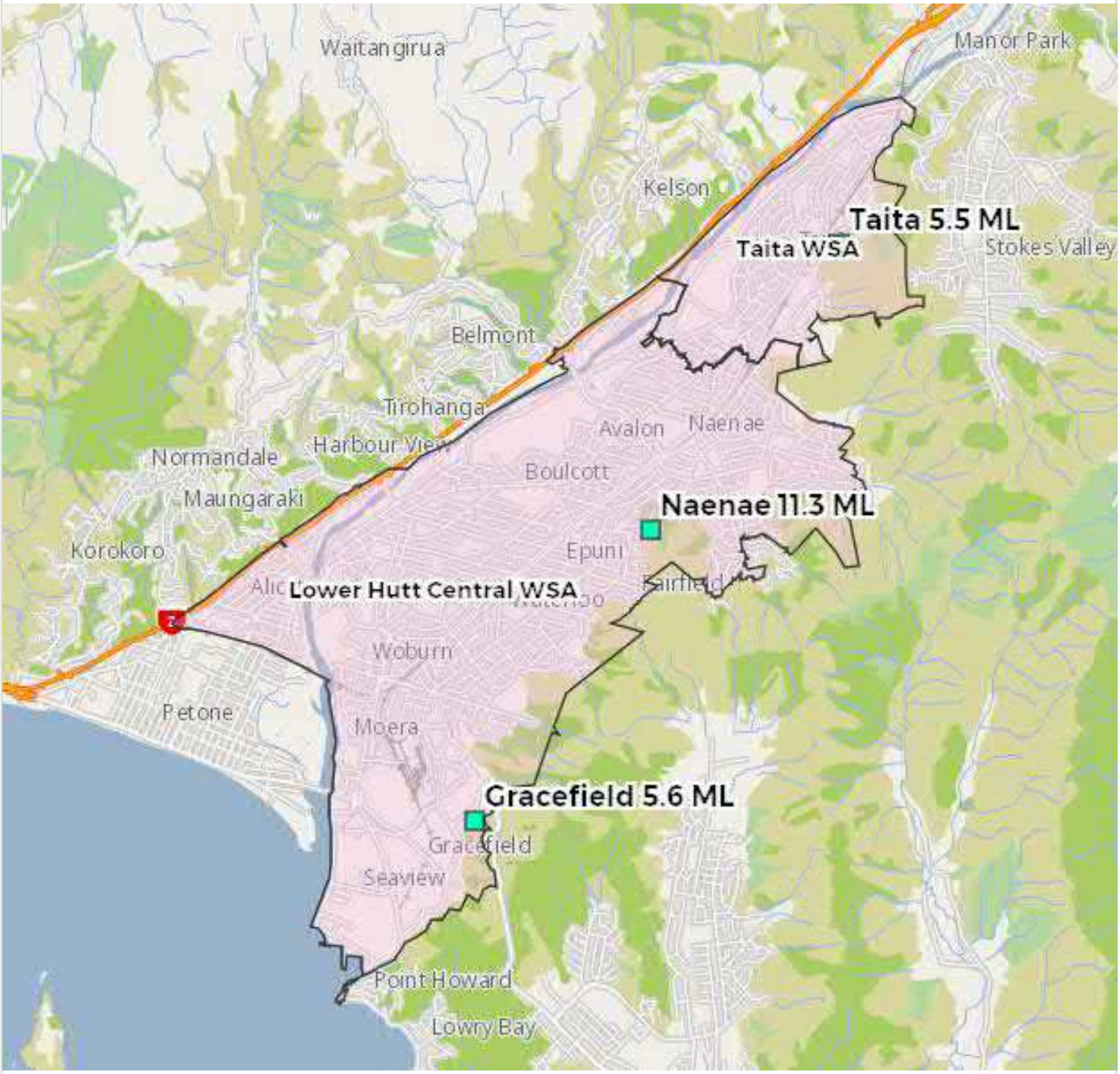
Site Selection Report

Project Name: **Lower Hutt Central Reservoir**

Project No.: **OMC101031 / 3-WW021.02**

Date: **June 2022**



Our water, our future.

Document Control

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Client Council	Hutt City Council

REVISION SCHEDULE						
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Executive Summary

Background

Wellington Water's three customer outcomes are; safe and healthy water; respectful of the environment; and resilient networks which support our economy. These outcomes are supported by 12 service goals. Two of these service goals are the customer outcome focus of the Lower Hutt Central Reservoir Project: (i) 3.3 We plan to meet future growth and manage demand, and (ii) 3.4 We provide reliable services to customers. The risk score associated with these service goals is 16 of 25.

Available reservoir storage within the Lower Hutt Central and Taita Water Storage Areas (WSA) does not meet target levels of service. The storage deficit leaves this area vulnerable to bulk water supply interruptions (i.e. source, treatment, pumping and bulk pipeline failures) and there exists potential for unreliable water supply. This will be exacerbated by future development and population growth as these place additional demand on the network.

Additional treated water storage is required in order that Wellington Water can provide reliable services to customers and accommodate future population growth. To meet this treated water storage requirement, a new 15 megalitre (ML) potable water storage reservoir is proposed to serve the Lower Hutt/Taita WSAs. Target construction commencement date is 2024 with completion in 2026. The need for additional potable water storage, and confirmation of reservoir sizing is included in the earlier investigation report (*Lower Hutt Central and Taita Reservoir Storage Volume Assessment*, 7 December 2021, Connect Water).

Longlist option development and preliminary site Investigations

This report documents the work undertaken to identify and evaluate potential site options for the proposed reservoir and presents a site recommendation.

To enable integration with existing water supply network the proposed reservoir needs to be situated on a hillside, at an elevation matching that of existing reservoirs at Gracefield, Naenae and Taita. A desktop study identified twenty-eight locations at the required elevation contour, with potential access to/from the valley floor. Further consideration allowed half of these sites to be discounted, generally on the basis of unsuitable topography for the formation of a reservoir platform (steep terrain or unsuitable fill material) and access route to it. Initial earthworks volume and pipe route length estimates were prepared for the remaining sites. Sites with particularly high earthworks quantities, cut/fill depths, or very long pipe routes were eliminated, leaving a long list of seven potential options.

A variety of other factors were considered at a high level across the seven longlisted sites, this utilised publicly available GIS data and desktop assessments by subject matter experts. The collated information was presented using a GIS map viewer, and a qualitative scoring across a range of factors (excluding cost) was undertaken to inform a short list of sites that were advanced for multicriteria analysis (MCA). The shortlisting process was workshopped with stakeholders (Wellington Water and Hutt City Council) and three site options were shortlisted:

i. Cambridge Terrace, above Cambridge Tce/Kowhai St

ii. Naenae 2, adjacent to existing Naenae reservoir on Summit Rd

iii. Gracefield 2, adjacent to existing Gracefield reservoir on Wainuiomata Rd

Multi Criteria Analysis of shortlisted options

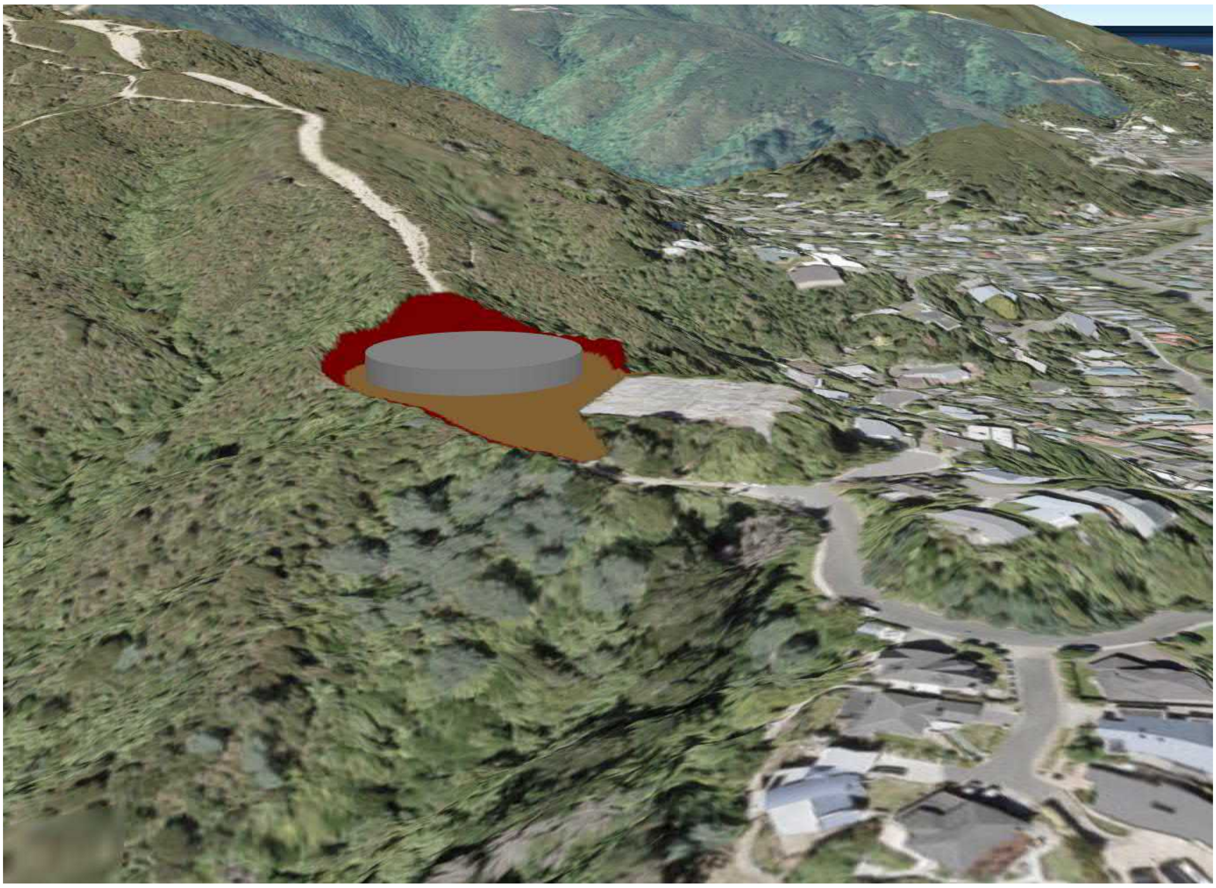
An MCA approach was used to evaluate and score each of the three short listed options against a range of environmental, social, technical, and financial criteria. The highest scoring (preferred) site option is Naenae 2, adjacent to the existing Naenae reservoir. This site scored as most favourable in most criteria groupings and is also the lowest cost option by a significant margin. The Naenae 2 site still ranks highest if the financial criterion is excluded from the analysis. The Naenae 2 site scored poorly in the Social criteria grouping, reflecting the potential impacts of heavy vehicle movements and pipeline construction works on the residential community adjacent to the site. This does not alter the outcome of the MCA but reinforces the importance of strong community engagement through the design and construction process.

