability of Hampden waste at Palmerston is discussed further in Section 5.2.1.

2.2 Beach Road Landfills

Two landfilled gullies exist beneath and within coastal cliff faces immediately east of Beach Road. It has been reported that unlicensed filling of these gullies occurred between the 1950s and 1970s.

[3] ANZECC & ARMCANZ (2000) Water Quality Guidelines
[4] Australian & New Zealand Guidelines for Fresh & Marine Water Quality (2018)

The northern landfill lies approximately 200 m north of the Awamoa Road intersection and extends from the cliff face, beneath Beach Road and into the lay-by area west of Beach Road. The southern landfill lies less than 50 m south of the Awamoa Road intersection and extends inland from the cliff-face to the edge of Beach Road.

The legacy landfills were inspected by ORC and partially remediated by Council in 2017 after complaints of rubbish washing out of the cliff onto the beach. Approximately 60 tonnes of waste were removed and disposed to Oamaru Landfill in October 2017, immediately prior to its closure in November 2017. The works only addressed waste materials that had fallen from higher fill areas onto lower sections of the cliff face and the beach. ORC completed a Preliminary Site Investigation (PSI) report on the sites in 2018, which were followed-up with Detailed Site Investigations (DSI) completed by WSP consultants in 2020/21.

The beach-cliffs are steep and rise up to 20 metres above the beach level. The cliffs comprise loess soil deposits over highly weathered sedimentary rock formations and the coastline is retreating at a rate that threatens the public road-reserve and private landholdings along the coast. Approximately 1.2 kilometres south of Awamoa Road, an approximate 1.7 kilometre stretch of Beach Road (between Gardiners Road and Thousand Acre Road) has been abandoned since 2009 and has already been lost to coastal recession.

In 2020, ORC undertook works to address coastal erosion at the base of the landfilled gullies. The works included the installation of a rock wall (coastal rock rip rap) and were completed in accordance with Coastal Permit Consent No RM11.079.01-02 & 03.

2.2.1 Beach Road regulatory status

Following formal identification of the landfills in 2017, both sites were added to the ORC Hazardous Activities and Industries List (HAIL) Register as verified HAIL sites, with a contamination status of ‘not investigated’. The landfilled Beach Road gullies are not administered or managed under any Resource Consent but are actively monitored and managed by Council under the Beach Road Closed Landfills Management Plan (Waugh, 2018).

2.2.2 Beach Road waste character and quantity

The following information is summarised and developed from previous PSI (ORC, 2018) and DSI (WSP, 2021a) reports, which included:

– The collection of 4 samples from each exposed waste face (8 samples in total) and the sampling of three pieces of potential asbestos containing material (ACM) during the PSI
– The DSI works included drilling 11 soil-bores in and around the inferred landfill footprints, including:
    - 6 soil-bores at the northern landfill, with two encountering landfill waste
    - 5 soil-bores at the southern landfill, with two encountering landfill waste

General observations from the site investigations included:

– That waste profiles exist to significant thicknesses in central gully alignments (greater than 8 m depth at BH07 drilled in the head of the southern landfill and potentially up to 15 m thick at the cliff-face)
– Types of waste encountered include glass, plastics, ceramic, fabric, metal, concrete, brick, ash and tar
– Positive identification of ACM has been reported in both the PSI and DSI.

Waste quantity

Delineation of buried wastes at both sites remains uncertain, with investigations likely hampered by cliff-edge access constraints and by Beach Road activity. The parabolic shape of the filled gullies is apparent and visible when viewing the landfill profiles in the cliff-face from beach level. But the orientation and shape of the filled gullies further inland has not been mapped accurately.

From the DSI results WSP estimated the following landfill waste volumes:

– Northern Landfill (Landfill 1) waste volume of 2,250 m^3, based on
    - landfill area of 677 m^2 and an average waste depth of 3.3 m
– Southern Landfill (Landfill 2) waste volume of 4,300 m^3, based on
    - landfill area of 722 m^2 and an average waste depth of 5.9 m

Based on our review of the available information and in considering whether appropriate waste-volume conservatism has been adopted, our opinion is that previously reported volumes may be low. GHD recommend the following be adopted in forward cost estimates and project viability assessments (conversions to tonnes based on an assumed aged-waste density of 1.5 t/m^3):

– Northern Landfill (Landfill 1) waste volume of 4,000 m^3, (6,000 tonnes) based on
  - Approximate dimensions of 25 m x 40 m, being 1,000 m^2 with an average waste depth of 4 m
– Southern Landfill (Landfill 2) waste volume of 4,000 m^3, (6,000 tonnes) based on
  - Approximate dimensions of 20 m x 40 m, being 800 m^2 with an average waste depth of 5 m

Waste character

Summary statements in the DSI and subsequent remediation options report (WSP, 2021b) as well as information provided in the PSI report, suggest that:

– Very low concentrations of hydrocarbon compounds and pesticide residues have been detected in very few of the samples collected from Beach Road landfills.
– Wastes buried within the Beach Road sites appear to carry higher contaminant concentrations than wastes sampled from the Hampden Landfill, with the northern landfill shown to contain greater metal concentrations than the southern landfill (based on analytical results of the PSI).
– Results of both investigation phases suggest a potential risk to human health from some components of the waste. Lead concentrations in three of eight samples from the PSI and seven of 64 samples in the DSI exceed recreational land use criteria (noting not all DSI samples were collected from within waste profiles).
– Multiple samples, collected from both landfill areas, exceed Class A landfill acceptance criteria for heavy metals including arsenic, cadmium, chromium, copper, lead, nickel and zinc.
– Of the seven samples submitted for leaching (TCLP) analysis, four returned lead and zinc concentrations in leachate extracts greater than Class A Landfill TCLP acceptance criteria. Three of these samples were collected from BH07 (southern landfill) with the fourth being from BH03 (northern landfill).

Beach Road waste conclusions

Compared to Hampden, Beach Road sites present notably higher contaminant concentrations in soil samples collected during previous investigations. Based on available waste characterisation data, this material would be classified as 'Category C – controlled waste' under the (now expired) SWBL as per the ORC descriptions around waste acceptance in December 2021. Further discussion with ORC and testing may be required to understand whether soil mixing or chemical pre-treatment is required for the waste to meet acceptance criteria (for Palmerston or any landfill). A more comprehensive waste characterisation assessment would provide greater certainty in this regard and would also provide an opportunity to perform bench-scale chemical stabilisation trials. In most instances, the acceptance of waste of this nature is typically at the discretion of the landfill operator, who can plan to specifically handle or blend more concentrated waste streams with cleaner materials during its placement.

2.3 Coastal Erosion

2.3.1 Coastal retreat in the Waitaki District

NIWA has recently updated mapping and modelling of coastal erosion in the Waitaki District as detailed in the following report:

National Institute of Water & Atmosphere Research (NIWA) 2019. *Waitaki District Coastal Hazards - Prepared for the Otago Regional Council.*

Current and predicted rates of shoreline retreat are reported as follows:

> *"The shoreline analysis of historical imagery shows that more than 60 % of the coast of Waitaki District is retreating at a rate of 0.15 m/y or more. The largest erosion rates of 2.0 m/y occur north of Hampden at the location of a large slump. North of Oamaru, the entire coastline is retreating at rates between 0.3 and 0.9 m/y. Small pockets of accretion have occurred at the north end of Beach Road (0.3 m/y accretion), north of All Day Bay (0.16 m/y accretion), and the Shag River mouth spit (0.9 m/y accretion)." … "Elsewhere, the*

southern portion of Beach Road is an erosion hotspot, eroding at an average rate of 0.38 m/y (Figure 3-22), while the shore along the southern portion of Katiki Beach, alongside SH1, is eroding at 0.4 – 0.6 m/y".

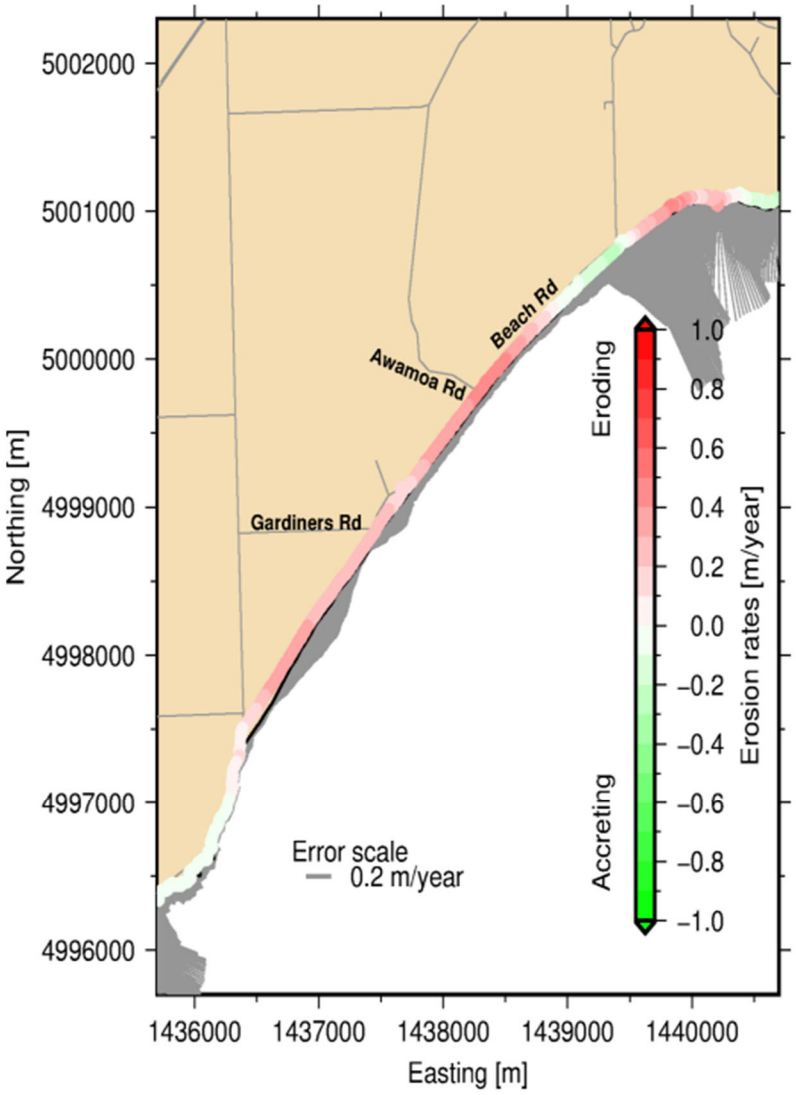


Figure 3-22: Calculated shoreline trends along Beach Road. Green and red shaded circles show the average erosion rate [m/year]. The grey lines show the standard error calculated for the erosion rate. High error may be due to lack of data or imprecise shoreline fixing.

The report also provides direct observations in relation to coastal protection sites:

> *"Small-scale coastal protection, such as short spans of riprap or concrete seawall, have not been taken into account in this analysis. This is mostly because these structures are often built with a shallow footing (e.g. ~1 m deep at Katiki), and therefore they will have a limited lifespan. Many dislodged blocks of riprap litter the shoreline of Katiki Beach, which is a sobering example of the inability of these structures to hold the shoreline along Beach Road" … "Moreover, repeated LiDAR surveys (2004 and 2016) show that even the heavy armouring used at Oamaru degraded and settled over the intervening 12 years" … "This experience warns that where structures may be chosen for protecting additional assets in the future, heavy, deeply-footed armouring and high maintenance would be required."*
>
> "*At Beach Road, a current hotspot for coastal erosion south of Oamaru, the CHZ95* [95th percentile of the predicted coastal hazard zone width] *is close to 200 m wide on the northern section and 40 m wide along the southern section. Despite recent accretion trends at the north end of the beach, the wide hazard zone there reflects the uncertainty of how the backshore dunes and cliffs respond in the short term. This section of the beach is also likely to erode in response to the acceleration of sea-level rise. The cliff section at the south end of Beach Road appears more stable but the extent of potential slumps is unclear. The slump*

that occurred in 2016 just north of the Coast Café was taken into account in the analysis but it is not clear whether other large slumps are likely on this stretch of coast."

Photograph 1: Typical cliff erosion between the two Beach Road landfill sites.

Erosion of the Beach Road sea-cliff is further shown in the November 2021 photograph above. The failure and collapse of loess profiles from upper sections of the sea-cliff are evident in the photograph, which also suggests that wave action is eroding weathered rock profiles at the base of the cliff. Conclusions from GHD site inspections in November 2021 and from our review of erosion modelling information in the 2019 NIWA report, are that it is not technically or financially feasible to protect the Beach Road waste deposits (or Beach Road itself) from coastal erosion within even medium-term (10 to 50 year) timeframes.

Rates of coastal retreat near the Beach Road landfills were modelled by NIWA to be between 0.3-0.5 m per year, suggesting the shoreline may be up to 25 m further inland within 50 years. The protection of this section of coast from natural rates of erosion will implicate enormously costly (and potentially futile) coastal protection works, as is demonstrated in the costs provided for Option B3-2 later in this report. That option is scaled from the cost of erosion protection works commissioned by the New Zealand Transport Authority to protect a similarly threatened section of State Highway 1 north of Katiki beach (specifically referenced by NIWA in the quotation above).

The coast near the Hampden Landfill appears more stable, with NIWA modelling suggesting rates of erosion in this area of 0.2 m per year. Despite the lesser predicted rates of erosion, the slip-failure mechanisms affecting the Hampden Landfill are likely exacerbating the exposure and protrusion of the landfill into the coastal zone. The insecurity of Hampden Landfill wastes is further evidenced by the requirement for remedial works in 2009 and by

the fact that Resource Consents for the closed landfill are already tailored to permit ongoing, incremental removal of the landfill.

2.3.2 Current design basis for coastal protections

Council's current erosion protection repair and maintenance strategy is calibrated to a notional design life of 50 years to secure Council assets along the 7 km stretch of Beach Road, between Cape Wanbrow and Kakanui, which includes the single lane, two-way road and a 150 mm water main (aligned inland of Beach Road). It is anticipated that sea level rise and current rates of coastal erosion will overcome maintenance efforts within the next 50 years, when managed asset abandonment will be required. An approximate 1.7 km stretch of Beach Road (between Gardiners Road and Thousand Acre Road) was abandoned in 2009 and has since been mostly eroded away by coastal recession.

It is understood Council presently allocates an annual budget of $80,000 for reactive maintenance works to maintain the cliff face and protect Council assets, noting that this budget is allocated for the full 7-km coastal stretch of Beach Road and not the two landfill sites alone.

The effects of sea-cliff erosion mechanisms were observed in site inspections by GHD in November 2021 and include wind and rain weathering of the near vertical loess material at the top of the cliff and to a lesser extent, wave and storm erosion of weathered rock profiles at beach level. (Refer Photograph 1 above.)

2.3.3 Performance of existing protections

Current Beach Road landfill protection measures were upgraded over the 2021 winter and as such their performance has not been tested beyond one winter. The additional rip rap rock constructed to the toe of the Hampden Landfill in 2009 was required because the original protection was disintegrating due to the horizontal movement of the toe towards the sea. The current slope stabilisation treatments are by no means robust long-term solutions but are rather relatively low-cost maintenance solutions. The potential 'lifetime' of the protection measures cannot easily be determined and will depend on several factors, including the frequency and magnitude of coastal storm events and the rate of continuing slip advancement (including potential acceleration of the slip failure where additional loading effects are introduced by capping repair works).

It is plausible that options to improve and maintain capping and rock protection of the landfilled wastes could eventually create isolated landfill "peninsulas" on an otherwise retreating cliff alignment. As erosion causes adjacent sections of cliff to recede, protection of the landfill sites will become increasingly costly and future waste removal, particularly from the Beach Road sites, will become more difficult if direct road access is lost.