Mana whenua values identified in the Wellington Region Natural Resources Plan and outlined in Te Mahere Wai te Kahui Taiao were considered during the MCA process, however mana whenua representatives were unable to participate during this process. An advisor to Taranaki Whanui attended the MCA workshop as an observer, and subsequent discussions were held with Taranaki Whanui Chief Executive to share information about the project and discuss risk of impacts that will be factored into design and agree on an engagement approach for future project stages. Taranaki Whanui has provided feedback confirming that the Naenae 2 site presents the lowest risk of significant impacts on mana whenua values out of the three shortlisted options.

It is recommended that;

- **the Naenae 2 site be adopted as the preferred option for concept design.**
- **further design information as it is developed is shared with Taranaki Whanui to support the development of a Cultural Impact Assessment at later stage of project.**

Outline of location of recommended site – Naenae 2



3D sketch of recommended site – Naenae 2

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1 Introduction

A new 15 megalitre (ML) potable water storage reservoir is proposed to serve the Lower Hutt/Taita Water Storage Areas (WSAs), shown in Figure 1. This will likely be a circular, reinforced concrete structure, of approximately 55m diameter, situated on a hillside at the same elevation as existing reservoirs at Gracefield, Naenae and Taita.

Wellington Water are seeking to identify a suitable site for the proposed reservoir in order to progress further investigations, community engagement, consenting and design for this major infrastructure project.

This report documents the site selection process including:

- Initial identification of potential sites,
- Longlisting of sites that may be technically feasible,
- Shortlisting of favoured sites,
- Multicriteria analysis of shortlisted sites, and
- Recommendation of a preferred site.

Figure 1. Lower Hutt Central and Taita Water Storage Areas and Existing Reservoirs

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2 Background

2.1 Why is a new reservoir required?

Available reservoir storage within the Lower Hutt Central and Taita Water Storage Areas (WSA) does not meet target levels of service. The storage deficit leaves this area vulnerable to bulk water supply interruptions (ie source, treatment, pumping and bulk pipeline failures) and there exists potential for unreliable water supply. This will be exacerbated by future development and population growth as this places additional demand on the network.

Additional treated water storage is required in order that Wellington Water can provide reliable services to customers and accommodate future population growth. The customer outcomes and service goals linked to this activity are shown in the table below.

Table 1. Customer outcomes and service goals

Primary customer outcome		Outcome 3: Resilient networks support our economy
Primary goal		3.3 We plan to meet future growth and manage demand
Secondary customer outcome		Outcome 3: Resilient networks support our economy
Secondary goal		3.4 We provide reliable services to customers

2.2 How large does the reservoir need to be?

A reservoir storage volume assessment has been completed (Lower Hutt Central and Taita Reservoir Storage Volume Assessment, 7 December 2021, Connect Water). This considered the availability of existing storage capacity (Naenae, Gracefield and Taita reservoirs) relative to the required storage volume assessed in accordance with the Regional Standard for Water Services (2019). This report identified a storage deficit based on current demand, with further deficit over time in response to projected development and population growth in the Lower Hutt Central and Taita areas.

Surplus storage available in adjacent areas has been investigated and this can be used to manage short term risk of the current deficit. Demand reduction from around 350 L/person/day to less than 300 L/person per day reduces the projected storage volume required in the longer term and has been assumed in the sizing assessment. There are opportunities for staging the provision of additional storage capacity over time as existing reservoir assets are renewed, and potentially upsized, at end of life.

The assessment recommends that a new reservoir of 15 ML capacity be constructed over the 2024/27 period. Subsequent replacement of the existing 11.3 ML Naenae reservoir in the mid

2040's with a new 16.3 ML reservoir would provide adequate storage capacity through to around 2065, coinciding with the anticipated replacement and potential upsizing of the Gracefield and Taita reservoirs.

2.3 Project Objectives

The project objectives are (adapted from activity brief November 2020): *[for confirmation with Wellington Water and HCC]*

- Address the current storage shortfall and ensure sufficient storage for future growth in the Lower Hutt Central and Taita water storage areas (WSA).
    - To ensure disaster resilience of the Lower Hutt Central and Taita WSAs by providing a seismically resilient water supply capable of meeting Wellington Water's target level of service for the WSA of 7 days (day 8 to day 15) supply under a survival and stability state following a significant water supply disruption event.
    - To ensure the Lower Hutt Central and Taita WSAs are operationally resilient by providing sufficient secure, safe, and reliable water storage to supply 48 hours of water to residents, businesses, and critical water users (including the fire service) under normal operating conditions, based on projected demand with appropriate consideration of population growth.
- To deliver a secure, safe, and reliable water storage solution that has a 100-year design life.
- To integrate the chosen solution into the Lower Hutt Central WSA network in a cost-effective manner.

2.4 Project Constraints

Project constraints include:

- **Funding** – The project has Long-term Plan (LTP) funding allocated, however, there may be insufficient funding compared to the forecast costs once the cost estimate has been revised following identification of an appropriate site.
- **Top water level and network configuration** – The top water level is required to be the same as the existing Naenae/Gracefield/Taita reservoirs to ensure efficient water supply operation.
- **Site constraints** – There will be a wide range of site constraints that will influence the design of the reservoir on any potential site. These relate to current and future land use, property, access, the environment, site ecology, geotechnical features, archaeology, contaminated land, cultural significance, landscaping requirements among others. Consultation with key stakeholders is required to confirm these and identify any additional constraints prior to concept design.
- **Consents** – Resource consents will be required for the proposed reservoir and these will set conditions and constraints on the project. These will vary depending on the selected site.

3 Identification of Potential Sites

3.1 Overview

A staged approach was taken to identify and assess potential reservoir sites in the lower portion of the Hutt Valley. This initially involved consideration of the existing water network, topography and hydraulic requirements to establish a target contour zone for the reservoir site, which in turn was considered relative to access constraints/opportunities to broadly identify potential sites within the target zone. On closer examination many of the sites were able to be discounted from further consideration, generally due to steep terrain that would make access or formation of a suitable reservoir platform not feasible. Fourteen sites were taken forward for further consideration.

An indicative earthworks extent was developed for a reservoir construction pad and access road to each site providing an initial impression of the extent of work and associated impacts. Potential pipeline corridors (inlet, outlet) were also identified. Based on earthworks volumes, cut/fill depths, access road and pipeline lengths a longlist of seven potential sites was developed. The initial longlisting process was reviewed with Wellington Water staff in a workshop setting and seven potential sites accepted for further consideration. GIS mapping was used to aid the identification and assessment of sites. These maps have been compiled within a web-based StoryMap application which was presented and made available for stakeholder engagement through the site selection process. Screenshots from the StoryMap are included in this report and the StoryMap can be viewed directly at:

https://nz-maps.wsp.com/portal/apps/MapSeries/index.html?appid=f59d367b9b1f43b2b2a9ab96ca968d56

To request access to the StoryMap please contact Connect Water Project Manager: Paul Carran, paul.carran@wsp.com.

3.2 Existing Network

Groundwater is abstracted from the Waiwhetu aquifer and treated at the Waterloo Water Treatment Plant (WTP). Treated drinking-water is then pumped to reservoirs at Naenae and Gracefield through dedicated bulk water distribution mains (coloured **cyan** in Figure 2). These reservoirs provide a gravity water supply to Lower Hutt Central. A pump station supplies water into the Taita WSA and the Taita reservoir. These features are shown on the adjacent map. Also shown are the large diameter mains (>=225 mm dia.) in the distribution network which conveys drinking-water under gravity pressure from the storage reservoirs to consumers (coloured **blue** in Figure 2).

The proposed new reservoir will require an **inlet** pipeline from the Waterloo WTP or a connection to a suitable existing bulk water main (coloured **cyan** in Figure 2). A separate **outlet** pipeline from the reservoir will need to connect to one or more of the larger trunk mains in the distribution network (coloured **blue** in Figure 2).

Proximity to the existing mains is a key consideration for identification of potential reservoir sites.

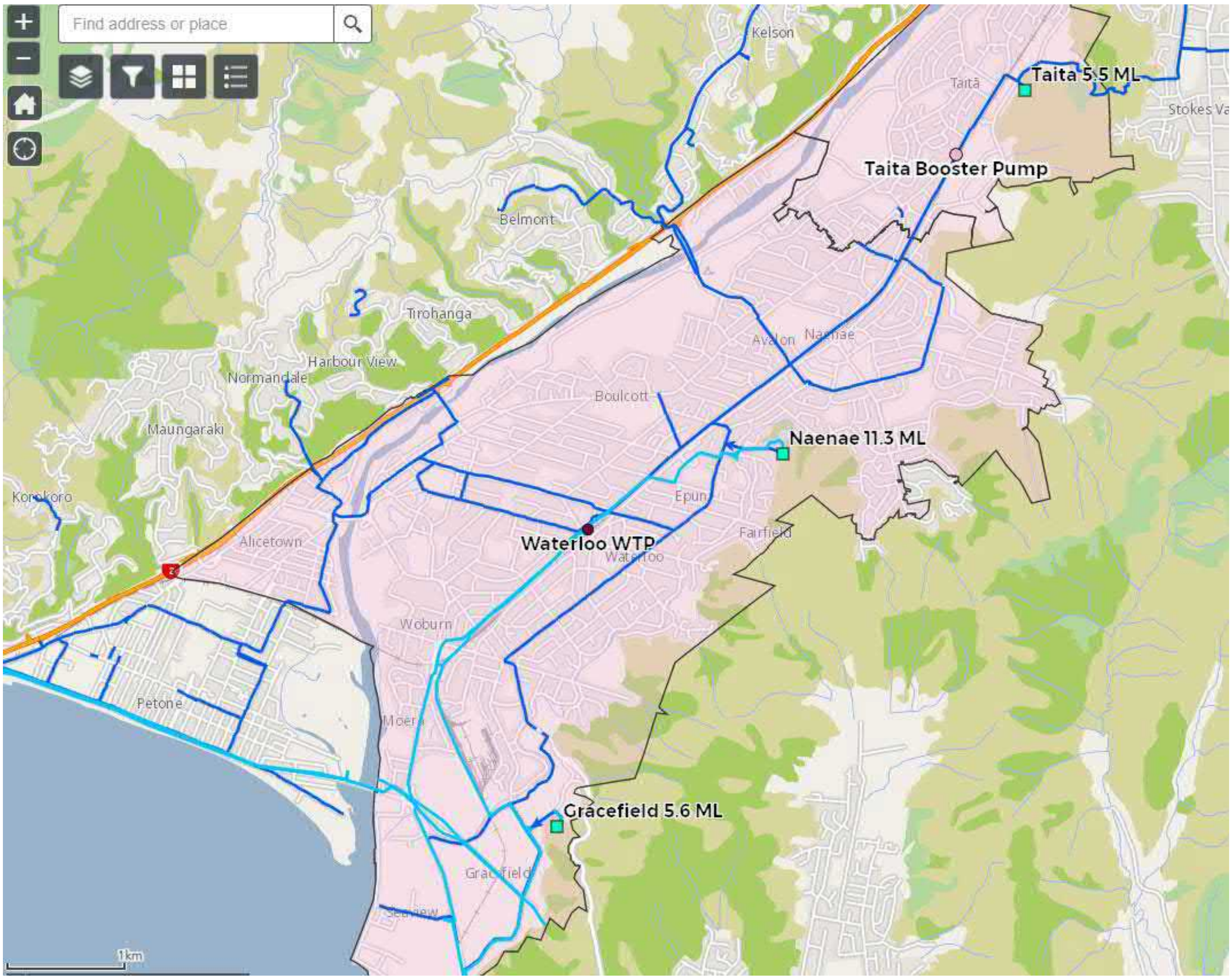

Figure 2. Existing bulk water supply (cyan) and large diameter network distribution (blue) mains