The erosion rates documented in the NIWA 2019 report suggest current methodologies used to maintain the coastline and protect Council assets will not be adequate. Even if the methodologies were increased to designs used at SH1 at Katiki Beach, the NIWA report observes that these types of protection works are also failing.

2.4 Adopted *'50-year design-life Beach Road profile'*

At the Beach Road landfill sites, the sea cliff is estimated at 12 to 15 m high. It is assumed and proposed in this Study that remediation options adopt minimum site reinstatement standards that align with the current '50-year design life Beach Road profile', with construction methodologies similar to those used in recent repairs south of the landfill sites, as shown in Photographs 2 and 3 and as described below. The current slope stabilisation repair methodology is constructed as follows:

- Undercut a trench in the beach 1.0 m deep. Rock trench located away from the cliff toe to allow easing of upper slopes. Extending the rock trench either side of the site to form a groyne to build-up sand deposits around the rock.
- Install lower, embedded levels of rock (size 1.0 m) in the geofabric lined trench.
- Install outer layer rock (size 0.6 m).
- Ease existing slope to 1V:2H and backfill behind rock toe with local cliff material. Reshape and contour using slip shoulder material where available.
- Install weathering layer of ungraded overburden material sourced from local quarry to the slope.

– Construct a bund at the slope top edge to divert storm water run-off from entering the slope face.
– Natural re-vegetation is allowed to occur or planting of local species and grasses to the new slope (no topsoil placed).

There is an existing consent in place to carry out this repair solution on the beach. All works are within Council land; the boundary being many metres towards the sea from the cliff toe.

Photograph 2: Cliff-base stabilisation south of the Beach Road landfill sites (repairs installed in 2020, photographed here November 2021).

Photograph 3: Cliff-top slope stabilisation at a similar site at Orore Point on Waianakarua Road. Original rock riprap constructed 2017, up-slope material added 2018 and additional material from Aviemore Airdale Quarry in 2020.

2.5 Summary of remediation drivers

The drivers for remediating any of the legacy landfills stem from the long-term insecurity of the waste deposits, which lie within an increasingly erosion prone coastline. There are drivers in terms of environmental contamination, human health and visual and amenity issues which are discussed in the following sections.

2.5.1 Environmental risk drivers

Whilst low-level environmental risks are posed by the long-term discharge of leachate and leachate impacted groundwater, risks to coastal environments and marine ecological receptors are considered insignificant, due to the massive dispersive and contaminant-diluting capacity of the receiving coastline.

The release of contaminants via leachate pathways can be (and is being) reduced at all sites via:

– Repairs to capping materials to reduce infiltration rates
– Maintenance of water-shedding slopes, to promote runoff rather than ponding on landfill surfaces
– Maintenance of stormwater diversions, to divert runoff from upgradient areas away from the landfills

These best-practice actions may reduce overall leachate discharge rates, but in the case of Hampden Landfill will not prevent leachate discharge, due to the interaction of that landfill with groundwater through-flow.

2.5.2 Human-health risk drivers

Risks to human-health are primarily of a public-hazard nature, rather than toxicity-related risks.

Although Beach Road wastes are documented to contain lead concentrations greater than recreational land use guidelines, occurrences of direct exposure to the waste are expected to be brief and infrequent, due to the locations of the waste. Similarly, the occasional presence of ACM does not pose a considerable health risk, unless the materials are disturbed. In the case of Hampden Landfill, contaminant concentrations in capping and waste materials have been shown to comply with recreational land use guidelines.

Physical injury risks may be posed by the nature of some of the landfilled wastes (sharp and solid objects) and by uneven capping, cracks or voids caused by the continuing erosion and movement of the landfills.

Risks to human health are presently considered manageable via the continued implementation of capping layer repairs and via the maintenance of site access restrictions. The management of waste security, capping integrity and access controls will require increasing levels of investment, as coastal erosion continues.

2.5.3 Pollution control drivers

The key remediation driver for all three sites is the risk of recurring pollution events, which affect the visual and environmental amenity value of local beaches and near-shore environments during and immediately following coastal erosion events. Negative publicity and reputational damage may also result from major coastal pollution events, or from ongoing occurrences of minor pollution events.

The greater coastal protection measures installed at the toe of Hampden Landfill, in combination with the more gradual topography of the site appear to provide more waste security than at the Beach Road landfills. But the failure of capping and engineered containment controls at Hampden Landfill also stem from wider slip failures within and surrounding the landfill site, and not coastal erosion risks alone.

3. Remediation option development

The remedial options listed in Tables 3.1 and 3.2 have been developed under this Feasibility Study.

Table 3.1 Hampden Landfill – ongoing management or remediation options

H1	Status Quo	Reactive repairs and ongoing maintenance
H2	Do minimum	Additional capping improvements and erosion protection repairs
H3	Do more	Remove next 10m strip of landfill and relocate coastal protection measures inland (per current Resource Consent)
H4	Complete solution	Remove all legacy landfill material and reprofile site for managed coastal retreat

Table 3.2 Beach Road Landfills – ongoing management or remediation options

B1	Status Quo	Reactive repairs and ongoing maintenance
B2	Do minimum	Partial (minimum) remediation to allow improved and stabilised capping profile and improved coastal protection measures
B3-1	Do more	Remove all legacy landfill material and reinstate Beach Road to pre-1972 alignment (at northern landfill)
B3-2		Remove all legacy landfill material, reinstate current alignment of Beach Road and provide improved coastal protection along 2.4 kilometre stretch of erosion-prone road.
B4	Complete solution	Remove all legacy landfill material, abandon Beach Road and reprofile site for managed coastal retreat

Remediation options have been developed under a framework of four broad categories that represent an increasing degree of remediation achievement and certainty as follows:

– **Status-quo** – reflects the continuation of recent or current site management activities, that are largely reactive to pollution events or risks.
– **Do Minimum** – this may be the status quo, but otherwise involves some action informed by policies, minimum design standards or existing Resource Consents (where granted).
– **Do More** – options incorporate proactive remediation activities to facilitate partial or full waste removal and increased levels of coastal erosion protection.
– **Complete Solution** – removal of the entire waste mass from the coast to a permanent, secure, disposal location and to facilitate managed coastal retreat.

Generally, ‘site remediation’ must incorporate some level of ‘site reinstatement’, which in the case of these coastal sites must include consideration of coastal protection measures, where necessary.

3.1.1 Financial drivers

Financial drivers for remediation are associated with the ongoing liabilities of maintenance and management costs for all three landfill sites. Council is currently providing responsive action to coastal erosion events. This requires a budgetary allocation which is only likely to increase given the predicted rates and extents of coastal erosion at all sites.

At Beach Road there are associated costs in relation to maintaining the road itself. As coastal erosion continues, Council is required to continue to fund this risk management. Parts of Beach Road to the south of the site have already been abandoned. The abandonment of the northern portion of Beach Road requires consideration in conjunction with the remediation options, as the road structure itself will be disturbed if all of the Beach Road wastes are excavated. Financial considerations will need to consider whether the road is reinstated in its current location, reinstated further inland or abandoned.

Outline cost estimates are presented in Section 7.

3.2 Hampden Landfill remediation options

The continuum of site remediation options developed for Hampden Landfill are described in Table 3.3

Table 3.3 Development of Hampden Landfill remediation options

	H1 Status quo	H2 Do minimum	H3 Do more	H4 Complete solution
Pollution control	Reactive waste clean-up when storms or slips cause pollution			NA
Maintenance	– Vegetation clearance – Safety fencing – Surface-water diversions	Per H1 plus – capping improvements (repair cracks and perimeter slip) – erosion protection repairs (ensure 1V:3H rip-rap)		NA
Monitoring	Monitor landfill creep, erosion protection measures (toe) and rates of coastal retreat (per resource consents)		Recalibrate monitoring (following remediation work)	NA
Remediation	Waste remains in-situ. Plan and provide budget allocations for next 'managed retreat' event.		Remove next >10m strip of waste to activate 'managed retreat' earlier than consented 15-m buffer condition **(remove 3,000 – 5,000 m^3)**	Remove all legacy landfill material to consented landfill **(remove 21,000 m^3)**
Reinstatement	NA	NA	Relocate coastal protection measures landwards and re-cap remaining waste	Adapt site reinstatement objectives to match long-term coastal retreat by re-profiling resulting beach hollow/void

NA = Not Applicable

3.2.1 Hampden maintenance and monitoring

The status-quo (H1) and do minimum (H2) options involve continuing monitoring and maintenance activities for Hampden Landfill, which are dictated by the existing Closed Landfill Management Plan and Resource Consents for the site. These management tools permit the ongoing passive discharge of contaminants to air, land and water and allow for works in the coastal marine zone to facilitate the gradual managed retreat of the landfill.

Maintenance and monitoring requirements will require re-calibration in the case of partial waste removal (H3) but are assumed to be unnecessary in the case of full waste removal (H4). Although minor post-remediation monitoring may be required in the case where all wastes are removed, it is anticipated that monitoring and maintenance will revert to standard coastal retreat monitoring applied elsewhere throughout the District.

Key maintenance activities for H1, H2 and H3 include:

– Maintenance of signage and security fencing, to prevent public access and reduce hazards to the public
– Vegetation clearance, to maintain capping performance and to keep the site in a manageable state
– Monitoring the subsidence of the landfill, and the rate of coastal retreat, as required to inform decisions on the timing of further waste removal and landward relocation of coastal protection measures
– Monitoring the integrity (and minimum slope requirement of 1V:3H) of coastal protection measures at the toe of the landfill
– Repairs and maintenance to capping material and to upgradient stormwater diversions, to reduce surface water infiltration, slip-failure acceleration and scouring of the landfill itself.

Rates of landfill subsidence have increased in recent years such that quarterly subsidence monitoring has been altered to account for the loss of capping surface position markers, several of which have been lost completely due to landfill and capping movement.

Capping repairs have also recently been paused as the rate of subsidence and the degree of capping failure has been greater than anticipated. It is possible that the application of additional capping material will accelerate rates of subsidence; and in lieu of decision-making around partial or complete removal of the waste mass, the placement of additional capping material on the landfill has not been actioned.

3.2.2 Hampden waste extraction

The do more (H3) and complete solution (H4) options respectively involve partial and complete extraction of waste materials from the site.

Despite only delaying the inevitable requirement to relocate the entire landfill at some point in the future, the partial waste removal option (H3) has been aligned to the intent of managed retreat conditions detailed in Resource Consent 2008.431 and the previous 2009 works. Option H3 thus assumes a minimum landfill width of 10 m would be removed from the landfill toe and that rock protection rip-rap would be reconstructed at the resulting landward position. It is estimated such works would produce between 3,000 m^3 and 5,000 m^3 of waste for off-site disposal (4,500 – 7,500 tonnes). Hypothetically, extraction works similar to the scale of the 2009 works would need to occur four more times at intervals of between 10 and 15 years to achieve the removal of the entire 21,000 m^3 of waste.

The complete solution option (H4) involves the complete relocation of all landfill wastes and capping materials with an estimated combined volume of approximately 21,000 m^3 (31,500 tonnes).

These options represent significant civil-earthworks and transport logistics and would also involve a range of site management controls, including as a minimum:

– Waste-handling health and safety controls including monitoring and management of potential landfill gas
– Odour and dust management procedures, which may include restrictions on works during onshore wind conditions, limiting the size of open work areas and contingencies for providing temporary cover
– Procedures to account for risks of working platform instability, voids and collapse
– Procedures to account for working at or below groundwater levels, including a means of draining saturated wastes before they are loaded and mechanisms to contain and treat liquids, if required
– Unexpected finds protocols, to manage risks of discovering undocumented hazardous waste materials and ACM (which, depending on quantities, may prompt an asbestos management plan and protocols)
– Traffic management requirements and upgrades to Stafford Road will be necessary, in relation to:
    - preventing damage to the rail crossing on Stafford Road, and
    - Upgrading the intersection of Stafford Road and State Highway 1, to incorporate turning slip-lanes for heavy vehicles and to improve road safety in general, for the duration of the works

3.2.3 Hampden reinstatement requirements and options

Coastal reinstatement requirements do not apply in the status-quo (H1) and do minimum (H2) options as waste removal is not part of these options.

Coastal erosion protection works in the do-more option (H3 – partial waste removal) will be similar in scope to the 2009 remedial works, where rip-rap structures protecting the landfill toe are relocated landwards.

Under the complete solution (H4 – full waste removal), it is assumed that reinstatement works will be limited to re-profiling the resulting excavation void within the shallow coastal terrace above the Landfill, using only (uncontaminated) site-won materials. Importing cleanfill materials to reconstruct existing site profiles is considered futile, given the predicted rates of coastal erosion, which are estimated to be around 0.2 m/yr in the vicinity of Hampden Landfill (NIWA, 2019).

3.3 Beach Road remediation options

The continuum of site remediation options developed for the Beach Road landfills are described in Table 3.4.

Table 3.4 Development of Beach Road remediation options

	B1 Status quo	B2 Do minimum	B3-1 Do more	B3-2 Do more	B4 Complete solution
Pollution control	Reactive clean-up when storms cause coastal erosion and pollution		NA	NA	NA
Maintenance	– Repairs to cliff-base protection measures (under-sized rip-rap and geotextile) – Repairs to road-edge surface-water diversions	Do minimum to meet 50-year design-life i.e. 'Beach Road' model (per nearby sites): – Relax cliff-top batter slope and cohesive cap – Plant stabilising vegetation – Re-shape loess-exposures – Increase cliff-base rip-rap diameter and embedment – Install additional rip-rap at cliff-base		Appropriate long-term maintenance	NA
Monitoring	Monitor erosion protection, capping integrity and surface water diversions		Default long-term coastal erosion monitoring		
Remediation	NA	Partial remediation – Remove waste from cliff-top & cliff-face **(remove 2,500 m^3)**	Remove all legacy landfill material **(remove 8,000 m^3)**		
Reinstatement	NA	– Reinstate road (if damaged) on current alignment – Re-construct improved capping for remaining waste (50-yr design)	– Realign Beach Rd to pre-1972 alignment – Re-construct capping for remaining waste (50-yr design)	– Reinstate Beach Rd on current alignment – Install Beach Road protection (along 2.4 km south of golf-course corner)	– Finish gully surface to mitigate accelerated weathering – Abandon Beach Rd

3.3.1 Beach Road maintenance, monitoring and clean-up activities

Continuing monitoring and maintenance activities, as well as reactive beach clean-up works are required under options B1, B2 and B3 described in Table 3.4. Ongoing monitoring and maintenance requirements will largely be defined by the severity of storms and consequences of coastal erosion, but are otherwise defined in accordance with the Beach Road Closed Landfill Management Plan (Waugh 2018) and include:

– Maintenance of cliff-top capping and stabilisation systems (geotextiles and/or stabilising vegetation)
– Maintenance of surface water drainage, including roadside diversions, to prevent excess runoff entering fill materials and to reduce any potential for accelerated erosion or scouring of the cliff-structure
– Maintenance of existing (or improved) rip-rap defences at the cliff-base, particularly following high-risk tidal or storm events (or any combination of those events)
– Monitoring the rates of cliff face erosion and scheduling clean-up activities when wastes are dislodged to lower cliff or beach areas

3.3.2 Beach Road waste extraction

The do-minimum (B2), do-more (B3) and complete solution (B4) options respectively involve increasing degrees of waste extraction.

Option B2 involves the removal of waste materials from the cliff-top areas to the road edge, to allow implementation of the *'50-year design-life Beach Road profile'*, which will improve the integrity of capping and the security of waste materials at each of the Beach Road sites.

Options B3-1, B3-2 and B4 involve complete waste removal at both sites, involving the removal of an estimated combined waste volume of approximately 8,000 m^3 (12,000 tonnes).