3.3 Geography

The new reservoir will need to be situated on the western or eastern hills, at a similar elevation to the existing reservoirs, to integrate with the existing distribution system and provide a gravity supply to Lower Hutt.

Key features:

- Flat valley floor
- Steep hillsides – west and east
- State Highway 2
- Wellington Fault
- Hutt River / Te Awa Kairangi
- Lower Hutt Central Business District (CBD)
- Railway corridors
- Waiwhetu Stream

A site on the western hills would require the inlet and outlet pipelines to cross the Hutt River, State Highway 2 and the Wellington Fault. These features would introduce complexity, risk and increased cost for pipelines to and from the new reservoir. Additionally, construction would likely impact the CBD and major transport routes.

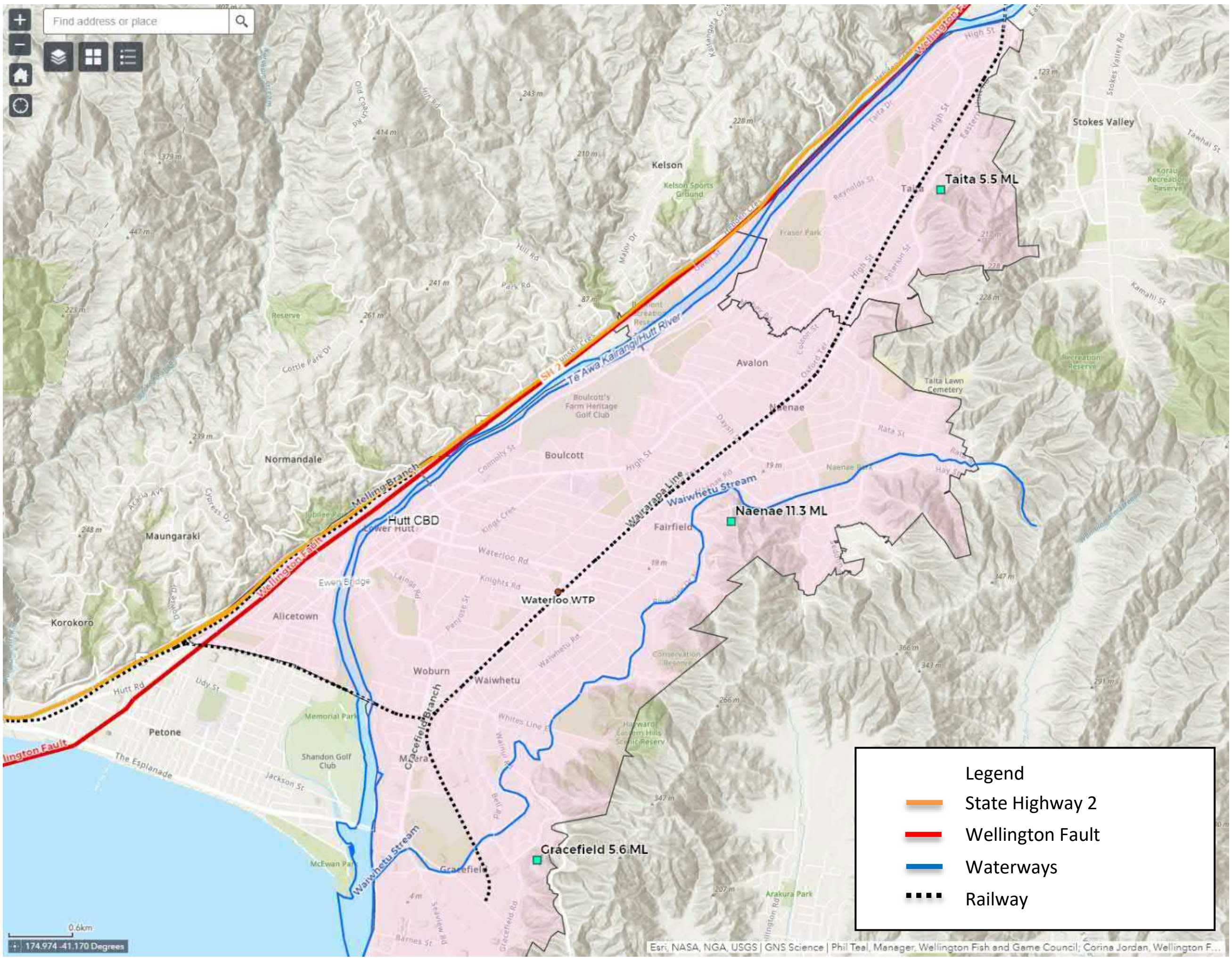

Figure 3. Key geographic features mapped in the Hutt Valley

3.4 Hydraulic Requirements

The existing Taita, Naenae and Gracefield reservoirs provide a gravity fed water supply to the distribution network and are hydraulically linked with the same top and bottom water levels. The new reservoir must match these top and bottom water levels to ensure efficient water supply operation.

- Top water level (TWL) = 72.9 m
- Bottom water level (BWL) = 66.4 m

On the adjacent map the **blue** band shows the area between the top and bottom water level contours. This is the target zone for siting a new reservoir. A wider band indicates a flatter site which would be preferable, while a narrow band indicates a steeper site that would require more extensive earthworks.

The **orange** band shows the area up to 10m below the BWL. A site in this band would require filling to achieve the required reservoir level.

The **red** band shows the area up to 10m above the TWL. A site in this band would require additional excavation to construct the reservoir at the required level.

Sites outside of the indicated bands are unlikely to be suitable for the proposed reservoir. This significantly constrains the potential locations for a new reservoir.

The existing bulk supply mains to the Gracefield and Naenae reservoirs are DN375 and DN750 respectively. It is anticipated that the new reservoir will require a bulk inlet main size in the order of DN750. This is to ensure there is enough supply capacity in the network when the existing Naenae reservoir is taken offline for renewal/replacement in the mid 2040's.

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Technical Note 1: All levels are in terms of the Wellington Vertical Datum 1953.

Technical Note 2: DN refers to the nominal pipe diameter (mm).

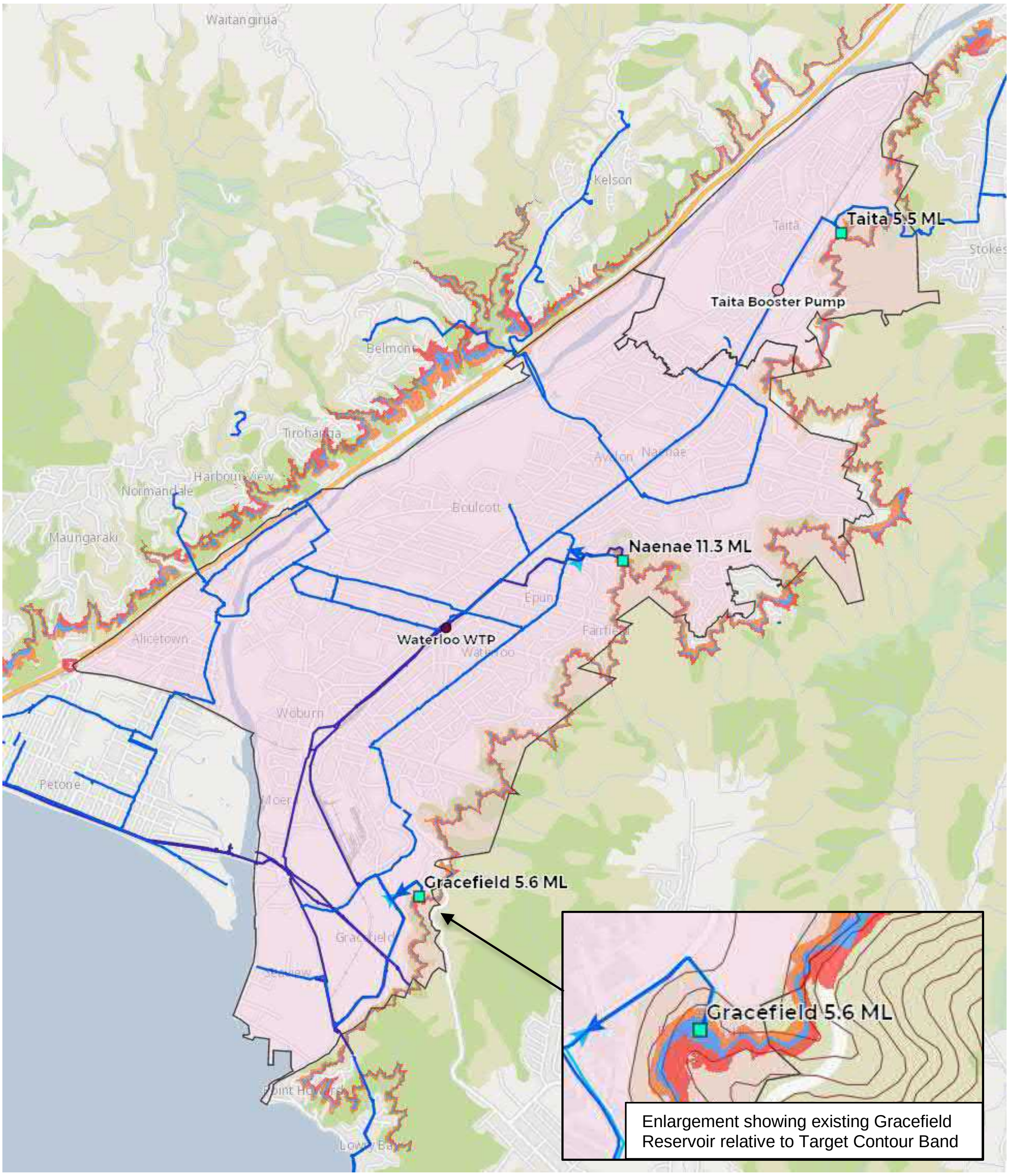

Figure 4. Target contour band for the proposed reservoir site

3.5 Access Constraints

Suitable, permanent access will be needed to the reservoir for construction, operation, and maintenance. The access road must be suitable for heavy vehicles (construction plant, water tankers etc).

Existing land use, particularly residential development, limits the number of access points to potential reservoir sites. The adjacent map shows where existing development and the Taita Cemetery appear to preclude formation of an access road from the existing road network on the valley floor to the target hillside zone in the eastern hills. There is limited existing road access to the target contour on the eastern hills and typically no road access from above.

- Residential/developed property - **crimson**
- Wesleyhaven Village and Open Polytechnic - **purple**
- Taita Cemetery - **pink**

There are relatively few opportunities for access from the valley floor up to the target contour zone along the eastern hills. Gaps in the existing development mapping should not be directly interpreted as suitable access corridors as these include reserve land, steep/inaccessible sites, and other properties where access may not be practicable or appropriate.

Constructing an access road from the valley floor to a site on the western hills would be challenging due to the steep terrain between the target contour band and SH2. Access to potential sites on the western hills would most likely be from an existing road above the desired BWL. This would require a sidling cut along the hillside grading down to the BWL.

It is preferable for potential reservoir sites to be located close to an existing public road with suitable characteristics to accommodate construction, operation, and maintenance traffic.

Topography (steep hillsides, deep gullies) may make accessing a potential reservoir site unfeasible. Construction of hillside roads generally requires extensive earthworks and a long route across a hillside may have a significant visual impact.

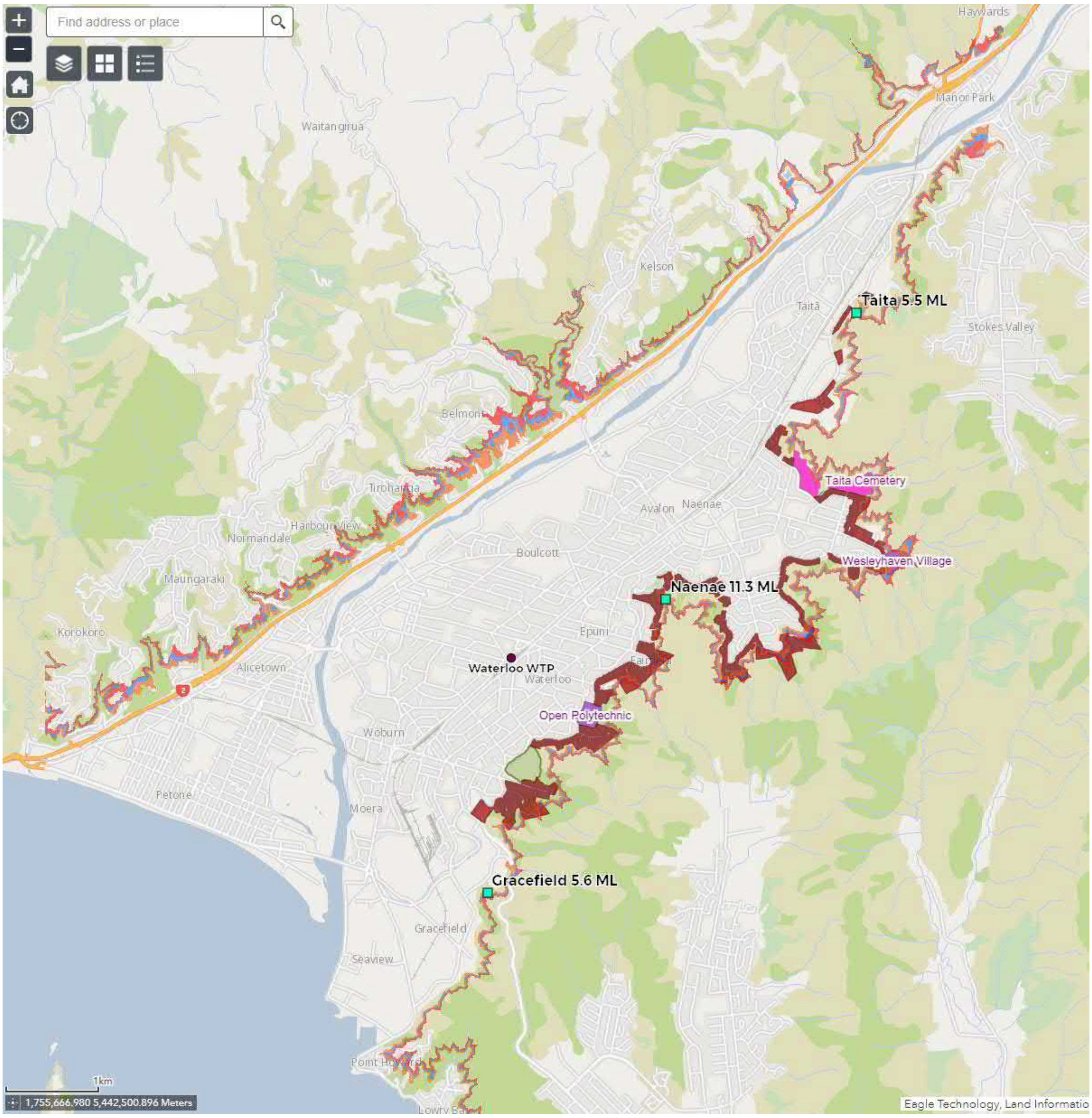

Figure 5. Existing development constraints on the eastern hills

3.6 Design Assumptions

Some simple design assumptions are made here for the purpose of screening potential sites at the target elevation with opportunity for road access, and subsequent estimation of quantities (earthworks, pipeline lengths etc) for preliminary cost estimation. All design assumptions will need to be reviewed, revised, and confirmed at the preliminary design stage following site selection.

3.6.1 Reservoir Shape, Size and Form

A **circular reservoir** is preferred over a rectangular reservoir for structural efficiency. Sites have been assessed for suitability assuming a circular reservoir, although this does not preclude use of a rectangular structure where site constraints make this solution more favourable.

For a circular reservoir with top and bottom water levels of 72.9 m and 66.4 m an internal diameter of 54.2 m would be required for 15 ML of storage. An **external diameter of 55.2 m** has been assumed, allowing for wall thickness and internal columns.

The **overall height will be approximately 8.35 m**, comprising a 250 mm base slab, 6.5 m internal water height, 1 m freeboard and a 600 mm roof thickness.

Table 2. Structural Elements – Initial Assumptions

Walls:	Precast post-tensioned reinforced concrete with cast-in-situ stitch joints – initial assumption of 250mm thickness
Roof:	Precast pretensioned reinforced concrete or cast in-situ reinforced concrete – initial assumption of 600mm deep beams supporting 150mm prestressed planks
Columns:	Precast reinforced concrete – initial assumption of 400mm square
Floor:	Cast in-situ reinforced concrete – initial assumption of 250mm thickness

For long-term maintenance and inspections of the reservoir above-ground structures are preferred. The benefits of soil pressure on side walls are countered by the imposed seismic loads that are associated with the soil, and in the event of any leakage it is almost impossible to determine where it is occurring when walls and foundations are buried.

For this initial screening it has been assumed that the reservoir will be **above ground** (not buried or partially buried). An above ground reservoir is preferable for inspection, maintenance, and minimising water quality risks.

Table 3. Structural Elements – General Design Parameters

Importance level:	**IL4** The importance level of an asset relates to the criticality or consequence of loss of the asset. An IL4 structure can be defined as a *utility or emergency supplies or installation required as backup for buildings and facilities of Importance Level 4 (buildings with post-disaster functions e.g. hospitals, civil defence headquarters, fire stations etc)*
Design life:	Concrete structures – **100 years** (design and durability) Access stairs, pipework, etc – 50 years (design and durability) The design working life is a concept used to select the probability of exceedance of different design actions – it does not mean that when the design working life is reached the structure will fail; nor does it mean that the design working life should correspond exactly with the intended useful life or with the durability of the construction materials.
Limit state design:	**1:2500 yr. AEP – ULS** 1:25 yr. AEP – SLS1 **1:500 yr. AEP – SLS2** SLS1 is a load that the reservoir must withstand *without requiring repair* to the reservoir after the event. SLS2 is only required for IL4 structures. For SLS2 the reservoir is required to *maintain operational continuity* (note that this does not necessarily mean no damage is suffered by the reservoir). ULS is the load that the reservoir must withstand *without collapse*, or the reservoirs stability being seriously affected. Some damage is likely.
Water tightness class:	WT Class 2 (leakage to be minimal, appearance not to be impaired by staining).

3.6.2 Reservoir Footprint and Earthworks Extent

A reservoir construction pad level of 66.15m has been assumed from a 66.4m bottom water level and allowance for a 250mm base slab. The construction pad needs to accommodate an approximate 55.2m diameter reservoir. In addition to this a 5m buffer has been assumed for slope stability above natural slopes or below cut batters. This brings the **total construction pad diameter required to 65.2m**.

The extent and volume of earthworks required to form the construction pad has been determined by applying **1H:1V cut slopes** and **2H:1V fill slopes** to form the nominal construction pad.

A nominal 20m buffer has been allowed for between the existing Naenae reservoir and a potential reservoir at this site. This is to allow for upsizing of the existing reservoir at a later stage, as anticipated in the reservoir sizing assessment. This buffer will need to be confirmed if the site is taken to the shortlist.

3.6.3 Access

Site access must be suitable for construction equipment, delivery of materials and for ongoing operation and maintenance purposes. A **nominal 5 m width** has been adopted for access roads. The **maximum grade** (slope) will need to be limited to about **10%** (10 m vertical climb over 100 m horizontal distance) with **minimum horizontal radius curves of 20 m**.

3.6.4 Inlet/Outlet Pipelines

The new reservoir is required to have **dedicated inlet and outlet mains**. An initial assessment suggests that these will need be in the order of **DN (nominal diameter) 750 mm pipelines** in order to deliver the anticipated peak day volume over an 18-hour period, with the existing Naenae reservoir out of service (i.e., during repair, refurbishment or renewal).