As with remediation site controls described in relation to Hampden Landfill, waste extraction will involve significant earthworks and transport logistics and a range of associated site management controls, including:

– Waste-handling health and safety controls, including monitoring and management of potential landfill gas
– Odour and dust management procedures, which may include restrictions on works during onshore wind conditions, limiting the size of open work areas and contingencies for providing temporary cover
– Procedures to account for risks of cliff-top work locations, potential voids and collapse
– Unexpected finds protocols, to manage risks of discovering undocumented hazardous waste materials and ACM (which have been confirmed in relatively small quantities that would not yet warrant implementation of formal asbestos management plans or controls)
– Traffic management requirements, involving the temporary closure of Beach Road

Additional aspects of waste transport and disposal are described in Section 3.3 below.

3.3.3 Beach Road reinstatement requirements and options

No reinstatement of cliff-top capping or cliff-base erosion protection measures are envisaged under the status-quo (B1) option, where waste is not actively removed, and existing protections are only monitored and repaired.

Under the do-minimum (B2) and do-more (B3-1) options, the adopted *'50-year design-life Beach Road profile'* will be installed at each site. This reinstatement profile is pictured and described further in Section 2.4, but generally includes:

– Cutting back upper cliff-edge slopes, to gradients of less than 1V:2H (where possible)
– Placement and compaction of local quarry strippings, which contain a reasonable cohesive-soils fraction, to re-construct capping over the residual wastes remaining in-situ
– Planting of stabilising vegetation cover in the compacted capping material
– Importing more and larger sized rip-rap, for deeper embedment, placement and stacking at the cliff-base

Under option B2, remedial waste extraction and cliff-top reinstatement are only performed to the edge of Beach Road (but does not include the road itself – the road realignment is included under Option B3-1).

Under option B3-1, all wastes are removed and Beach Road is realigned inland to its pre-1972 alignment. The resulting set-back cliff face is still restored on the basis of the adopted *'50-year design-life Beach Road profile'*, as presently implemented elsewhere along the Beach Road coastline.

Reinstatement under B3-2 allows the retention of the current Beach Road alignment and incorporates the installation of NZTA (Katiki Beach) type protection measures along a 2.4 kilometre length of Beach Road.

The complete waste removal option (B4) assumes reinstatement works will be limited to re-profiling excavations within the beach-cliffs, using in-situ natural loess materials and any other (uncontaminated) site-won materials. Option B4 assumes full remediation of the northern gully (Landfill 1) will result in the abandonment of Beach Road north of Awamoa Road. The southern gully (Landfill 2) may require backfill materials to be imported to allow Beach Road to be maintained south of Awamoa Road.

4. Planning/regulatory framework

The options discussed in this report are subject to the following planning requirements:

– The Regional Plan: Waste for Otago (the Waste Plan);
– The Regional Plan: Coast for Otago (the Coast Plan);
– Waitaki District Plan (WDP); and
– National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NESCS).

A high-level planning assessment is provided below for each of the options in relation to Hampden and Beach Road landfills, looking at the primary resource consents required for the options, other minor auxiliary resource consents may be required once the preferred option is decided, and detail design undertaken.

In addition to the planning documents above, the following planning documents and associated regulations may also be required to be considered when developing the associated resource consent and associated assessment of environmental effects:

– National Policy Statement for Freshwater Management 2020;
– New Zealand Coastal Policy Statement 2010;
– Marine and Coastal Area (Takutai Moana) Act 2011; and
– Kai Tahu Ki Otago Natural Resource Management Plan 2005.

Planning issues associated with the Palmerston Landfill are discussed in Section 5.

4.1 Summary of resource consents

A summary of the resource consents required are detailed within Table 4.1 below, for an expanded discussion on the consent options please refer to Section 4.2 – 4.5 below.

Throughout this section we have referred to the likelihood of consents being required or obtained. A more definitive answer cannot be provided at this time as the consents require assessment by council who have discretionary powers over the granting of consents. In such cases we have provided GHD's opinion based on our experience, however the final outcome on granting consent will be solely down to the opinion of those assessing consent applications.

Table 4.1 Summary of Resource Consent Requirements

Site	Action	District Council Requirements	Regional Council Requirements
Hampden Landfill	Status-quo	N/A[5]	N/A – Managed under existing consent
	Do minimum	N/A[5]	N/A – Likely managed under existing consent
	Do more	N/A[5]	Rule 7.6.2 (Closed Landfills) – discretionary activity Resource Consents under the Coast Plan for Modified Coastal Protection under Rules 7.5.1.5, 8.5.19 and 9.5.3.6 - discretionary activity
	Complete Solution	N/A[5]	Rule 5.6.1 (Hazardous wastes at contaminated sites) – Discretionary Activity
	Status-quo	Rule 4.3.3.12 for any disturbance works within a Significant Coastal Landscape.	Rule 5.6.1 (Hazardous wastes at contaminated sites) – Discretionary Activity

[5] An NESCS consent maybe required in accordance with Section 43D of the RMA depending on how Council apply this section.

Site	Action	District Council Requirements	Regional Council Requirements
Beach Road Gullies		Rule 4.3.3.14 for the use of land for a closed landfill	
	Do minimum	Rule 4.3.3.12 for any disturbance works within a Significant Coastal Landscape Disturbance activities under NESCS Rule 4.3.3.14 for the use of land for a closed landfill	Rule 5.6.1 (Hazardous wastes at contaminated sites) – Discretionary Activity
	Do more	Rule 4.3.3.12 for any disturbance works within a Significant Coastal Landscape Disturbance activities under NESCS Rule 4.3.3.14 for the use of land for a closed landfill	Rule 5.6.1 (Hazardous wastes at contaminated sites) – Discretionary Activity Resource Consent for modified of coastal Protection under Rules 7.5.1.5, 8.5.19 and 9.5.3.6 of the Coast Plan - discretionary activity
	Complete Solution	Rule 4.3.3.12 for any disturbance works within a Significant Coastal Landscape Disturbance activities under NESCS	Rule 5.6.1 (Hazardous wastes at contaminated sites) – Discretionary Activity Resource Consent for modification of Coastal Protection under Rules 7.5.1.5, 8.5.19 and 9.5.3.6 of the Coast Plan - discretionary activity

4.2 Status-quo

4.2.1 Hampden Landfill

Regional Council

Hampden Landfill has existing resource consents from ORC for the management of a closed landfill which includes the authorisation to disturb land for remedial work (RM19.456.03) and to occupy and disturb the CMA for erosion protection (RC2008.432).

The status-quo discussed in Table 4.1 above may be continued to be manged under these existing resource consents, however, an updated Landfill Management Plan may need to be supplied to ORC to specify the pollution control monitoring and actions.

The three consents gained associated with the management of a closed landfill expires in 2027, during the renewal process it would be advised to have these future resource consents provide for greater flexibility in the management and retreat of the Hampden Landfill.

A replacement consent may be required if the activity expands beyond the effects that the original consent anticipated, this maybe the case for any increase in erosion protection placed along the coastline. In order to confirm whether or not a replacement consent is required a within scope determination should be sought from Council.

District Council

This site is designated under the District Plan as a Closed Landfill (I.D 73), and the works are considered to fall within the purpose of the designation.

However, a land use consent for the disturbance of a contaminated site may be required under the NESCS. Further consideration of interaction of the NESCS and the designation will need to be considered under Section 43D of the RMA. This will require dialogue with Council to confirm how they interpret and apply s43D.

4.2.2 Beach Road Gullies

Regional Council

The Beach Road site's pre-date 1991, they are not managed by the Landfill rules within the Waste Plan for Otago, instead they are considered a contaminated site and are managed under Rule 5.6.1 (Hazardous wastes at

contaminated sites) and a resource consent will be required as a discretionary activity for their ongoing management.

Any disturbance activities to remove any waste will also require resource consents under Rule 5.6.1, this is regardless of volume of waste removed, this could be built into the resource consent applications applied for the existing site.

The existing coastal protection has been completed in accordance with Coastal Permit Consent No RM11.079.01-02 & 03

District Council

The two Beach Road sites are located adjacent to the CMA on Beach Road; both sites are zoned as Rural General and are also located within a Significant Coastal Landscape overlay.

A land use consent is likely required under Rule 4.3.3.14[6] of the WDP for the use of land as a closed landfill. However, the use of land for the site may also be considered under existing use rights if it is shown that the disposal of waste at the site(s) was lawful pre-RMA. Further evaluation would be required to remove this requirement.

As the sites are located within the Significant Coastal Landscape overlay, a resource consent for any earthworks will be required under Rule 4.3.3.12 as a discretionary activity.

The volume of material removed will also need to be considered against the permitted activity standards[7] in the NES-CS, if they are exceeded a land use consent will also be required. However, this can be bundled into the earthworks application lodged under the WDP.

4.3 Do minimum

4.3.1 Hampden Landfill

Regional Council

The proposed activities are likely to be able to be managed within the site's existing resource consents for the management of a closed landfill. When these resource consents are renewed before 2027, greater flexibility in the long-term management and retreat of the closed landfill should be sought within the consent application.

An updated Landfill Management Plan should be supplied to ORC to specify the pollution control monitoring and actions and other minor changes detailed in Table 3.1 above.

A replacement consent will be required for coastal protection work if it differs from what the existing consent authorises.

District Council

This site is designated under the District Plan as a Closed Landfill (I.D 73). The proposed works fall within the purpose of the designation.

However, a land consent for the disturbance of a contaminated site will be required under NESCS as the volume of soil removed will exceed the permitted activity threshold. Further consideration of interaction of the NESCS and the designation will need to be considered under Section 43D of the RMA.

[6] Any Other Activity, which is not listed as a Permitted Activity, Controlled Activity, Discretionary Activity or Non-Complying Activity, and which complies with all of the Critical Zone Standards (Rule 4.5).

[7] Regulation 8(3) of the NES-CS

4.3.2 Beach Road Gullies

Regional Council

A resource consent will be required as a discretionary activity for their ongoing management and disturbance activities under Rule 5.6.1 of the Waste Plan.

District Council

As above, the sites will require a land use consent under Rule 4.3.3.14 of the WDP to remain as a closed landfill area unless existing use rights can be proven.

The proposed remediation work will require a land use consent for disturbance work under both the WDP and the NES-CS (bundled consent).

4.4 Do more

4.4.1 Hampden Landfill

Regional Council

While the landfill has an existing resource consent for the management of a closed landfill, the proposed remediation works are likely be considered out of scope of these consents, and a change of conditions or a new consent will be required under the Closed Landfill Rules. Discussions should be held with the regional council to confirm whether they would accept it a change of conditions or require a new consent.

The level of remediation that can be undertaken is defined within Condition 1 of the consents which references several site plans and related documents. As these reference documents will now be outdated, the consent will need to be changed to reflect the changes or replacements of these documents.

However, as these consents expire in 2027 an early renewal of the existing consent could be undertaken to better align the consents and associated management philosophy of the site.

The relocation of the coastal protection measures would also require a new resource consent requirement under the Coastal Plan.

District Council

This site is designated under the District Plan as a Closed Landfill (I.D 73), and the works will fall within the purpose of the designation.

However, a land consent for the disturbance of a contaminated site will be required under NESCS as the volume of soil removed will exceed the permitted activity threshold. Further consideration of interaction of the NESCS and the designation will need to be considered under Section 43D of the RMA. Consultation should be undertaken with Council to confirm how they apply this section of the RMA.

4.4.2 Beach Road Gullies

Regional Council

A resource consent will be required as a discretionary activity for their ongoing management and disturbance activities under Rule 5.6.1 of the Waste Plan.

District Council

As above, the sites will likely require a land use consent under Rule 4.3.3.14 of the WDP to remain as a closed landfill area.

The proposed remediation work will require a land use consent for disturbance work under both the WDP and the NES-CS (bundled consent).

4.5 Complete Solution

4.5.1 Hampden Landfill

Regional Council

The scale of works in our opinion falls outside of the existing resource consent and the remediation work (disturbance and discharges) will require new resource consent(s) under Rule 5.6.1 of the Waste Plan.

The resource consent could be structured to require post remediation validation and monitoring to confirm the site is no longer considered contaminated before the consents expire or are surrendered.

District Council

This site is designated under the District Plan as a Closed Landfill (I.D 73), and the works fall within the purpose of the designation.

However, a land consent for the disturbance of a contaminated site may be required under the works associated with the NESCS. Further consideration of interaction of the NESCS and the designation will need to be considered under Section 43D of the RMA. Consultation should be undertaken with Council to confirm how they apply this section of the RMA.

4.5.2 Beach Road Gullies

Regional Council

A resource consent will be required under Rule 5.6.1 of the Waste Plan, this consent application would include post remediation verification or reporting.

District Council

The proposed remediation work will require a land use consent for disturbance work under both the WDP and the NES-CS (bundled consent).

5. Palmerston Landfill development options

5.1 Existing operations and expansion opportunity

Landfilling operations at the Palmerston Landfill commenced around 1990 and are subject to three operational resource consents (discharge permits) that expire in 2027. The current consents were renewed in 2007 to replace original consents granted in 1996. The original consents (Consent 94309) included the provision to discharge an average of 4,000 m^3 per year of municipal and domestic solid waste to land.

Ministry for the Environment (MfE) landfill classification definitions (MfE, 2004) categorise the Palmerston Landfill as a Class B landfill facility, due to the absence of engineered lining and leachate and gas capture systems.

Based on more recent industry definitions (WasteMINZ, 2018) Palmerston Landfill might be considered a Class 3 (Managed Fill) landfill, to which predominantly clean fill and controlled fill may be received. However, an assumption of a Class 3 landfill definition is that fill materials do not contain putrescible or reactive materials that when deposited could result in the generation of leachate or landfill gas.

The Palmerston Landfill is unlined but is sited on a reasonably competent clay soil thickness. Original consent applications provided geotechnical information suggesting underlying clay soils at the site provided a minimum permeability of $4x10^{-9}$ m/s. On this basis the site was deemed suitable for landfill development.

Current site stormwater management involves the diversion of clean stormwater via open swale drains and pipe networks away from active landfill areas to discharge into the unnamed waterway that exits the northeast corner of the property. Leachate drains are installed within the toe of progressively constructed landfill cells and leachate is additionally intercepted by cut-off drains installed downgradient of historically filled areas. Leachate is discharged via a pipe network to the Leachate Evaporation Pond located in the eastern third of the site (Stage 2 Area, refer Figure 2, section 5.5.2). When insufficient evaporation occurs, the Leachate Evaporation Pond discharges to the same waterway that receives stormwater runoff from the site.

There is no landfill gas capture at the site and the site is unlikely to have been operated in an optimal fashion due to the low rates of waste receipt. Annual waste volumes are so low that disproportionally high volumes of daily and intermediate cover soils are likely to be co-disposed with wastes at Palmerston Landfill, with inadequate disruption of horizontal waste layering being a common outcome in this scenario. The site previously accepted waste from Oceana Gold (Macraes Gold Mine). However, this has ceased, and the current site throughput is less than 500 tonnes per annum.

The Palmerston Landfill Closure Plan states a portion of historical waste received was treated timber waste, but there are no details on quantity of waste. This was believed to be in the form of a boron contaminated woodchip stockpile. A “Preliminary Risk Assessment – Boron-Impacted Leachate” (August 2009), prepared by Golder Associates (NZ) Limited concluded that “leachate-impacted runoff from the Palmerston Landfill is not likely to be causing a negative impact on the overall health of the downstream receiving environment”. Monitoring of boron in streams was undertaken historically but ceased after eight consecutive rounds were below the threshold, allowing monitoring to be ceased.