The required inlet and outlet pipeline lengths will be determined by proximity to Waterloo WTP, and large diameter distribution pipework in the supply area. Potential connection points have been identified and pipeline routes are likely to follow road corridors.

Further hydraulic analysis will be needed to confirm pipeline sizes, connection points and alignments for preferred options.

3.7 Site Identification

A range of potentially accessible reservoir sites within the target elevation band have been identified. These are indicated on the adjacent map and tabulated below. Other values (eg cultural, ecology, land ownership) are not included in this initial screening process which his intended to identify technically suitable sites.

Sites with closer proximity to the Water Treatment Plant are more favourable due to reduced need for additional new pipe network infrastructure.

Consideration of sites has not been limited to the eastern hills, although there are significant challenges that would make siting a new reservoir on the western hills an unattractive proposition. In particular, the need to construct connecting pipelines through the CBD, across the Hutt River, the Wellington fault, and State Highway 2. A few representative sites have been included in the initial screening assessment.

On closer examination many of the sites can be discounted from further consideration, generally due to steep terrain that would make access or formation of a suitable reservoir platform not feasible. Some sites have also been set aside where an adjacent site offers clear benefits.

Fourteen potential sites were taken forward for further consideration.

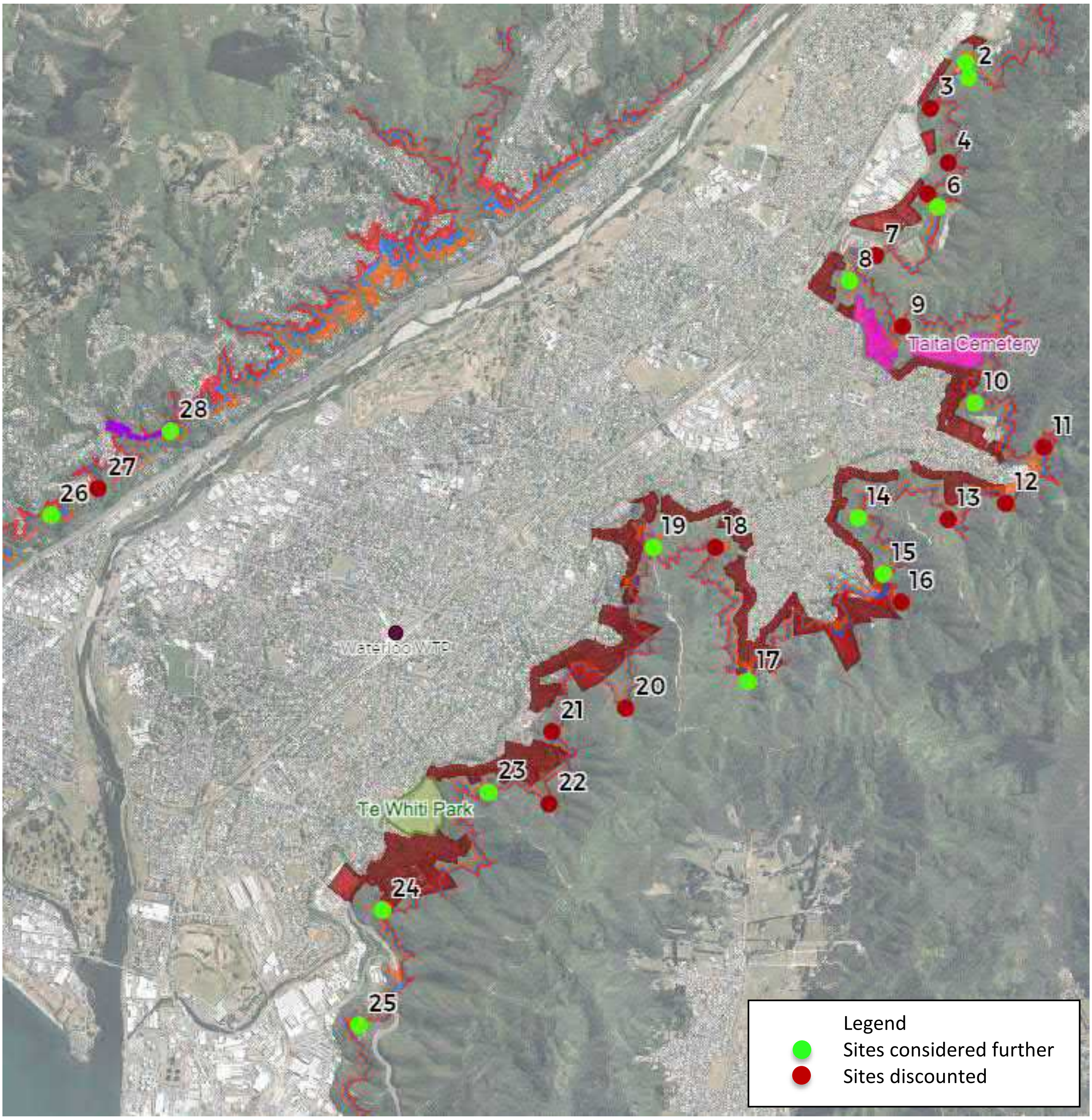

Figure 6. Potential reservoir sites considered in initial screening assessment – refer Table 4.

Table 4. Initial site screening summary

Site Number	Site Name ✖= discounted	Initial screening comment	Outcome
1	Taita 3	Site has existing road access to Taita reservoir. Potential site for long list assessment.	Consider further
2	Taita 2	Site has existing road access to Taita reservoir. Potential site for long list assessment.	Consider further
3	✖	Access to this site does not look feasible due to steep grades. Ridgelines are narrow and steep which will lead to large earthworks volumes. Not feasible.	Discounted
4	✖	This site has a narrow contour band indicating that the site is very steep. Access to this site does not look feasible due to steep grades.	Discounted
5	✖	The site has an existing access road crossing the bottom water level. However, this site is very steep. A reservoir pad at this location would likely extend to approximately the 95m contour before grading at 1:1. This will lead to very high cut heights which look unfavourable compared to other nearby sites.	Discounted
6	Page Grove	Existing road crosses the required bottom water level. Wider contour band than surrounding sites.	Consider further
7	✖	The site is very steep. A 65m diameter reservoir pad at the bottom water level would be at roughly the 100m contour before grading at 1:1. Site is not feasible at these earthworks heights.	Discounted
8	Cambridge Terrace	Wide contour band at the desired bottom water level. Potential site for long list assessment.	Consider further
9	✖	Sites in this area are adjacent to the Taita cemetery. No go option for the long list assessment.	Discounted
10	Patricia Grove	Wide ridgeline between desired bottom water level. Access may be possible from existing development with short extension to bottom water level. Potential site for long list assessment.	Consider further
11	✖	Would require access through the existing Wesley Rata Village (rental accommodation, rest home and hospital care). Access to this site seems unlikely.	Discounted
12	✖	This looks to have easy access from the existing road leading to the Rata reservoir. However, this site is very steep. A reservoir pad at this location would likely extend to approximately the 90m contour before grading at 1:1. This will lead to very high cut heights which look unfavourable compared to other nearby sites.	Discounted
13	✖	This site is very steep and would lead to very high cut heights which do not look feasible. Other sites in the nearby gullies will have similar high cuts and will have added drainage design issues.	Discounted
14	Waddington Drive	Wide ridgeline between desired bottom water level which is favourable for site earthworks. However, requires constructing a long access road. Potential site for long list assessment.	Consider further

Site Number	Site Name ✖= discounted	Initial screening comment	Outcome
15	Swainson Street	Potential site location with a short access road construction required.	Consider further
16	✖	A site at this location would require grading down at approximately 10% to the required 66.15m level. Adding the reservoir pad dimensions to this mean that the ground level that would need to be cut is at approximately 120m. This level of cut is unfeasible.	Discounted
17	Willcox Grove	Existing road leads to the required bottom water level. Potential site for long list assessment.	Consider further
18	✖	Possible location although looks less favourable than beside the existing Naenae site. Would also be difficult to get an access road to this site.	Discounted
19	Naenae 2	Existing road leads close to the required bottom water level. Potential site for long list assessment.	Consider further
20	✖	The site has unfavourable access beside existing residential properties and through a scenic reserve. The gullies would have unfavourable ground conditions with soft sediments. The surrounding hills are very steep and a reservoir pad cut into these would have very high cuts and high earthworks volumes.	Discounted
21	✖	A site at this location would require access through the Open Polytechnic. The sites are very steep and it will be unfeasible to construct an access road of 10% grade or less to the reservoir platform.	Discounted
22	✖	Access to this location does not look feasible due to existing developments. The gullies would have unfavourable ground conditions with soft sediments. The surrounding hills are very steep and a reservoir pad cut into these would have very high cuts and high earthworks volumes.	Discounted
23	Te Whiti Riser	Some wide ridgelines in this area which may be suitable for a reservoir. However, the site is steep which may be difficult for road access. Potential site for long list assessment.	Consider further
24	Mawson Street	Wide ridge which looks suitable for a reservoir platform. Potential site for long list assessment.	Consider further
25	Gracefield 2	Existing access road to Gracefield reservoir. New reservoir may be able to be cut in behind the existing reservoir. Potential site for long list assessment.	Consider further
26	Normandale Road	Wide contour band at the desired bottom water level. Potential site for long list assessment.	Consider further - representative of western hills sites
27	✖	Appears to be in the process of being developed from aerial photographs.	Discounted
28	Harbour View Road	Wide ridgeline which may be suitable for a reservoir construction pad.	Consider further - representative of western hills sites

3.8 Site Option Development

Following the initial screening assessment, fourteen potential site options were further developed to assess indicative earthworks volumes, cuts and fills to form a suitable reservoir platform and access road, and potential corridors for inlet and outlet pipelines. These are shown in Figure 7 along with nominal pipeline corridors (red = inlet, yellow = outlet) for each option. The pipeline length offers an indication of relative costs for the various options, community disruption and construction challenges including rail and waterway crossings.

Figures 8 to 15 show each site in more detail with the purple hatched areas indicating the anticipated extent of earthworks, providing an indication of the potential cost and impact of each option.

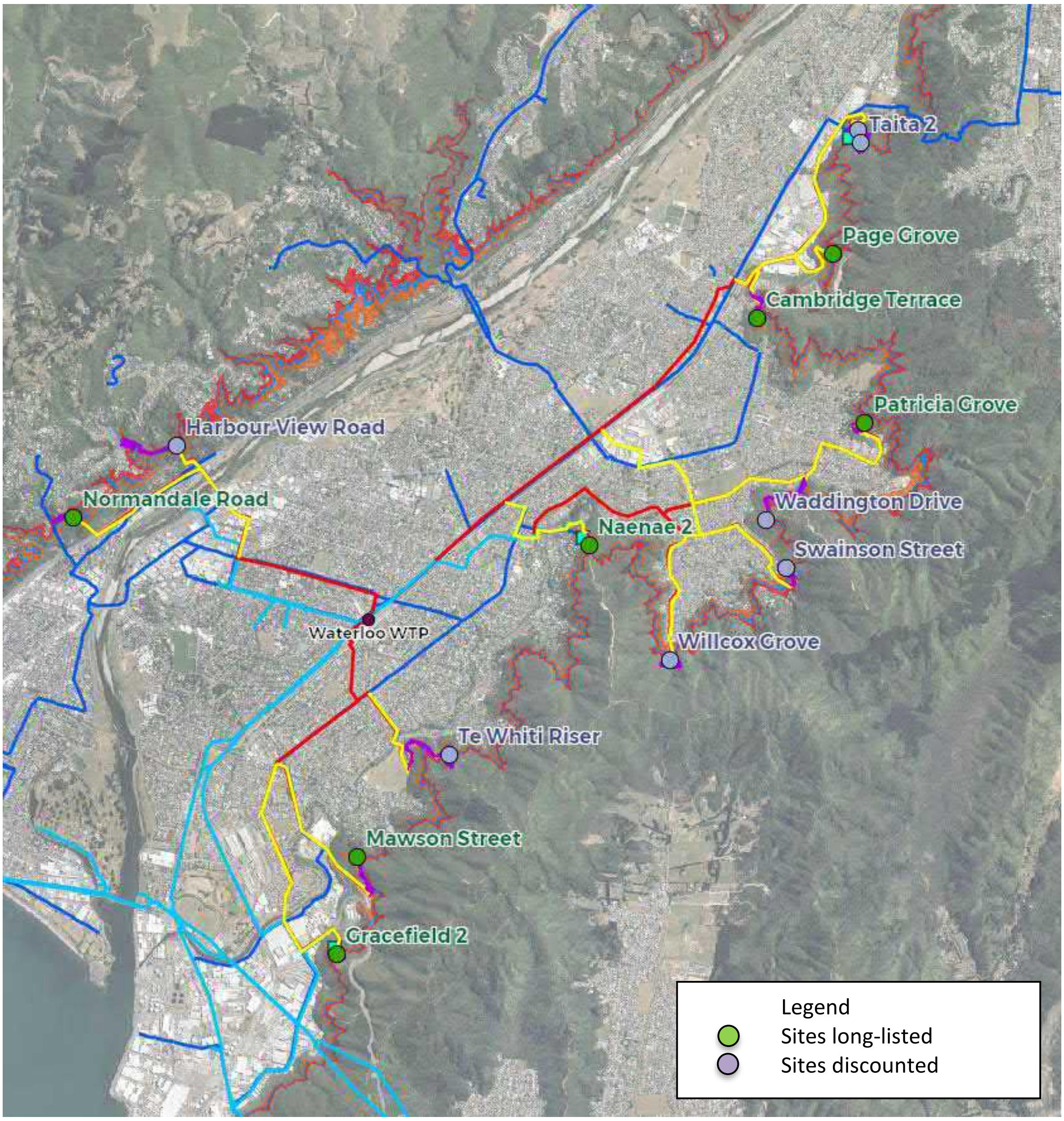

Figure 7. Overview of potential sites and pipeline corridors

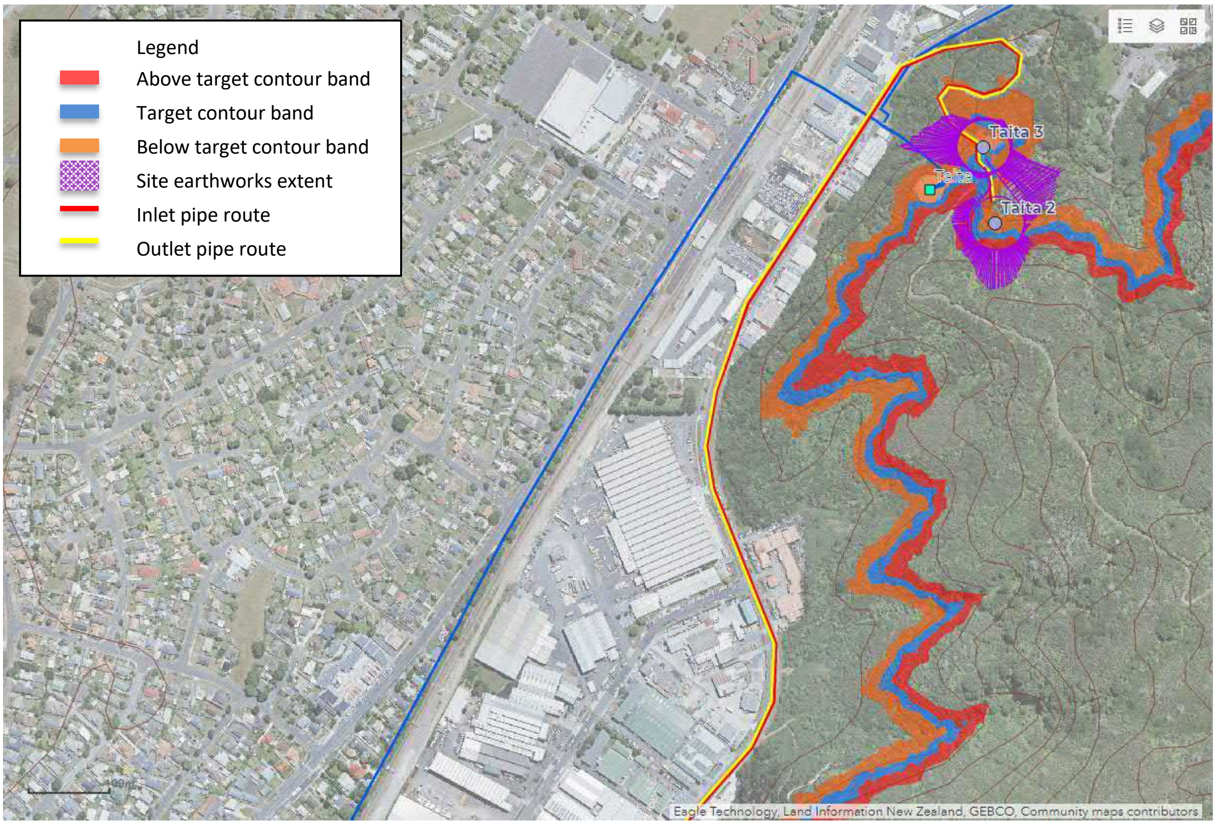

Figure 8. Earthworks extents for Taita 2 and Taita 3 sites

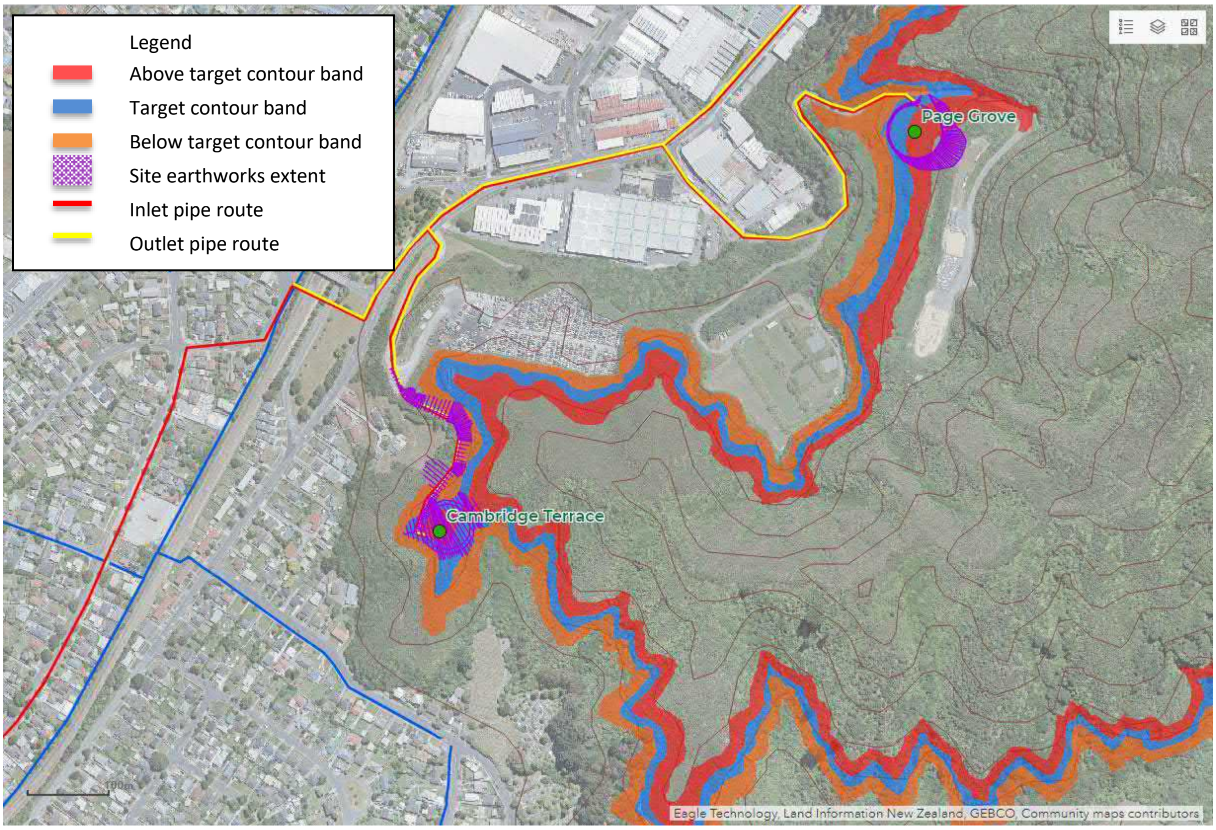

Figure 9. Earthworks extents for Page Grove and Cambridge Terrace sites

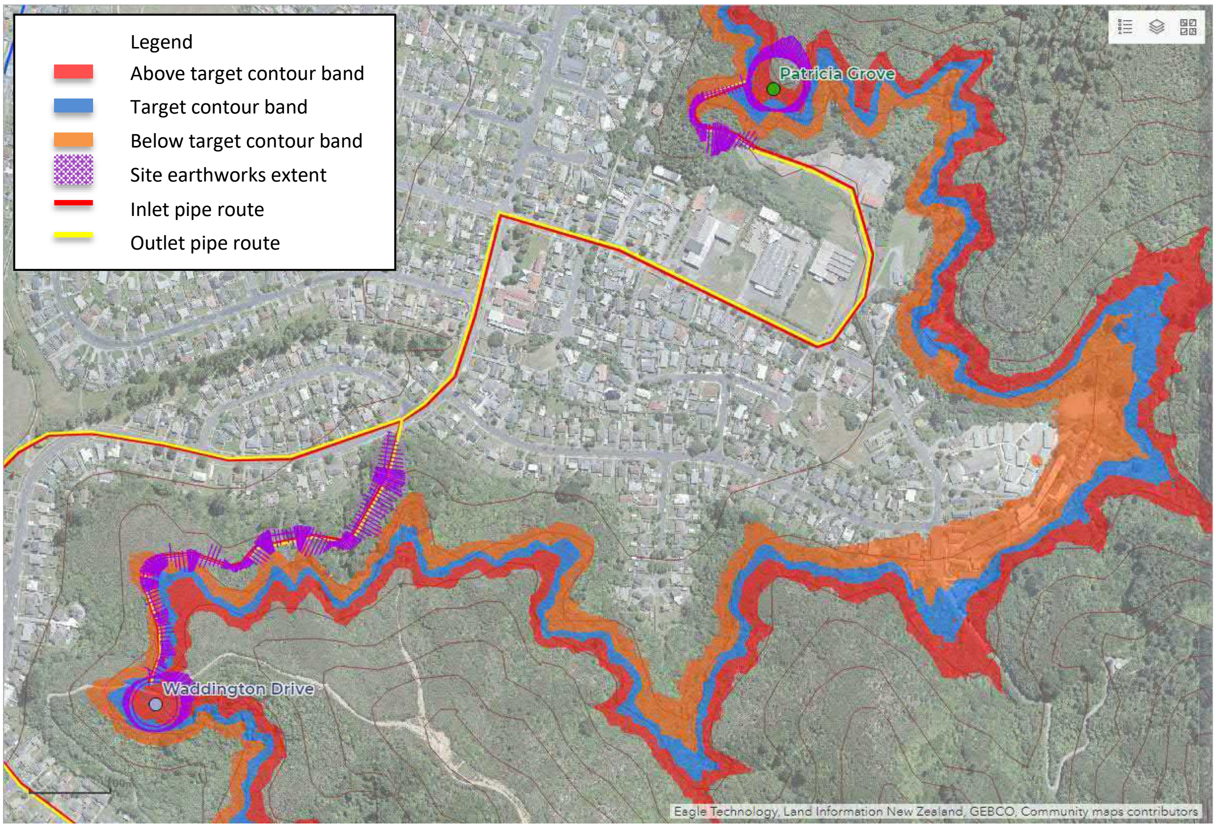

Figure 10. Earthworks extents for Patricia Grove and Waddington Drive sites

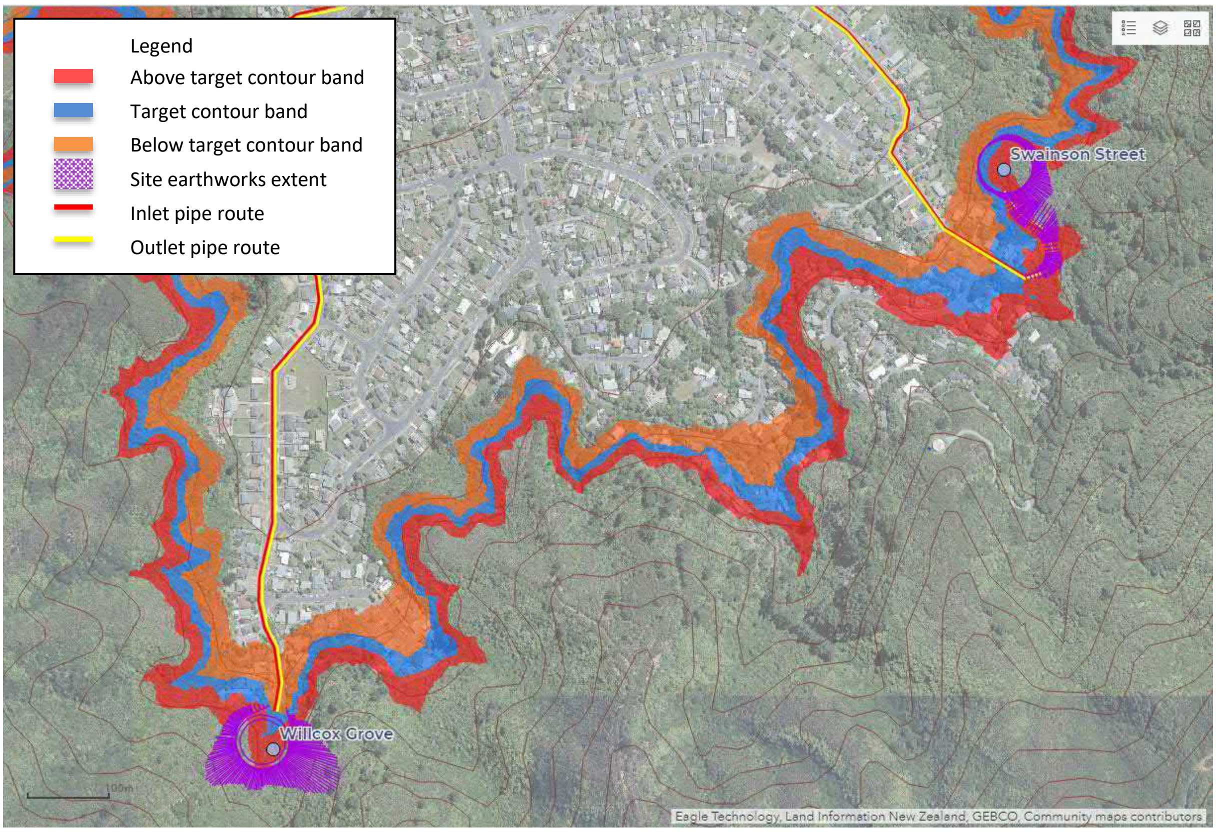

Figure 11. Earthworks extents for Swainson Street and Wilcox Grove sites

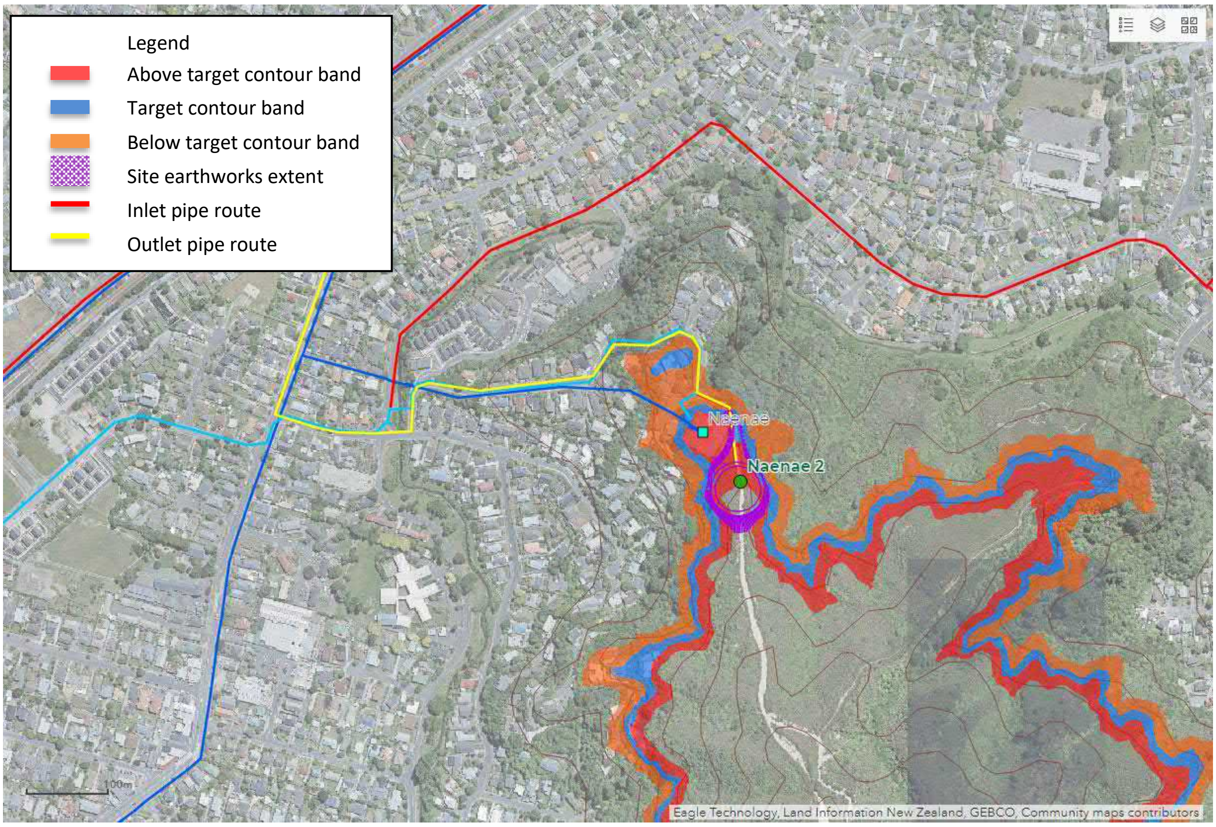

Figure 12. Earthworks extents for Naenae 2 site

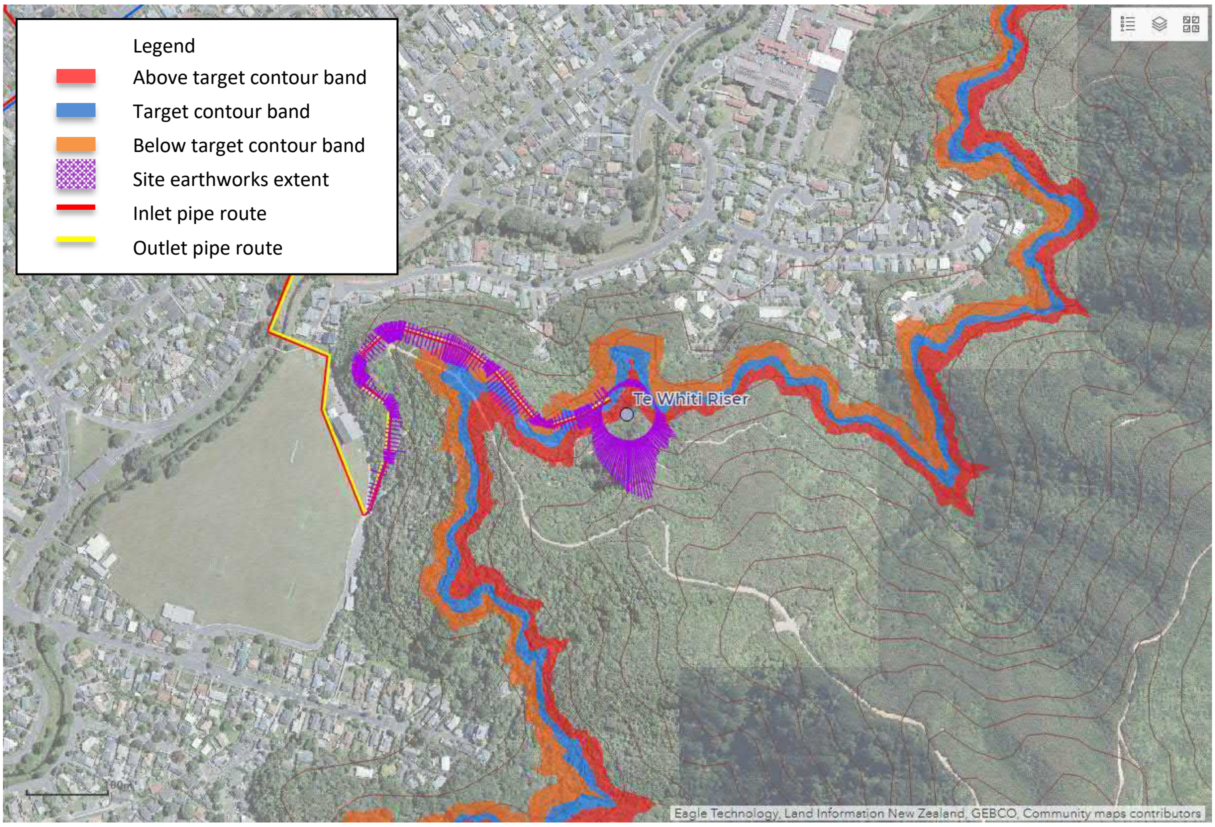

Figure 13. Earthworks extents for Te Whiti Riser site

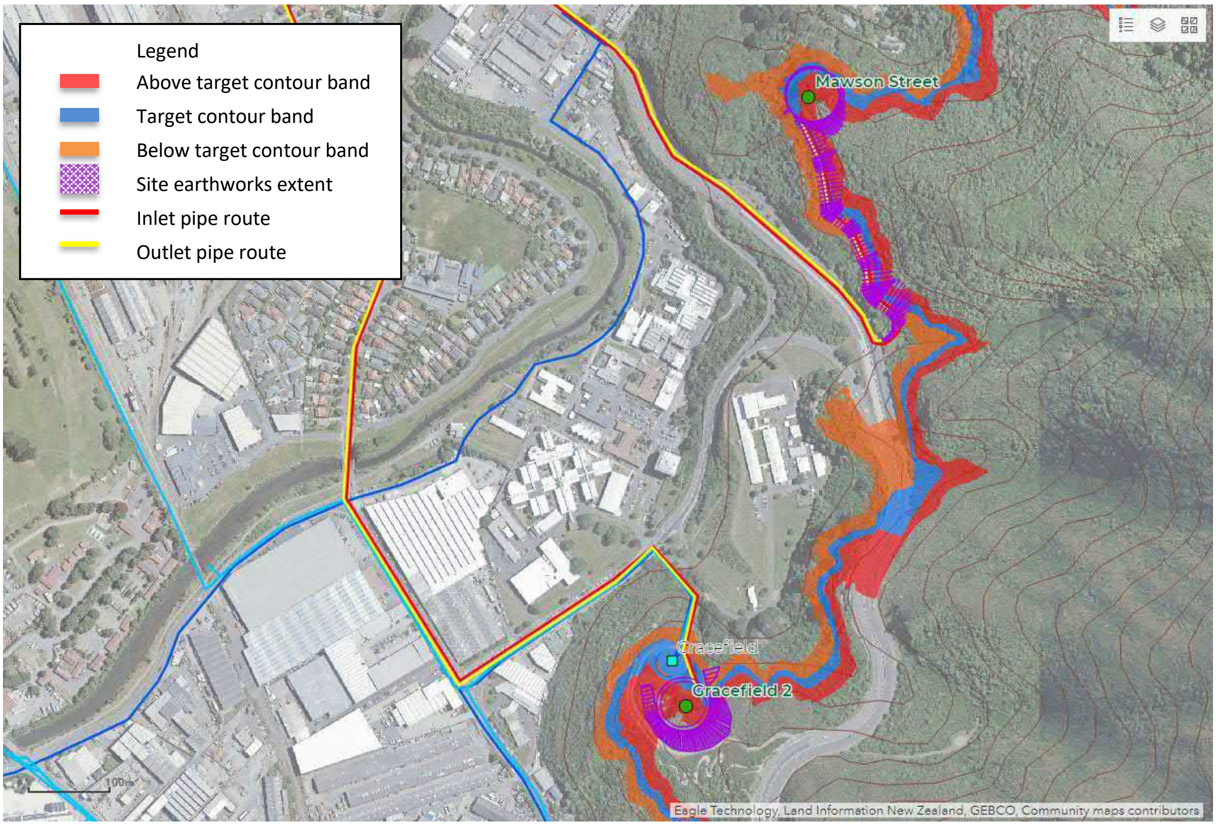

Figure 14. Earthworks extents for Mawson Street and Gracefield 2 sites

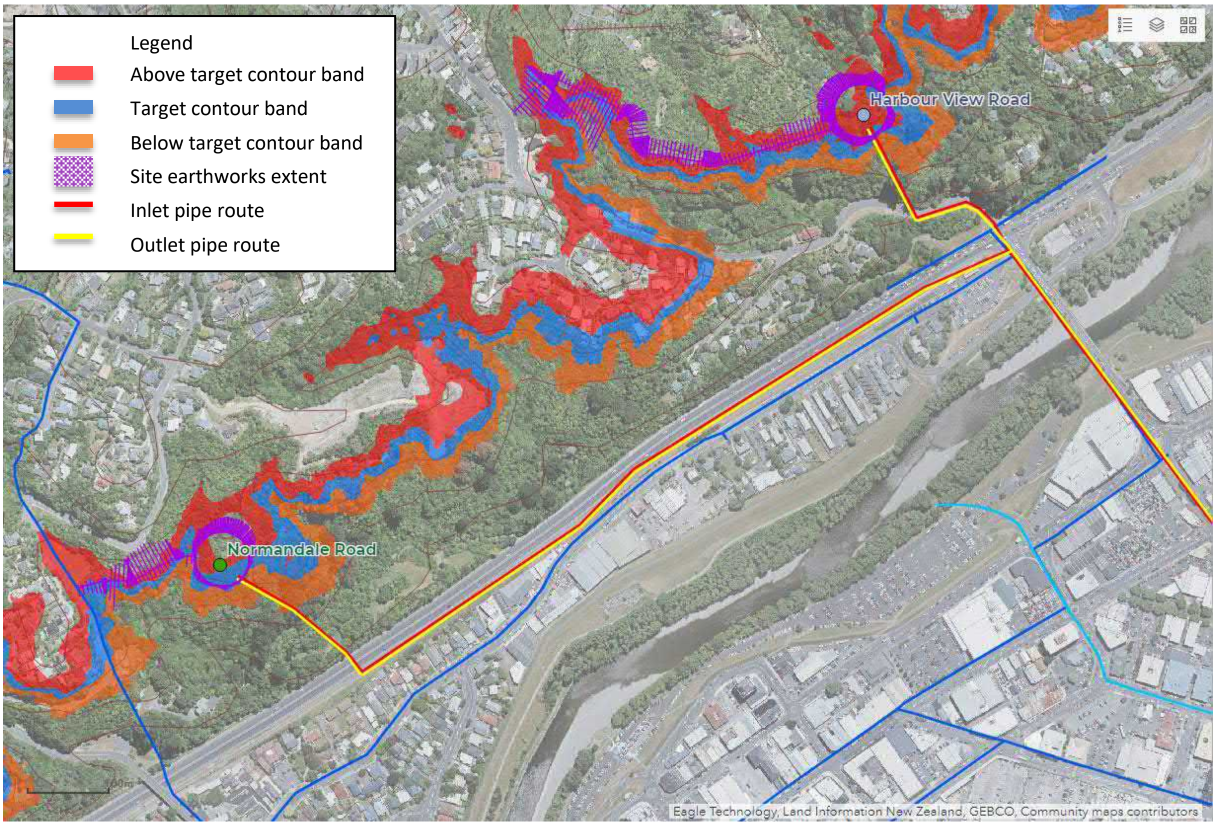