Precedence exists for the relocation of Hampden Landfill wastes to Palmerston Landfill, as this was performed in 2009 during the previous round of remediation work. Waste materials previously recovered from the Beach Road landfills were also disposed to Oamaru Landfill in October 2017, immediately prior to the closure of Oamaru Landfill. Whether these precedents have any bearing on future remediation works is questionable, given that both remedial operations were undertaken as a form of pollution response and under regulatory approvals that may now be superseded. However, it is noted that Resource Consents for Palmerston Landfill specifically reference the potential receipt of wastes requiring relocation from Hampden Landfill.

An evaluation of the viability (regulatory, technical and costs) of upgrading Palmerston Landfill to allow it to commercially accept additional volumes and/or wider varieties of waste on an ongoing basis is introduced in Sections 5.3 to 5.5 below, and describes the potential development of Stage 3 of Palmerston Landfill to Class A landfill standard. It is envisaged that further development of Palmerston Landfill may generate revenues that could offset legacy landfill remediation costs over time.

5.2 Current waste acceptance requirements

The acceptance of wastes into Palmerston Landfill is subject to qualitative waste definitions described in Table 5.1 below as summarised from:

– Palmerston Landfill Management Plan (PLFMP) 2019
– Waitaki District Council Solid Waste Bylaw (SWBL) 2010

Table 5.1 Summary of Palmerston Landfill waste acceptance criteria (PLFMP conditions and SWBL definitions)

Accepted Wastes	Wastes Not Accepted
Ordinary non-hazardous waste, defined by the SWBL to include: **Category E – normal waste** such as normal domestic refuse including minor quantities of difficult waste (Category D) **Category F – inert waste** such as clean fill **Greenwaste** such as lawn clippings, hedge clippings, leaves and garden weed May provisionally accept difficult non-hazardous waste: **Category D – difficult waste** provided always that the acceptance of such waste is subject to prior approval and specific handling and management techniques are applied to the waste.	Hazardous wastes as defined by SWBL to include: **Category A – prohibited waste** includes explosives, flammable liquids, flammable solids, oxidising substances, substances which may spontaneously combust, radioactive substances and corrosives. Specified waste types include clinical wastes, various industrial wastes from biocide and pharmaceutical manufacture, refinery wastes, organic solvents. **Category B – restricted waste** includes any hazardous waste not listed as Category A or Category C. **Category C – controlled waste** includes poisonous, toxic or ecotoxic substances. Specified substances include a range of industrial waste, but also "waste collected from households". Wastes containing a wide range of metals (including lead, copper, zinc and arsenic) are also defined at Cat C waste. **Category D – difficult waste** includes dust, foam, sludge, fish, animal or other putrescible waste, liquids and any other waste which the Council may prescribe as difficult waste. Any other wastes which have a high leachate, odour or nuisance generating propensity, nor any waste that is problematic to handle or receive, including: – Putrescible waste (such as bulk kitchen scraps, decomposing greenwaste, silage or other farm processed waste) – Bulky and difficult to handle (such as greenwaste not able to be shredded)

In general, contaminant concentrations and the 'strength' of waste materials has been shown to be greater within Beach Road landfill sites than within Hampden Landfill. However, all sites contain aged wastes co-disposed within a soil matrix, that makes up more than 50% of the overall waste profiles. Some of the soils were likely introduced as temporary capping to reduce odour and pest impacts during filling. Despite the presence numerous non-waste bearing soil layers, the segregation of notionally cleaner soil materials from wastes is not considered practical.

5.2.1 Acceptability of Hampden Landfill waste

Tonkin and Taylor's DSI report on Hampden Landfill concluded that:

– The material observed in the landfill comprised a relatively small proportion of domestic type wastes within a predominant soil matrix
– the material can meet the definition of Category E (normal) waste as defined in the WDC SWBL and would therefore be acceptable at Palmerston Landfill
– Hampden Landfill wastes do not meet definitions of Category A (prohibited) or D (difficult) wastes, which are not accepted into Palmerston Landfill
– dissolved concentrations of copper and zinc detected in groundwater within the body of the landfill material (used as a proxy leachate assessment) exceeded guideline criteria for the protection of marine and freshwater species by less than an order of magnitude. Tonkin and Taylor considered more than a ten-fold dilution of leachate discharging from the Palmerston landfill would occur before it reached a receiving water body. On this basis they considered that the Hampden Landfill waste does not meet the definition of 'ecotoxic' and would therefore not be classified as either Category B (restricted) or Category C (controlled) waste.

Tonkin and Taylor also recommended that WDC consult with ORC to confirm Hampden Landfill wastes meet the Palmerston Landfill waste acceptance criteria.

Given the nature of the waste and the lower concentrations observed at Hampden, the 2019 Tonkin and Taylor conclusion supporting Category E is valid and ORC have recently confirmed the remaining Hampden Waste would meet the Palmerston waste acceptance criteria (December 2021). However, ORC also stated that "*contaminated soil would be considered special waste, so it would only be acceptable if the volume of contaminated soil and concentrations were such that the mixed soil met cleanfill criteria".* This means that the much of the soil in its current form will meet the requirement however some soil may require pre-treatment before meeting the cleanfill criteria required by ORC.

5.2.2 Acceptability of Beach Road waste

The DSI and Remedial Options Assessment (ROA) prepared by WSP for the Beach Road sites did not comment on the classification of Beach Road wastes under the WDC SWBL. They concluded based on limited soil and TCLP analytical results exceeding Class A landfill acceptance criteria, that wastes would be classed as Managed Fill, not Clean-Fill. WSP stated that pre-treatment of soil would likely be required before acceptance at an offsite facility. As part of their ROA they only considered transport and disposal to out of district landfills, with Palmerston Landfill precluded due to it being a Class B landfill.

Given the presence of metals at concentrations above NES SCS recreational guidelines, presently available waste classification data suggests waste from Beach Road would be classified as 'Category C – controlled waste' as per the definitions in Table 5.1. Further waste assessment work is needed to understand whether soil-mixing or chemical pre-treatment is required to dilute or chemically stabilise the materials to allow waste acceptance to Palmerston (or any) landfill. A more comprehensive waste characterisation assessment would provide greater certainty in this regard and would also provide an opportunity to perform bench-scale chemical stabilisation trials. In most instances, the acceptance of waste of this nature is at the discretion of the landfill operator, who can plan to specifically handle or blend more concentrated waste streams with cleaner materials during its placement.

Alternatively, or in combination with any waste material pre-treatment, it is considered viable to develop a specific landfill zone or cell within Palmerston Landfill that is designed and constructed to higher-containment standards, and which may be used to accept Category C (controlled) wastes, as typified by wastes that exceed Class B landfill waste acceptance criteria.

5.2.3 Remediation waste acceptability summary

In summary, site investigations and waste characterisation assessments performed at the legacy landfills to date support the following general conclusions:

– The disposal of Hampden Landfill wastes to Palmerston Landfill is considered technically viable and is aligned to existing Palmerston Landfill Resource Consent conditions and the foreseen requirements to incrementally transfer Hampden Landfill wastes to Palmerston Landfill over an extended timeframe. However, the complete relocation of all 29,000 m^3 of Hampden Landfill waste in one operation is still likely to prompt an application to ORC for a change of consent conditions (refer Section 5.4)

– Based on existing waste characterisation results for the Beach Road landfills, the direct transfer of these wastes to Palmerston Landfill is not technically viable nor permitted under current Resource Consents. Solutions to address this conclusion follow:

  - It is recommended that additional waste characterisation investigations are performed on Beach Road waste materials.
  - In conjunction with additional waste characterisation works, bench-scale trials of waste blending and chemical stabilisation should be undertaken. Waste blending may be trialled with clean soil or less impacted waste materials (as may be derived from Hampden Landfill). Chemical stabilisation may involve the addition of lime or cement stabilising agents, which can act to chemically immobilise problematic metal compounds within the waste matrix, making them less leachable once placed in a landfill environment. The trials should be designed to determine the technical viability of pre-treating

Beach Road wastes to allow their disposal to Palmerston Landfill and should inform the design of full-scale waste pre-treatment operations, to be specified within a Remediation Action Plan.

- If stabilisation of Beach Road wastes is shown to be an unviable treatment to meet Class B landfill acceptance criteria, or where alternative drivers for upgrading Palmerston Landfill are favoured (such as to permit the acceptance of different or greater quantities of regional waste), the development of a project-specific containment cell within Palmerston Landfill or the upgrade of an entire Stage of Palmerston Landfill to Class A landfill standards would be needed to allow the acceptance of Beach Road wastes into the facility.

The above waste characterisation conclusions have been used to inform the Palmerston Landfill development options described in Section 5.3 below.

5.3 Palmerston Landfill development options

Palmerston Landfill presents the most logical within-district disposal site for legacy coastal landfill wastes as it is owned by Council, is close to the legacy landfill sites and has sufficient capacity to receive the wastes.

Challenges in respect of transferring the legacy wastes to Palmerston Landfill are associated with its ability to provide sufficiently safe and secure storage of the waste in the long-term and associated re-engineering and permitting requirements to achieve such waste security and management.

The following Palmerston Landfill development options have been assessed in relation to enabling it to receive the legacy landfill wastes and to receive additional regional waste streams (option P4) of approximately 12,000 tonnes per annum (as directed by Council):

Table 5.2 Palmerston Landfill – operational development options

P1	Status Quo	Palmerston Landfill continues to be used for local waste only, remediation project material disposed to out-of-district landfill(s)
P2	Do minimum	Accept remediation material from Hampden only (implicating minimal Resource Consent adjustments)
P3	Do more	Accept remediation material from Hampden and Beach Rd (pre-treated waste)
P4	Complete solution	Upgrade Palmerston Landfill to allow acceptance of remediation material from Hampden and Beach Rd (untreated) and ongoing receipt of additional regional wastes for commercial benefit

The requirements of Palmerston Landfill development options and interactions with the overall legacy landfill remediation project are further described in Table 5.3.

Table 5.3 Requirements of Palmerston Landfill development options

	P1 **Status quo**	**P2** **Do minimum**	**P3** **Do more**	**P4** **Complete solution**
Option	Maintain current operations to serve local catchment < 500 tonne / year	Transfer Hampden waste to Palmerston	Transfer Hampden and Beach Road waste to Palmerston	Develop landfill for receipt of Hampden, Beach Road (untreated) and other commercial waste
Requirement definition	NA	Materials meet current Waste Acceptance Criteria	Pre-treat Beach Road waste to meet Waste Acceptance Criteria	Upgrade portion of landfill to Class A facility
Remediation project waste disposal	Forces Out-of-District disposal	Hampden Waste to Palmerston (21,000 m^3) Beach Road to Out-of-District (Class A) facility (8000 m^3)	All remediation project waste to Palmerston (29,000 m^3 plus Beach Rd pre-treatment bulking factor)	All remediation project waste to Palmerston (29,000 m^3)

	P1 Status quo	P2 Do minimum	P3 Do more	P4 Complete solution
Landfill Engineering Requirements	NA	Upgrade stormwater and leachate management controls for increased scale of operations		Development of Stage 3 as a Class A landfill

5.4 Regulatory requirements for disposal to Palmerston

5.4.1 Regional Council

The Palmerston Landfill Extension has several resource consents authorised by ORC for the operation of an active landfill, these resource consents expire in 2027.

The consent conditions generally limit the scale and scope of the landfill and content by the requirements to manage the site in accordance with the Landfill Development and Management Plan (LDMP).

Condition 7 of 2007.318-V1 also states that no special waste or hazardous waste (as defined by the Hazardous Substance and New Organism Act 1996) shall be accepted for disposal at the site.

As the resource consent conditions do not have a specific reference to volumes of waste that can be disposed, reference will need to be made to the original consent application and approved LDMP to confirm what can be accepted under the current authorisation.

If the proposed waste volume and/or classification extends beyond what is currently authorised, a new resource consent will be required to authorise the expanded activities.

The resource consent application would need to consider several matters including the appropriate management of the landfill, the capturing and treatment of leachate and the effects on the groundwater environment. The application will also need to address the ability of the site's discharge quality to meet the National Policy Statement for Freshwater Management (2020) environmental bottom lines.

If the volume and/or waste acceptance criteria changes are minimal, ORC may allow for a change of conditions to occur to allow for additional waste to be accepted.

As these consents expire in 2027, during the renewal of these applications the Council may wish to seek a change in the waste acceptance criteria authorised by the replacement consents, however, the process will still be required to address effects on the wider environment and the new environmental bottom lines at this point.

5.4.2 District Council

This site is designated under the District Plan as a Landfill (I.D 70), as the site is an active landfill its continued operation can be managed under this designation.

However, under the (now expired) SWBL, the Palmerston Landfill is limited in what types of material may be disposed to this facility. Several portions of the waste within all three landfills will be classified as prohibited under the (expired) SWBL.

For the Palmerston Landfill to accept this material, current references to the now expired SWBL will need to be updated and a new basis for re-establishing waste acceptance criteria for Palmerston Landfill will be needed.

5.4.3 Waste Disposal Levy and Emissions Trading Scheme

Waste Disposal Levy

The Waste Disposal Levy (WDL) was introduced under the Waste Minimisation Act 2008 and accumulates funds for the promotion and achievement of waste minimisation and to encourage more effective waste reduction, reuse, recycling and processing. For municipal solid waste the WDL was initially established at a rate of $10 per tonne in 2009 and increased to $20 per tonne in July 2021. The WDL is scheduled to increase annually to $60 per tonne on 1 July 2024. Half of the levy is re-directed to Territorial Authorities to fund waste minimisation initiatives; with the remainder contributed to the national Waste Minimisation Fund.

The applicability of the WDL to the transfer of insecure wastes from unlicensed legacy fill locations to more secure licensed disposal facilities is arguably counter-productive to the achievement of improved (legacy) waste management. Further consultation with the MfE is recommended to establish whether WDL costs may be waived for the transfer of Hampden and Beach Road wastes to Palmerston (or any) Landfill.

In lieu of any confirmed project-specific waiver from the MfE, the WDL is included in the cost estimates provided in Section 7, either as part of the landfill gate fee (for out-of-district landfills) or as a line-item cost of $20 per tonne for disposal to Palmerston Landfill.

Emissions Trading Scheme

Since 2013, landfill operators have been obliged to report methane emissions under the New Zealand Emissions Trading Scheme (ETS). Operators are considered responsible only for methane emitted through the biodegradation of organic waste in their facilities, where the waste disposed includes waste from a household.

Various exemptions exist in terms of the applicability of the ETS, including the following Clause 13B (inserted on 1 January 2022, by clause 4 of the Climate Change (General Exemptions) Amendment Order 2021 (LI 2021/292))

> ***13B Exemption for operating disposal facility disposing of waste from closed landfill***
>
> *(1) A person who carries out the activity of operating a disposal facility is exempt as a participant in respect of the part of the activity involving the disposal of waste that –*
> *(a) had previously been disposed of at a landfill that is now a closed landfill; and*
> *(b) is disposed of by the disposal facility on or after 1 January 2022.*
>
> *In this section, closed landfill means a landfill that is no longer accepting waste for disposal.*

Based on this exemption, ETS fees are excluded from the cost estimate for waste disposal to Palmerston Landfill. Cost estimates for disposal to out-of-district landfills are based on landfill gate fees observed on other recent and comparable remediation projects, without consideration or any confirmation of whether commercial landfill operators will discount their gate fees for the receipt of relocated closed landfill waste.

5.5 Technical requirements for disposal to Palmerston

Disposal of up to 29,000 m^3 of waste from the coastal landfill sites to Palmerston Landfill will require landfill development and operational adjustments.

5.5.1 Capacity

Landfill plans produced in 2021 (and reproduced in Figure 2 below) show progressive landfill development in three stages. The remaining capacity of each of the stages is detailed in Figure 2 and Table 5.4 below. It is assumed that reported capacities do not account for void-space loss associated with the construction of landfill lining elements or intermediate and final capping layers.

Even with such construction losses, Palmerston Landfill easily presents adequate capacity to receive the waste volumes associated with remediation of the coastal landfills. The remediation volume of 29,000 m^3 from Beach Road and Hampden represent between 10-14% of the currently modelled potential maximum capacity of Palmerston Landfill. The premise of Option P4 is that Palmerston landfill upgrades would allow the remaining void-space to be used for accepting other regionally derived wastes, subject to regulatory approvals and altered waste acceptance criteria achieved via landfill upgrades.

Table 5.4 Estimated remaining waste capacity of Palmerston Landfill

Landfill Stage	Waste capacity (m^3)	Comments
Stage 1	103,500	The active filling stage receives <500 tonne per year. Landfill operations progress within cells with a footprint of 1000 m^2 and generally to a depth/thickness of 2.5 m, providing individual cell volumes of 2,500 m^3.
Stage 2	52,500	Eastern area of landfill site, including the current leachate evaporation basin.

Landfill Stage	Waste capacity (m^3)	Comments
Stage 3	52,300 – 133,000	The lower capacity estimate assumes a volume of 35,300 m^3 of clay will be removed from the Stage 3 area for use as capping material during the progression of Landfill Stages 1 and 2. To optimise the capacity of Stage 3, it has been estimated that up to 116,000 m^3 of clay could be removed, increasing the overall capacity to a potential maximum of 133,000m^3
Total	**208,300 – 289,000**	

5.5.2 Engineering

As summarised in Section 5.2.3, although Hampden Landfill waste is interpreted to meet current (qualitative) Palmerston waste acceptance criteria, Beach Road wastes contain contaminant loads that exceed Class B (and some Class A) requirements, which will preclude their direct disposal to Palmerston Landfill. Options to address this include pre-treatment of the waste stream from Beach Road (via blending with cleaner waste soils or the application of chemical stabilisation agents) or alternatively the construction of a specific waste containment cell within the Palmerston Landfill.

Landfill upgrades to enable Options P2 and P3

Primary controls for leachate and stormwater management at Palmerston Landfill presently incorporate:

– Minimising the size of active filling areas
– Ensuring stormwater diversion away from open and active landfilling areas
– Collection of leachate liquids via sub-soil cut-off drains installed as toe drains at the base of placed waste materials for discharge to the leachate evaporation pond.

Landfill operations and stormwater and leachate management controls will require upgrades to receive the volumes of remediation waste involved under options P2 (21,000 m^3) or P3 (29,000 m^3). Significantly greater areas of active landfilling would be in operation and would at least temporarily produce greater stormwater and leachate quantities. Risks associated with over-flowing the current leachate evaporation pond are posed not just by the nature of leachate generated from imported waste, but by the potential flushing of leachate mixtures already detained within the pond.

Due to the age and highly degraded nature of the legacy waste, formal landfill gas control systems are unlikely to be needed. A modified capping system that adequately prevents infiltration, but provides passive venting is likely to provide an adequate gas control solution.

Cost estimates summarised in Section 7 assume a new landfill cell would be developed to receive legacy landfill materials. The new cell should incorporate improved leachate collection, with a leachate sump or chamber allowing leachate to be pumped to an above-ground leachate storage tank, from which leachate may be collected and disposed as trade-waste. It may be possible to connect or retrofit leachate collection from the current sub-soil leachate drainage system of Stage 1 of the Landfill. This would allow decommissioning of the Leachate Evaporation Pond or re-purposing it for the management and controlled discharge of stormwater only.

Due to the short-term duration of the legacy landfill remediation works (less than one year) neither option P2 or P3 include the installation of weighbridge facilities or any other ancillary operational infrastructure.

Landfill upgrades to enable Option P4

Option P4 assumes more significant development of Stage 3 of the Landfill to Class A landfill standards. Such improvements would allow the receipt of all legacy landfill remediation project wastes and the continuing receipt of regionally generated waste quantities, under a commercial landfill operational framework. Until demonstrated otherwise via additional waste characterisation studies (see Section 5.2.3) or otherwise allowed under regulatory approvals, it has been assumed Class A landfill improvements would still require that Beach Road wastes are pre-treated prior to acceptance into the Landfill.

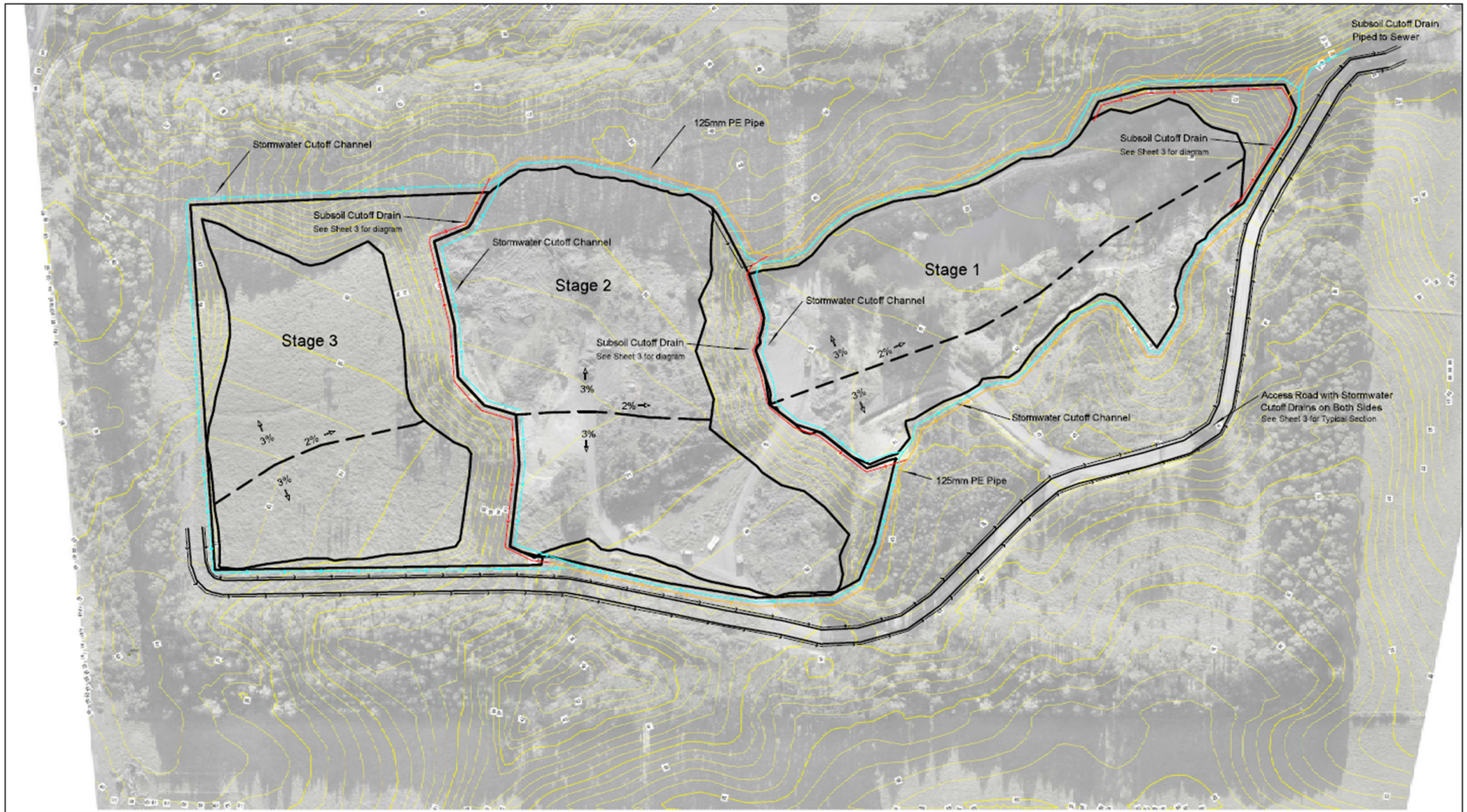
Cost estimates summarised in Section 7 assume the following landfill improvements under option P4:

1. Site entrance and access upgrades, including the completion of the planned and partly constructed perimeter access road
2. Upgrade of site amenities and service connections, including administration buildings, machinery storage/workshop, weighbridge, kiosk, load inspection platform, wheel-wash and potential power, water and sewer connection upgrades
3. The construction of Class A Landfill cell(s) in the Stage 3 area of the Landfill, involving excavation to stockpile of approximately 100,000 m3 of clay soils, sub-grade preparation and under-drainage installation, construction of 'Class 1 Type 1' landfill liner system (including 600 mm compacted clay, Flexible Membrane Liner and protection geotextiles) and leachate drainage layers to collect leachate to a pumped-to-tank system
4. Above-ground leachate management infrastructure (similar to that proposed for Option P2 and P3 and) including larger above-ground storage tank to serve the larger Stage 3 area and to receive existing flows from Stage 1 sub-soil leachate drainage system
5. Stormwater management system (similar to that proposed for Option P2 and P3 and) involving the conversion of existing leachate evaporation pond for stormwater diversion and management and the upgrade of all drains, diversions, grates, manholes, pipes and swales.
6. Provisional landfill gas (LFG) management system, incorporating gas collection systems and flare only (i.e. no allowance for co-generation).

   A provisional sum of $1,000,000 has been assigned for an LFG management system in P4 cost estimates. However, it must be noted that Hampden and Beach Rd wastes are relatively gas-inert and LFG capture is not required under the National Environmental Standard for Air Quality for landfills with a capacity of less than 1-million tonnes. This item is only included to address any potential requirements for active LFG management, as may be required to offset ETS liabilities for the ongoing receipt of 12,000 tonnes per annum of MSW or putrescible wastes, or to address potential resource consent requirements or environmental concerns generally.
7. Class A landfill final cover system, including intermediate cover, sub-grade preparation, compacted clay capping layer, drainage layer and topsoil.

Costs for project management, Resource Consent applications (and Assessment of Environmental Effects and supporting studies), detailed design, construction management and contractors preliminary and general costs have also been estimated within option P4 cost estimates, as presented in summary cost estimates in Section 7 and detailed cost breakdowns in appended Table A-2.

Figure 2 – Palmerston Landfill Closure Model Design



Stage	Waste Volme m³	Clay Cap Volume m³ (0.6m depth)	Cap Area m²	Subsoil Drail Length m 150mm HDPE	Collector Pipe m 125mm PE (to base of site)
Stage 1	103,500	10,600	17,870	145	33
Stage 2	52,500	13,500	22,530	139	544
Stage 3	52,300**	11,200	11,200	206	332
Total	208,300	35,300	51,600	490	909

**The volume of waste that can fit between the existing surface and stage 3 cap is 17,000m³. If 35,300m³ of clay is excivated from the stage 3 area for capping, then the volume of waste that can fit into stage 3 is 52,300m³. The maximum amount of clay that could be removed from the stage 3 area is 116,000m³. This would result in enough space for 133,000m³ of waste in stage 3.

Contours and heights on this plan are in terms of New Zealand Vertical Datum 2016

File Ref:

Prepared For: Waitaki District Council — Growing strong communities.

No.	Amendments	Drawn	Date

Palmerston Landfill

Closure Model Design Options

Project No.:	Surveyed: JR
Scale: 1:1500	Designed: JR
Date: 22/06/21	Drawn: JR
Sheet: 002	Checked: JR

Overview Surveying

Reproduction provided by Waitaki DC, credit to Overview Surveying

6. Initial regulatory consultation

Preliminary consideration of supplementary government funding avenues for remediation have been initiated in developing this Feasibility Study, as follows. These cost discounting opportunities have a potential bearing on forward project cost modelling.

6.1 Ministry for Environment – Contaminated Sites Remediation Fund

Discussion with MfE on Tuesday 23 November 2021 indicated the project would be unlikely to receive funding through the Contaminated Sites Remediation Fund (CSRF) and that this would be considered as a climate change project. MfE stated that an application could be made to the fund, but it would rank lower than other sites already on the CSRF Priority List. In addition, it was stated that if MfE funded landfill projects such as this, the CSRF would be quickly exhausted. Our conclusion from the meeting was that an application to the CSRF was unlikely to be successful.

MfE indicated that there are other government programmes in progress concerning waste management and relic/closed landfills, however the benefits and outcomes of these may be 12 months away.

6.2 Otago Regional Council

MfE pointed to a recent study by Environment Canterbury designed to assess, and risk-rank historical landfill sites. During a meeting on 30 November 2021, ORC confirmed that they recognised the coastal landfill issue and that this was the first project of this nature on which they had been approached.

In addition to the above, advice was also sought from ORC on several topics including:

- Consent questions in relation to what works if any can be undertaken before consent is required
- What planning rules are relevant to the proposed project
- Who ORC would consider as potentially affected parties for consultation purposes
- What level of assessment is required in relation to the National Policy Statement for Freshwater
- Confirmation of expectations around the content of Remedial Action Plan(s)
- Whether the waste from either or both sites can be accepted under the existing Palmerston consent
- Whether there are any funding opportunities at a Regional Level that WDC can apply for

The responses received from ORC have been discussed previously in this report with the exception of regional funding opportunities. ORC responded on 15 December 2021 that support was available for processing fees related to a consent however this is for community and catchment groups so WDC were unlikely to be eligible. No other avenues of funding support were suggested by ORC.

7. Preliminary cost estimates

7.1 Legacy coastal landfill remediation

A summary of estimated costs for each of the options for Hampden Landfill and Beach Road is provided in Table 7.2 (at the end of Section 7.1). A more detailed price breakdown for each of the options is provided in the appended Table A-1, which provides the schedule of quantities and prices used to develop the cost estimates. In reviewing the cost estimates, the following points (and assumptions) should be noted:

General

1. Cost estimates for each of the options are provided independently of each other (nine individually priced options), such that costs for the application of different management approaches for Hampden Landfill and the Beach Road gullies can be combined to provide an overall project price.
2. For each of the options involving active waste removal, costs are provided for the disposal of wastes to Palmerston, AB Lime and Kate Valley landfills, such that three remediation project costs are provided for each remediation options. This allows consideration of scenarios where Hampden Landfill wastes are disposed within-district to Palmerston Landfill and Beach Road wastes are disposed to an out-of-district landfill.
3. Cost estimates for Beach Road options assume the same level of treatment and remediation works are applied to each of the infilled gullies. Costs for the application of different approaches at the northern and southern gullies are not provided separately in this report and would require further re-estimation.

Significance of waste transport and landfill gate fees

4. Landfill gate fees and waste transport costs contribute the most significant remediation project costs, representing between 74% and 94% of the overall cost estimate for options involving active waste removal and excluding consideration of option B3-2 which incorporates high reinstatement costs.
5. It is unlikely that legacy wastes will be accepted into Redruth Landfill or Green Island Landfill, with both facilities nearing closure and with respective owners (Timaru District Council and Dunedin City Council) seeking to preserve remaining landfill capacity for local waste catchment requirements. Cost estimates for waste disposal to out-of-district landfills are therefore limited to AB Lime Landfill in Southland and Kate Valley Landfill in Canterbury.

Waste transport

6. Transport distances to out-of-district landfills are tabulated in comparison to Palmerston Landfill below in Table 7.1, which summarises return-trip distances and total predicted cartage kilometres, based on:
    - The use of truck-and-trailer units, with an average load weight of 24-tonnes.
    - waste tonnage estimates from each legacy landfill, as described in Sections 2.1.2 and 2.2.2.

Table 7.1 Summary waste transport distances

Receiving Landfill		**Hampden Landfill 21,000 m³ / 31,500 tonnes 1312 loads**		**Beach Road North 4,000 m³ / 6,000 tonnes 250 loads**		**Beach Road South 4,000 m³ / 6,000 tonnes 250 loads**	
Landfill	Landfill Class	Round trip (km)	Total kilometres	Round trip (km)	Total kilometres	Round trip (km)	Total kilometres
Palmerston	Class B	50	65,625	110	27,500	110	27,500
AB Lime, Winton	Class A	554	727,125	616	154,000	616	154,000
Kate Valley, Hurunui	Class A	680	892,500	620	155,000	620	155,000

7. Unit rates for waste transport have been estimated based on recent comparable project experience held by GHD and Morrison Low, with assumed cartage unit rates being:
    - $ 1.00 per tonne per kilometre for disposal to Palmerston Landfill
    - $ 0.40 per tonne per kilometre for disposal to AB Lime and Kate Valley landfills

    The lower unit rate for longer cartage distances is associated with the cost efficiencies of longer cartage runs.

Landfill Gate Fees

8. Landfill gate fees for out-of-district landfills are similarly based on industry knowledge and recent project experience of GHD and Morrison Low. Assumed landfill gate costs incorporated into the cost estimates are:
    - $ 156 per tonne for AB Lime, Winton
    - $ 250 per tonne for Kate Valley, Hurunui
9. The applicability of Palmerston Landfill gate fees is effectively an internal cost to Council but is nominally set to $ 100 per tonne for the purposes of comparing waste disposal costs and in acknowledging that operational costs of receiving legacy wastes should be transparently borne by the remediation project. As discussed in Section 5.4.3 the current (2021/22) WDL of $ 20 per tonne has been applied in addition to the $ 100 per tonne gate fee, but exemption from ETS costs has been assumed. The overall comparative Palmerston Landfill gate fee is thus $ 120 per tonne.
10. As further noted in Section 5.4.3 it is assumed that WDL and ETS costs are inherently charged within gate fees of out-of-district landfills.

Treatment of operational and capital expenditure

11. Cost estimates were initially developed to assess only the capital expenditure (CAPEX) of active remediation and site reinstatement works. However, this approach disguised comparisons to options involving only ongoing in-situ waste management, described by status-quo (H1/B1) and do minimum (H2) options. In these options costs are primarily for continuing monitoring, maintenance and operational expenditure (OPEX).
12. OPEX cost estimates have been forecasted and summed for a 10-year operational period, based on current (2021/22) Council budgets for ongoing monitoring and maintenance of coastal landfills, as follows:
    - Annual monitoring and inspection work for Hampden Landfill (for 10 years under options H1, H2 and H3; and two years under H4) are based on the 2021/22 Council budget of $20,000 for this item, escalating by 5% per year.
    - Costs for in-situ maintenance of Hampden Landfill (under H2 and H3) are based on an estimated 5-yearly recurrence of major capping repairs, assumed to include capping and rip-rap repairs (2021/22 budget being $300,000 for this item) and the maintenance of drainage, access, fencing, signage and vegetation clearance in intervening years (being $10,000 per annum).
    - Annual monitoring budgets for Beach Road are based on 2021/22 budgets of $10,000 per annum, escalating by 5% per year and forecasted for a 10-year period under options B1/B2; and only for a period of two years under options B3-1, B3-2 and B4, which involve the complete removal of all legacy wastes.
    - Status-quo (B1) maintenance costs are based on half of the current $80,000 annual budget allocated for maintaining protection measures for the fuller Beach Road asset (i.e. $40,000) escalating by 10% per annum to reflect the predicted increasing threat and cost of coastal erosion events.
    - Maintenance costs for improved cliff-top capping and cliff-base rip-rap (under options B2 and B3-1) are assumed to cost $80,000 per annum, increasing by 10% per year.
    - Costs for operational maintenance of protection measures for the 2.4 km stretch of Beach Road (installed under option B3-2) are assumed to cost $100,000 per year, increasing by 10% per annum to account for increasing rates of coastal erosion.

Coastal protection for Beach Road (Option B3-2)

13. Costs for improved coastal protection along the 2.4 km stretch of Beach Road between North Otago Golf Course and Awamoa Creek have been estimated based on the cost of repairs undertaken by NZTA to coastal cliffs at 10 sites near Katiki Beach to protect State Highway 1. Those protections involved the installation of geogrid and geofabric reinforced rip-rap along (approximately) 540m of the coast. Information provided by

NZTA stated that costs for the Katiki erosion protection measures project were in the order of $3,000-$6,000 per metre with an average of $4,000 per metre. The $4,000 per metre average has been used as the “Coastal Protection Unit Rate” within Option B3-2.

Table 7.2 Summarised cost estimates for continued in-situ management or active remediation of legacy coastal landfills

LEGACY COASTAL LANDFILL	HAMPDEN LANDFILL				BEACH ROAD LANDFILLS				
MANAGEMENT OR REMEDIATION OPTION	H1	H2	H3	H4	B1	B2	B3-1	B3-2	B4
	Status Quo	Do minimum	Do more	Complete solution	Status Quo	Do minimum	Do more		Complete solution
Summary description	Reactive repairs and ongoing maintenance	Additional capping improvements and erosion protection repairs	Remove next 10m strip of landfill and relocate coastal protection measures inland (per current Resource Consent)	Remove all legacy landfill material and reprofile site for managed coastal retreat	Reactive repairs and ongoing maintenance	Partial (minimum) remediation to allow improved and stabilised capping profile and improved coastal protection measures	Remove all legacy landfill material and reinstate Beach Road to pre-1972 alignment (northern landfill)	Remove all legacy landfill material, reinstate current alignment of Beach Road & provide improved coastal protection for 2.4 km of erosion-prone road.	Remove all legacy landfill material, abandon Beach Road and reprofile site for managed coastal retreat
ONGOING MONITORING & MAINTENANCE (10 yrs OPEX)	**$ 252,000**	**$ 1,112,000**	**$ 932,000**	**$ 41,000**	**$ 763,000**	**$ 1,401,000**	**$ 1,295,000**	**$ 1,614,000**	**$ 21,000**
MONITORING (2022-2031)	251,558	251,558	251,558	41,000	125,779	125,779	20,500	20,500	20,500
MAINTENANCE (2022-2031)	-	860,000	680,000	-	637,497	1,274,994	1,274,994	1,593,742	-
REMEDIATION WORKS (CAPEX - excl. cartage & disposal)	**$ -**	**$ -**	**$ 458,000**	**$ 1,125,000**	**$ -**	**$ 382,000**	**$ 1,014,000**	**$ 10,989,000**	**$ 456,000**
DESIGN, CONSENTS, APPROVALS & MANAGEMENT	-	-	178,000	339,000	-	135,000	305,000	270,000	174,000
PRELIMINARY & GENERAL	-	-	71,350	244,500	-	25,675	116,525	-	79,150
Assumed Works Duration (weeks)			*8*	*16*		*4*	*12*	*26*	*8*
SITE PREPARATION & MAINTENANCE	-	-	12,150	17,400	-	8,640	17,750	-	19,250
EXTRACTION, PRE-TREATMENT & LOADING OF WASTE	-	-	66,250	277,750	-	136,938	431,000	431,000	431,000
EARTHWORKS, COASTAL PROTECTION AND CAPPING	-	-	87,480	145,980	-	50,810	108,160	10,252,960	62,560
SITE REHABILITATION	-	-	40,300	88,500	-	20,650	20,650	20,650	10,450
ROAD REPAIRS	-	-	2,300	11,500	-	4,330	14,880	14,880	-
CARTAGE & DISPOSAL OF WASTE									
Palmerston	-	-	1,275,000	5,355,000	-	862,500	2,898,000	2,898,000	2,898,000
AB Lime - Winton	-	-	2,832,000	11,894,400	-	1,509,000	4,828,800	4,828,800	4,828,800
Kate Valley - Hurunui	-	-	3,915,000	16,443,000	-	1,867,500	5,976,000	5,976,000	5,976,000
REMEDIATION WORKS (CAPEX - incl. cartage & disposal)									
REMEDIATION PROJECT TOTAL - PALMERSTON	$ -	$ -	$ 1,733,000	$ 6,480,000	$ -	$ 1,245,000	$ 3,912,000	$ 13,887,000	$ 3,712,000
REMEDIATION PROJECT TOTAL - AB LIME	$ -	$ -	$ 3,290,000	$ 13,019,000	$ -	$ 1,891,000	$ 5,843,000	$ 15,818,000	$ 5,643,000
REMEDIATION PROJECT TOTAL - KATE VALLEY	$ -	$ -	$ 4,373,000	$ 17,568,000	$ -	$ 2,250,000	$ 6,990,000	$ 16,965,000	$ 6,790,000
TOTAL OPTION COST (CAPEX & 10-yr OPEX)									
TOTAL OPTIONS COST – PALMERSTON [1]			$ 2,665,000	$ 6,521,000		$ 2,646,000	$ 5,207,000	$ 15,501,000	$ 3,733,000
TOTAL OPTION COST - AB LIME	$ 252,000	$ 1,112,000	$ 4,222,000	$ 13,060,000	$ 763,000	$ 3,292,000	$ 7,138,000	$ 17,432,000	$ 5,664,000
TOTAL OPTION COST - KATE VALLEY			$ 5,305,000	$ 17,609,000		$ 3,651,000	$ 8,285,000	$ 18,579,000	$ 6,811,000

Total option costs for waste disposal to Palmerston Landfill do not include Palmerston Landfill development costs, which are summarised separately in Table 7.3.

7.2 Palmerston Landfill development

Summary cost estimates for Palmerston Landfill development options are provided in Table 7.3. A more detailed price schedule for each of the options is provided in the appended Table A-2. The following points and assumptions should be noted in relation to the Palmerston Landfill development option cost estimates:

General

1. The Palmerston Landfill development options variously align with and enable several of the legacy landfill remediation options, as noted in the header rows of Table 7.3. Remediation approaches for Hampden Landfill and the Beach Road gullies that involve the disposal of waste to Palmerston Landfill must therefore also consider the associated cost of the relevant Palmerston Landfill upgrade option. The combined costs of legacy landfill remediation works and the relevant Palmerston Landfill upgrades may be considered to represent an overall remediation project cost estimate.
2. Palmerston Landfill development options are based on existing landfill designs, provided by WDC and developed by Overview Surveying. The development options and cost estimates presented herein, relate only to upgrades to infrastructure and construction standards needed to provide a remediation project-specific containment cell (P2 and P3); or to construct all of Landfill Stage 3 to Class A Landfill standards (P4). A summary description of items and methods considered and priced under each of the options is provided in Section 0 and in the itemised breakdown provided in Table A-2. The landfill development options do not represent any updates or optimisation of the proposed final landfill geometry or landform.

Treatment of operational and capital expenditure

3. Consistent with the cost estimate breakdown for legacy landfill remediation works, the cost estimates for Palmerston Landfill development summarised in Table 7.3 distinguish between CAPEX (capital expenditure associated with landfill upgrade works) and OPEX (ongoing operational, monitoring and reporting costs).
4. OPEX estimates are based on proportional adjustment of current annual operational budgets, as provided by Council (operation and maintenance budget of $85,000/yr; consents and monitoring budget of $14,000/yr). OPEX estimates are provided in an annual format only and are not forecasted over any time-period or subject to any cost escalation under the Feasibility Study. Forward cost modelling will be provided by Net Present Value calculation within the companion Outline Business Case Report to this Feasibility Study Report.
5. Additional (extra-over) OPEX and aftercare costs have been forecasted for the year in which legacy landfill remediation works are undertaken. These costs are scaled approximately in relation to waste the predicted waste volumes to be received and in relation to landfill development complexity.
6. In estimating CAPEX for landfill improvements, the following rates and assumptions have been applied, which are based on GHD's experience in delivering landfill designs and in managing regulatory approval processes for new landfills and/or for significant modifications of existing landfills:
    - Under option P4 only, planning and pre-development tasks are assumed to include stakeholder consultation, survey and preliminary design, detailed studies (geotechnical, hydrogeological, ecological noise, traffic, visual impact assessments), Assessment of Environmental Effects and the Resource Consent application process
    - Project management, engineering and construction management items are estimated in proportion to the cost of the civil construction (development) costs under each of the landfill development options P2, P3 and P4, as follows:
        – Project management 3%
        – Detailed design and documentation 8%
        – Construction management 5%
        – Construction contractor Preliminary and General costs 15%

Stage 3 landfill design and capacity assumptions

7. GHD's interpretation and assumptions applied to estimating the capacity and potential operational life of the current Stage 3 area (if developed to Class A landfill standards per Option P4) follow:

- Stage 3 of the Palmerston Landfill will include the progressive construction of sub-cells within the approximate Stage 3 plan dimensions of 100 m x 160 m, being 16,000 m^2
- Current Stage 3 design void-space is 133,000 m^3 (from Overview Surveying Drawing - Sheet 02, reproduced in Figure 2 above)
- Corresponding average landfill depth/thickness over 1.6 ha Stage 3 area is thus 8.3 m
- Net void-space (available for waste deposition) assumed as 119,700 m^3, based on 10% void-space loss for landfill element construction (such as lining, drainage, cover and capping)
- Net waste tonnage (based on 0.8 tonne/m^3 landfilled waste density factor) is 95,670 tonnes
- After receipt of legacy coastal landfill wastes, additional wastes are to be received at an assumed rate of 12,000 tonnes per annum (tpa) (as suggested by Council)
- After receipt of legacy coastal landfill wastes, and based on additional waste receipt rates of 12,000 tpa, the remaining Stage 3 capacity would be operational for a further 4 years and 3 months, prior to requiring closure
- Development (CAPEX) costs per m^3 landfilled waste are estimated to be approximately \$77/m^3
- Development (CAPEX) costs per tonne of landfilled waste are estimated to be approximately \$97/tonne

Provisional landfill gas management

8. As described in Section 5.5.2 and as noted in Table A-2, a provisional sum of \$1M has been allocated for LFG management (collection and flaring) under option P4. LFG controls are assumed unnecessary in relation to the aged and relatively gas-inert legacy coastal landfill wastes. This item is only included to address potential future requirements for active LFG management, as may be required to offset ETS liabilities for the ongoing receipt of 12,000 tpa of municipal or putrescible wastes, or to address potential resource consent requirements or environmental concerns generally.

Table 7.3 Summarised cost estimates for Palmerston Landfill development options

PALMERSTON LANDFILL DEVELOPMENT OPTIONS	P1	P2	P3	P4
	Status Quo	Do minimum	Do more	Complete solution
Summary description	Continued operation for local waste only, remediation project material disposed to out-of-district landfill(s)	Accept remediation material from Hampden only	Accept remediation material from Hampden and Beach Rd (pre-treated waste)	Upgrade Stage 3 of Landfill to Class A standards to accept remediation wastes and additional regional wastes for commercial benefit
Legacy coastal landfill remediation option(s) enabled	Out of district disposal	H3/H4	H3/H4 and B2/B3/B4	H3/H4 + B2/B3/B4 and 12,000 t/yr other waste
ONGOING OPERATIONAL & MONITORING COSTS (OPEX)				
OPEX (in year of remediation project)	$ 99,000	$ 248,000	$ 297,500	$ 567,000
Annual OPEX thereafter	$ 99,000	$ 163,000	$ 170,000	$ 397,000
LANDFILL UPGRADES (CAPEX)				
Planning, Approvals and Pre-Development Costs	-	14,000	17,000	774,000
Engineering (Design, P&G and Management)	-	134,000	162,000	1,858,000
Development Works	-	478,000	578,000	6,635,000
CAPEX TOTAL (for landfill development prior to receipt of legacy wastes)	**$ -**	**$ 626,000**	**$ 757,000**	**$ 9,267,000**

8. Summary and recommendations

8.1 Summary

8.1.1 Remediation requirement

Due to their location within erosion-prone coastlines, Hampden Landfill and landfill deposits (infilled gullies) at Beach Road, Awamoa will continue to pose environmental pollution risks and will impose ongoing maintenance, management and clean-up (pollution response) liabilities and costs to Council and the District.

This Feasibility Study has developed, described and provided preliminary cost estimates for a range of remediation options for the Hampden and Beach Road sites, as well as consideration of a range of associated site reinstatement options and coastal protection measures.

Remediation options range from status-quo to full remediation, where all legacy wastes are removed to a permanent and secure disposal location.

Whilst provided for completeness and for cost-comparison purposes, status-quo and do minimum options that involve ongoing in-situ management and monitoring of the legacy wastes do not address remediation drivers and the ongoing risks of environmental pollution, which are exacerbated in this case because continuing long-term waste release events are an inevitable consequence of coastal retreat processes occurring along the Waitaki District coast.

It is not feasible to indefinitely protect, treat or stabilise the legacy waste deposits in their current locations. If the wastes are not relocated in the near term, they will require removal and transfer at some point in the future (unless storms and coastal retreat events cause their prior release and dispersal along the North Otago coastline). It is likely that the cost of remediation works, waste transfer and waste management will continue to increase over time, providing further reason to commit to active waste removal and transfer in the near-term.

Drivers for pursuing full remediation of the legacy coastal landfills in the near term are not only associated with environmental betterment and pollution risk mitigation. Full remediation options (H4 and B3 or B4) will further relinquish Council of virtually all long-term costs, risks and liabilities associated with the ongoing problematic management and maintenance of the legacy landfills in a retreating coastal environment. Residual post-remediation monitoring costs will apply, for the purposes of proving site remediation achievement, but such commitments will be short-lived.

8.1.2 Rationale for disposal to Palmerston Landfill

Palmerston Landfill is the logical and obvious disposal site for legacy coastal landfill wastes, as it is located within-district, is owned by Council, is close to the legacy landfills and has sufficient capacity to receive the waste.

Waste transport and landfill gate fees represent the most significant cost components of remediation, such that Palmerston Landfill is also the most cost-effective disposal site. Based on comparative remediation option costs provided in Table 7.2 above, waste disposal costs to Palmerston Landfill are 45 – 60% of the costs of disposal to the next cheapest landfill solution (AB Lime).

Challenges in respect of transferring the legacy wastes to Palmerston Landfill are associated with its Class B Landfill status and uncertainties around its ability to provide sufficiently secure long-term storage for wastes that are not classed as normal waste or inert waste.

Waste characterisation work to date has demonstrated that from technical and regulatory perspectives Hampden Landfill wastes (21,000 m^3) can be disposed to Palmerston Landfill, but that Beach Road wastes (8,000 m^3) exceed current waste acceptance criteria for Palmerston Landfill (and other Class A landfill facilities).

Solutions to address the disposal of the apparently more problematic Beach Road wastes therefore include:

– Undertaking additional waste characterisation studies, in combination with waste blending and chemical stabilisation trials, to provide more waste characterisation certainty and to define treatability requirements

– Confirming whether out-of-district Class A landfills (AB Lime and Kate Valley) will accept Beach Road waste materials without pre-treatment (and at what cost)
– Performing pre-treatment (blending of stabilisation) of Beach Road materials, to permit their disposal to Palmerston Landfill (or any other landfill)
– Development of a project specific containment cell at Palmerston Landfill for the receipt of legacy landfill wastes, including by beneficial extension, the development of Stage 3 of Palmerston Landfill to Class A landfill standards

8.1.3 Palmerston Landfill development justification

In tandem with the consideration of legacy landfill remediation options, the opportunity to leverage additional development and upgrades to Palmerston Landfill have been considered in this Feasibility Study.

Aside from important sustainability and environmental value considerations, potential remediation project cost savings associated with disposing legacy landfill wastes to Palmerston Landfill rather than out-of-district landfills are significant and are expected to mostly offset the cost of landfill improvements and site reinstatement costs.

The remediation project cost savings of waste disposal (cartage and gate fee) to Palmerston rather than AB Lime (the next cheapest disposal solution) are significant:

– Disposal of 21,000 m^3 of waste from Hampden (option H4) to Palmerston Landfill rather than AB Lime provides a potential remediation project cost saving of approximately $6.54 M.
– Disposal of 8,000 m^3 of waste from Beach Road landfills (options B3-1, B3-2 or B4) to Palmerston Landfill rather than AB Lime provides a remediation project cost saving of approximately $1.93 M.

This overall remediation project cost saving of $8.47 M mostly offsets CAPEX estimates (of $9.27M) associated with upgrading Stage 3 of Palmerston Landfill to a Class A landfill facility (option P4). Furthermore,

– Following the receipt of legacy landfill wastes, the P4 development option for Palmerston Landfill results in spare Class A landfill capacity for around 50,000 tonnes of additional waste, which would enable commercial waste management revenues to be generated.
– CAPEX estimates for P4 also include a provisional sum of $1M for the installation of LFG controls, which are unlikely to be necessary for the management of aged and de-gassed legacy wastes, or for the relatively low rates and volumes of waste that could subsequently be received into Palmerston Landfill (theoretically estimated as 12,000 tonnes per annum over a further 4 year operational period).

8.2 Recommendations

Based on the preliminary cost estimates, technical feasibility assessments and regulatory assessments presented in this Feasibility Study, it is recommended that full remediation of the identified legacy coastal landfill sites is pursued in the near term, in combination with upgrading Palmerston Landfill to whatever standard is deemed necessary to enable the disposal of remediation wastes within-district. The required Palmerston development standard should be defined in detailed assessments and detailed design; and in relation to confirmed regulatory requirements and practices.

Confirming potential disposal alternatives and costs for Beach Road wastes; and improving confidence around both the quantity and character of the Beach Road waste deposits should be prioritised. Such tasks could be achieved via additional test-pitting and/or drilling or by geophysical surveys, to improve delineation of the Beach Road waste deposits and to allow collection of additional waste samples for chemical stabilisation trials.

9. References

Beach Road Landfills

Otago Regional Council. March 2018. *Preliminary Site Investigation: Beach Road Landfills, Oamaru.* (Reference A1097455)

Waugh Infrastructure Management Ltd. September 2018. *Beach Road Closed Landfills Management Plan.* (Report Number: 64-077-1189 F)

WSP. February 2021a. Beach Road Closed Landfills – Detailed Site Investigation

WSP. July 2021b. Beach Road Closed Landfills – Remedial Options Assessment

Hampden Closed Landfill

Tonkin & Taylor Ltd. October 2019. Ground Contamination Assessment – Hampden Landfill (Report)

Waugh Infrastructure Management Ltd. March 2021. Hampden Closed Landfill – Post Closure Care and Management Plan 2021. (Revision 4)

Palmerston Landfill

Otago Regional Council. May 1996. *Discharge Permit Consent No. 94290. To discharge an average of 780 and up to 1570 cubic metres per year of leachate and contaminated stormwater to land in a manner which this may enter water.* (Superseded by Consent 2007.317)

Otago Regional Council. May 1996. *Discharge Permit Consent No. 94308. To discharge landfill gas, odour and dust to air.* (Superseded by Consent 2007.315)

Otago Regional Council. May 1996. *Discharge Permit Consent No. 94309. To discharge an average of 4,000 cubic metres per year of municipal and domestic solid waste to land.* (Superseded by Consent 2007.318)

Otago Regional Council. March 2018.

Otago Regional Council. March 2018.

Overview Surveying. June 2021. Palmerston Landfill Drawing Set:
Sheet 1 – 19/06/21 – 1:1500 – Palmerston Landfill Existing Site Plan
Sheet 2 – 22/06/21 – 1:1500 – Palmerston Landfill Closure Model Design Options
Sheet 3 – 22/06/21 – Palmerston Landfill Diagrams

Waitaki District Council. May 2007. *Palmerston Landfill Closure Plan (Draft version 1.2)*

Waitaki District Council. May 2007. *Palmerston Landfill Management Plan*

General

Geofabrics *Case Study - Katiki Beach Coastal Erosion for NZTA*

Ministry for the Environment 2004. *Module 2: Hazardous Waste Guidelines – Landfill Acceptance Criteria and Landfill Classification*

National Institute of Water & Atmosphere Research (NIWA) 2019. *Waitaki District Coastal Hazards - Prepared for the Otago Regional Council*

Waste Management Institute of New Zealand (WasteMINZ) 2018. *Technical Guidelines for Disposal to Land.*

Attachment 1

Cost Estimate Details

Table A.1 Detailed cost estimate breakdown for legacy coastal landfill management and remediation options

Table A.1 Detailed cost estimate breakdown for legacy coastal landfill management and remediation options

			HAMPDEN				BEACH ROAD				
			H1	H2	H3	H4	B1	B2	B3-1	B3-2	B4
			Status Quo	Do minimum	Do more	Complete solution	Status Quo	Do minimum	Do more		Complete solution
	Pollution control		Reactive waste clean-up when storms or slips cause pollution			NA	Reactive waste clean-up when storms or slips cause pollution		NA	NA	NA
	Maintenance			– capping improvements (repair cracks and perimeter slip) – erosion protection repairs (ensure 1V:3H rip-rap)		NA		Do minimum to meet 50-year design-life 'Beach Road' model – Relax cliff-top batter slope and cohesive cap – Plant stabilising vegetation – Re-shape loess-exposures – Increase cliff-base rip-rap diameter and embedment – Install additional rip-rap at cliff-base		NA
	Monitoring		Monitor erosion protection, capping integrity and surface water diversions		Recalibrate monitoring (following remediation work)	NA	Monitor erosion protection, capping integrity and surface water diversions		NA	NA	NA
	Remediation			NA	Remove next >10m strip to activate 'managed retreat' earlier than 15-m buffer (consent condition) 3,000 – 5,000 m^3	Remove all legacy landfill material 21,000 m^3		Part remediation – Remove waste from cliff-top & face to road edge. Pre-treat waste. 2,500 m^3	Full remediation - Remove all legacy landfill material. Pre-treat waste. 8,000 m^3 (plus 5% stabilisation)	Full remediation - Remove all legacy landfill material. Pre-treat waste. 8,000 m^3 (plus 5% stabilisation)	Full remediation - Remove all legacy landfill material. Pre-treat waste. 8,000 m^3 (plus 5% stabilisation)
	Reinstatement			NA	Relocate coastal protection measures landwards and re-cap remaining waste	Adapt site reinstatement objectives to match long-term coastal retreat by re-profiling resulting beach hollow/void		– Reinstate road (if damaged) on current alignment – Re-construct improved capping for remaining waste (50-yr design)	– Realign Beach Rd to pre-1972 alignment – Re-construct improved capping for road protection (50-yr design)	– Re-instate Beach Rd on current alignment – Install Beach Road protection (2.4km south from golf-course corner)	– Abandon Beach Rd – Reinstate gully formations with surfaces finished to mitigate accelerated weathering

		unit	rate	H1 Qty	H1 amount	H2 Qty	H2 amount	H3 Qty	H3 amount	H4 Qty	H4 amount	B1 Qty	B1 amount	B2 Qty	B2 amount	B3-1 Qty	B3-1 amount	B3-2 Qty	B3-2 amount	B4 Qty	B4 amount
0	**ONGOING MONITORING & MAINTENANCE (OPEX)**																				
	MONITORING																				
	Annual cost-rate increase (monitoring)		5%																		
	Current Annual Monitoring & Inspection Budgets	2022		1	20,000	1	20,000	1	20,000	1	20,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000
		2023		1	21,000	1	21,000	1	21,000	1	21,000	1	10,500	1	10,500	1	10,500	1	10,500	1	10,500
		2024		1	22,050	1	22,050	1	22,050			1	11,025	1	11,025						
		2025		1	23,153	1	23,153	1	23,153			1	11,576	1	11,576						
		2026		1	24,310	1	24,310	1	24,310			1	12,155	1	12,155						
		2027		1	25,526	1	25,526	1	25,526			1	12,763	1	12,763						
		2028		1	26,802	1	26,802	1	26,802			1	13,401	1	13,401						
		2029		1	28,142	1	28,142	1	28,142			1	14,071	1	14,071						
		2030		1	29,549	1	29,549	1	29,549			1	14,775	1	14,775						
		2031		1	31,027	1	31,027	1	31,027			1	15,513	1	15,513						
	MAINTENANCE																				
	Annual cost-rate increase (maintenance)		10%																		
	HAMPDEN Assume major capping + rip-rap repairs every 5 years Drainage, access/fencing/signage controls and vegetation clearance other years	2022				1	300,000	1	300,000			1	40,000	1	80,000	1	80,000	1	100,000		
		2023					10,000		10,000			1	44,000	1	88,000	1	88,000	1	110,000		
		2024					10,000		10,000			1	48,400	1	96,800	1	96,800	1	121,000		
		2025					10,000		10,000			1	53,240	1	106,480	1	106,480	1	133,100		
		2026					10,000		10,000			1	58,564	1	117,128	1	117,128	1	146,410		
	BEACH ROAD - Maintenance of the reduced repose profile ('50-yr' design), including cappng, rip-rap, vegetation and surface drainage maintenance	2027				1	480,000	1	300,000			1	64,420	1	128,841	1	128,841	1	161,051		
		2028					10,000		10,000			1	70,862	1	141,725	1	141,725	1	177,156		
		2029					10,000		10,000			1	77,949	1	155,897	1	155,897	1	194,872		
		2030					10,000		10,000			1	85,744	1	171,487	1	171,487	1	214,359		
		2031					10,000		10,000			1	94,318	1	188,636	1	188,636	1	235,795		
	10-year OPEX SUB TOTAL	10			$ 252,000		$ 1,112,000		$ 932,000		$ 41,000		$ 763,000		$ 1,401,000		$ 1,295,000		$ 1,614,000		$ 21,000
1	**DESIGN, CONSENTS, APPROVALS & MANAGEMENT**																				
	DESIGN																				
1.1	Remediation Action Plan & SAQP (waste characterisation and site validation)	LS							25,000		50,000				20,000		20,000		20,000		20,000
1.2	Remediaiton Works Specifiation, Tender and Contact Documents	LS							20,000		40,000				10,000		40,000		50,000		40,000
1.3	Civil Design	LS							50,000		100,000				10,000		100,000		100,000		20,000
1.4	Remediation Site Validation Report	LS							10,000		20,000				10,000		20,000		20,000		20,000
	CONSULTATION																				
1.5	Stakeholder Consultation (Statutrory (several iwi groups), DOC, NZTA, KiwiRail, affected neighbours)	LS							5,000		5,000				5,000		5,000		5,000		5,000
	REGIONAL COUNCIL (incorporating AEE effort)																				
1.6	Existing resource consent	LS																			
1.7	New Consents - Closed landfill disturbance, discharge and works in a coastal marine area	LS							30,000		20,000				35,000		20,000		50,000		20,000
	DISTRICT COUNCIL (assuming external preparation of application)																				
1.8	WDC Land use consent (or outline plan of works for Hampden)	LS							5,000		10,000				10,000		10,000		20,000		10,000
1.9	NES-CS Land use consent	LS													5,000		5,000		5,000		5,000
1.10	**PROJECT MANAGEMENT**		4%						11,000		31,000				10,000		28,000				24,000
1.11	**CONSTRUCTION MGT & DOCUMENTATION**		8%						22,000		63,000				20,000		57,000				48,000
	SUB TOTAL								$ 178,000		$ 339,000				$ 135,000		$ 305,000		$ 270,000		$ 212,000
	CONTRACTED REMEDIATION / CONSTRUCTION WORK																				
	Assumed Works Duration	**wk**	**16**					**8**		**16**				**4**		**12**		**26**		**8**	
2	**PRELIMINARY & GENERAL**																				
2.1	General Obligations and Contract Requirements (Insurance, bonds, etc.)	LS	5,000					50%	2,500	100%	5,000			25%	1,250	75%	3,750			50%	2,500
2.2	Establishment / dis-establishment	LS	30,000					50%	15,000	100%	30,000			25%	7,500	75%	22,500			50%	15,000
2.3	Development and managing Contractor's Health and Safety Plan	LS	10,000					50%	5,000	100%	10,000			25%	2,500	75%	7,500			50%	5,000
2.4	Development and managing Quality Assurance plan	LS	10,000					50%	5,000	100%	10,000			25%	2,500	75%	7,500			50%	5,000
2.5	Development and managing Environmental Management plan and Controls including stormwater management	LS	2,000					50%	1,000	100%	2,000			25%	500	75%	1,500			50%	1,000
2.6	Development and managing the Resource Consent requirements	LS	5,000					50%	2,500	100%	5,000			25%	1,250	75%	3,750	INCLUDED IN OVERALL RATE ASSUMED FROM KATIKI SH1 REPAIRS		50%	2,500
2.7	Development and managing Archaeological requirements	LS	3,000					50%	1,500	100%	3,000			25%	750	75%	2,250			50%	1,500
2.8	Contract Management Plan (CMP) + Management	LS	500					50%	250	100%	500			25%	125	75%	375			50%	250
2.9	Traffic Management - approvals reqd from NZTA, WDC and KiwiRail (Hampden)	LS	2,000					70%	1,400	100%	2,000			5%	100	20%	400			20%	400
2.10	Traffic management at Beach Road	LS	40,000											20%	8,000	150%	60,000			100%	40,000
2.11	Traffic management at Stafford Street intersection with State Highway 6	LS	150,000					20%	30,000	100%	150,000										
2.12	Traffic Management at Stafford Road Rail Crossing	LS	20,000					30%	6,000	100%	20,000										
2.13	Survey and Setout	LS	5,000					20%	1,000	100%	5,000			20%	1,000	100%	5,000			100%	5,000
2.14	As-built plans	LS	2,000					10%	200	100%	$ 2,000.00			10%	200	100%	2,000			50%	1,000
	SUB TOTAL								$ 71,350		$ 244,500				$ 25,675		$ 116,525		$ -		$ 79,150
3	**SITE PREPARATION & MAINTENANCE**																				
3.1	Vegetation clearance & disposal	LS	5,000					10%	500	100%	5,000			5%	250	30%	1,500			50%	2,500
3.2	Stormwater protection/diversion	LS	7,000					10%	700	10%	700			2%	140	100%	7,000			100%	7,000
3.3	Clear and clean existing road drains	LS	1,000					20%	200	70%	700			5%	50	100%	1,000			100%	1,000
3.4	Realign existing drains to prevent clean runoff entering the works	LS	500					100%	500	100%	500			20%	100	20%	100			100%	500
3.5	Internal Site Haul Road and Beach Access Ramp Establishment	LS	5,000					100%	5,000	100%	5,000			100%	5,000	100%	5,000	INCLUDED IN OVERALL RATE ASSUMED FROM KATIKI SH1 REPAIRS		100%	5,000
3.6	Maintain haul road for duration of works	LS	500					50%	250	100%	500			20%	100	30%	150			50%	250
3.7	Removal and Restoration of Haul Roa at Work Completion completed	LS	3,000					100%	3,000	100%	3,000			100%	3,000	100%	3,000			100%	3,000
3.8	Provide and Maintain Safe Temporary Public Access to Beach - Hampdon (path and cliff steps)	LS	2,000					100%	2,000	100%	2,000										
	SUB TOTAL								$ 12,150		$ 17,400				$ 8,640		$ 17,750		$ -		$ 19,250
4	**EXTRACTION, CARTAGE & DISPOSAL OF WASTE**																				
4.1	Additional test pits to confirm extent of fill, and nature of waste (against Waste Acceptance Criteria) inclusive of additional analytical costs and waste character/assesment reporting	each	1,000					0	-	0	-			6	6,000	12	12,000	12	12,000	12	12,000
4.2	Remove to stockpile any capping layer or rock rip-rap - approved for reuse on site	m3	15					250	3,750	1,050	15,750			63	938	200	3,000	200	3,000	200	3,000
4.3	Progressively excavate and load waste materials to cartage fleet	m3	12					5,000	60,000	21,000	252,000			2,500	30,000	8,000	96,000	8,000	96,000	8,000	96,000
4.4	Waste blending / stabilisation	m3	40											2,500	100,000	8,000	320,000	8,000	320,000	8,000	320,000
4.5	Removal of Leachates **(Provisional)** via waste liquid vacuum truck suited to hazardous waste liquids. Rate to include recovery, cartage and disposal to sewer / trade-waste.	PS	2,500					1	2,500	4	10,000										
	SUB TOTAL								$ 66,250		$ 277,750				$ 136,938		$ 431,000		$ 431,000		$ 431,000
	PALMERSTON																				
P	Cartage - Plant to be used must have the capability of weighing the loads to ensure compliance with public road loadings	km $/T/km	$ 1.00					50	$ 375,000	50	$ 1,575,000			110	$ 412,500	110	$ 1,386,000	110	$ 1,386,000	110	$ 1,386,000
	Landfill Gate Fees	tonne	$ 100					7,500	$ 750,000	31,500	$ 3,150,000			3,750	$ 375,000	12,600	$ 1,260,000	12,600	$ 1,260,000	12,600	$ 1,260,000
	- Landfill levy (currently $20 - no increase factored)	tonne	$ 20					7,500	$ 150,000	31,500	$ 630,000			3,750	$ 75,000	12,600	$ 252,000	12,600	$ 252,000	12,600	$ 252,000
	- default ETS - for no / limited gas capture (not applied)	tonne	$ 50					0	$ -	0	$ -			0	$ -	0	$ -	0	$ -	0	$ -
	AB LIME - WINTON																				
AB	Cartage - Plant to be used must have the capability of weighing the loads to ensure compliance with public road loadings	km $/T/km	$ 0.40					554	$ 1,662,000	554	$ 6,980,400			616	$ 924,000	616	$ 2,956,800	616	$ 2,956,800	616	$ 2,956,800
	Landfill Gate Fees	tonne	$ 156					7,500	$ 1,170,000	31,500	$ 4,914,000			3,750	$ 585,000	12,000	$ 1,872,000	12,000	$ 1,872,000	12,000	$ 1,872,000
	KATE VALLEY - HURUNUI																				
KV	Cartage - Plant to be used must have the capability of weighing the loads to ensure compliance with public road loadings	km $/T/km	$ 0.40					680	$ 2,040,000	680	$ 8,568,000			620	$ 930,000	620	$ 2,976,000	620	$ 2,976,000	620	$ 2,976,000
	Landfill Gate Fees	tonne	$ 250					7,500	$ 1,875,000	31,500	$ 7,875,000			3,750	$ 937,500	12,000	$ 3,000,000	12,000	$ 3,000,000	12,000	$ 3,000,000
5	**EARTHWORKS, ROCK PROTECTION AND CAPPING**																				
5.1	Excavate Trench on Beach for Riprap Rock (1.0m deep)	m	150					60	9,000	60	9,000			40	6,000	40	6,000		-	40	6,000
5.2	Cut to Stockpile Existing Riprap Rocks	m	40					60	2,400	60	2,400			40	1,600	40	1,600		-	40	1,600
5.3	Topsoil Cut to Stockpile	m3	9					20	180	20	180			40	360	40	360	40	360	40	360
5.4	Cut to Fill (existing capping material and landfill shoulder loess material for general fill)	m3	12					2,000	24,000	6,000	72,000			500	6,000	1,000	12,000	1,000	12,000	2,000	24,000
5.5	Cut to Fill (existing road material)	m3	15													40	600	40	600	40	600
5.6	Supply and Place Capping Material (impermeable clay)	m3	35					300	10,500					200	7,000						
5.7	Supply and Place Quarry Overburden Material	m3	5											150	750						
5.8	Imported Fill (general non structural cleanfill)	m3	30							700	21,000			50	1,500	2,000	60,000	8,000	240,000	1,000	30,000
5.9	Supply and Place Geotextile For Riprap In Trench	m2	15					600	9,000	600	9,000			400	6,000	400	6,000				
5.10	Supply and Place Riprap Rock (2.0m x 3.0m)	m	90					360	32,400	360	32,400			240	21,600	240	21,600				
5.11	SH 1 Coastal protection unit rate (per metre sea-cliff 9m high)	m	4,000															2,400	10,000,000		
	SUB TOTAL								$ 87,480		$ 145,980				$ 50,810		$ 108,160		$ 10,252,960		$ 62,560
6	**SITE REHABILITATION WORKS**																				
6.1	Gabion Wall (2.0m high)	m	1,500											10	15,000	10	15,000	10	15,000		
6.2	Place Topsoil From Stockpile (100mm thick)	m2	10					300	3,000	500	5,000			50	500	50	500	50	500	50	500
6.3	Supply and Place Topsoil - Imported (100mm thick)	m2	25					100	2,500	1,500	37,500			150	3,750	150	3,750	150	3,750	300	7,500
6.4	Landscaping (hydroseed grass and planting)	m2	7					400	2,800	2,000	14,000			200	1,400	200	1,400	200	1,400	350	2,450
6.5	Fencing (stock post and wire)	m	80					100	8,000	100	8,000										
6.6	Fencing (pedestrian timber post and rail)	m	800					30	24,000	30	24,000										
	SUB TOTAL								$ 40,300		$ 88,500				$ 20,650		$ 20,650		$ 20,650		$ 10,450
7	**ROADING**																				
7.1	Sawcut existing Pavement	m	5											40	200	40	200	40	200		
7.2	Undercut Unsuitable Material in Subgrade (Provisional Item)	m3	35											5	175	20	700	20	700		
7.3	Supply, Place and Compact Topup Material AP65 (Provisional Item)	m3	55											5	275	20	1,100	20	1,100		
7.4	Supply, Place and Compact AP65 Subbase 250mm thick	m2	17					50	850	250	4,250			80	1,360	280	4,760	280	4,760		
7.5	Supply, Place and Compact M/4 AP40 Basecourse 150mm Thick	m2	20					50	1,000	250	5,000			80	1,600	280	5,600	280	5,600		
7.6	Two coat Chip Seal 3/5	m2	9					50	450	250	2,250			80	720	280	2,520	280	2,520		
	SUB TOTAL								$ 2,300		$ 11,500				$ 4,330		$ 14,880		$ 14,880		$ -
	Schedule Total (Excl. waste transport & Landfill Gate)								$ 457,830		$ 1,124,630				$ 382,043		$ 1,013,965		$ 10,989,490		$ 814,410

			HAMPDEN				BEACH ROAD				
			H1	H2	H3	H4	B1	B2	B3-1	B3-2	B4
	Total including disposal to - Palmerston	P			$ 1,733,000	$ 6,480,000		$ 1,245,000	$ 3,912,000	$ 13,887,000	$ 3,712,000
	Total including disposal to - AB Lime	AB			$ 3,290,000	$ 13,019,000		$ 1,891,000	$ 5,843,000	$ 15,818,000	$ 5,643,000
	Total including disposal to - Kate Valley	KV			$ 4,373,000	$ 17,568,000		$ 2,250,000	$ 6,990,000	$ 16,965,000	$ 6,790,000

Table A.2 Detailed cost estimate breakdown for Palmerston Landfill development options

Table A.2 Detailed cost estimate breakdown for Palmerston Landfill development options

			P1 Status Quo	P2 Do minimum	P3 Do more	P4 Complete solution
Option description			Maintain current operations to serve local catchment < 500 tpa	Transfer Hampden waste to Palmerston 31,500 tonnes	Transfer Hampden and Beach Road waste to Palmerston 45,000 tonnes	Develop landfill for receipt of Hampden, Beach Road and other commercial waste 45,000 tonnes then 12,000 tpa
Requirement definition			NA	Materials meet current Waste Acceptance Criteria	Pre-treat Beach Road waste to meet Waste Acceptance Criteria	Upgrade portion of landfill to Class A facility
Remediation project waste disposal			Forces Out-of-District disposal	Hampden waste to Palmerston ($21,000\ m^3$) Beach Rd to Class A landfill ($8,000\ m^3$)	All remediation project waste to Palmerston ($29,000\ m^3$ plus pre-treatment bulking factor)	All remediation project waste to Palmerston (29,000 m3 plus pre-treatment bulking factor)
Landfill Engineering Requirements			NA	Upgrade stormwater and leachate management controls for scale of increased operations		Development of Stage 3 as Class A landfill

	unit	rate	P1 amount	P2 amount	P3 amount	P4 amount
ONGOING OPERATIONAL & MONITORING COSTS (Annual OPEX)						
Operation and Maintenance	/yr		$ 85,000	$ 85,000	$ 85,000	$ 255,000
Additional (extra-over) O&M for period (1-year) of remediation work	/yr			$ 85,000	$ 127,500	$ 170,000
Consents and Monitoring	/yr		$ 14,000	$ 28,000	$ 35,000	$ 42,000
Aftercare	/yr		?	$ 50,000	$ 50,000	$ 100,000
Landfill Levy (annually increasing from $20 - $60 per tonne by 2026?)	/tonne		*Included in Gate Fee at current $20/tonne rate (remediation works schedule)*			
ETS - assume waiver for remediation waste then $50/tonne?	/tonne		*Not factored in at this stage*			
Annual OPEX in year of remediaiton project			**$ 99,000**	**$ 248,000**	**$ 297,500**	**$ 567,000**
LANDFILL UPGRADES (CAPEX)						
PLANNING & PRE-DEVELOPMENT						
Supporting studies, consultation, AEE + Consent Application						$ 575,000
Project Management		3%		$ 14,000	$ 17,000	$ 199,000
ENGINEERING						
Detailed design & Documentation		8%		$ 38,000	$ 46,000	$ 531,000
Construction Management		5%		$ 24,000	$ 29,000	$ 332,000
Contractors P&G		15%		$ 72,000	$ 87,000	$ 995,000
DEVELOPMENT						
Site Access and Entrance Upgrades (a)						$ 200,000
Site Amenities and Service connections (b)						$ 1,620,000
Cell construction (c)						$ 2,360,000
Leachate Management System (external to cell) (d)				$ 278,000	$ 278,000	$ 278,000
Stormwater Management System (e)				$ 200,000	$ 300,000	$ 500,000
Landfill Gas Management System (f)	*PS*					*$ 1,000,000*
Final Cover System						$ 677,000
SUB TOTAL				**$ 626,000**	**$ 757,000**	**$ 9,267,000**
Schedule Total (Excl. waste transport & Landfill Gate)				**$ 874,000**	**$ 1,054,500**	**$ 9,834,000**

Footnotes

(a) Includes completion of planned perimeter road

(b) Includes admin building, machinery storage/workshop, weighbridge, kiosk, platform, wheelwash and power/ water/ sewer connections

(c) Includes cut to stockpile 100,000m3, sub-grade preparation and drainage (@25m centres), Class 1 Type 1 lining system system (600mm compacted+FML+Geotextiles) and leachate collection system, including pumped-to-tank system (in-cell system only i.e.up to pumps - above ground elements in (d))

(d) Above-ground leachate management infrastructure including above-ground storage tank. Design to service new Stage 3 cell and to receive existing flows from Stage 1 sub-soil leachate drainage system

(e) Convert existing leachate evap. pond for stormwater diversion and management - all drains, diversions, grates, manholes, pipes and swales

(f) Flare only (i.e no co-gen). BUT unnecessary for Hampden/Beach Rd wastes - and not required under NES Air Quality for landfill <1-M tonnes capacity. Active capture likely required if future '12,000 tpa' is MSW or putrescible.

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