Figure 15. Earthworks extents for Normandale Road and Harbour View Road sites

Indicative earthworks, access road and pipeline requirements for each site are summarised in Table 5 below. The least favourable sites (marked X) have been discounted due to:

- Significantly greater earthworks volumes
- Very high earthworks cut and/or fill heights
- Long/unfeasible access roads
- Long pipeline routes

The remaining seven sites form our Long List for consideration across a broader range of attributes and values. This includes Normandale Road as a 'representative' western hills site option in order to explore any potential benefits of a western hills site that may counter the risks, difficulties and costs associated with crossing the Wellington Fault, Hutt River and State Highway 2.

Details for each site are summarised below, with favourable and unfavourable characteristics shaded green and pink respectively.

Table 5. Site earthworks, access road and pipe requirements for potential sites

Site		Site Earthworks				Access Road					Inlet Pipe	Outlet Pipe
		Cut (m3)	Fill (m3)	Cut (m)	Fill (m)	Length (m)	Cut (m3)	Fill (m3)	Cut (m)	Fill (m)	Length (m)	Length (m)
1	Taita 3	0	30000	5	67	~150	*Site discounted – not modelled*				5300	2200
2	Taita 2	-35000	45000	47	30	50	Included in site earthworks				5300	2200
6	Page Grove	-50000	0	30	0	existing					4300	1100
8	Cambridge Terrace	-30000	0	13	0	250	-11000	2000	19	15	3900	700
10	Patricia Grove	-70000	0	26	0	180	-2500	4500	15	15	3600	3300
14	Waddington Drive	-45000	0	22	0	550	-51000	600	28	9	3000	2600
15	Swainson Street	-65000	0	32	0	140	-2200	0	28	0	2700	2500
						Access road not considered to be feasible						
17	Willcox Grove	-130000	0	74	0	existing					2500	2500
19	Naenae 2	-70000	0	20	0	existing					100	1100
23	Te Whiti Riser	-120000	0	74	0	580	-50000	500	24	4	2100	1300
24	Mawson Street	-45000	0	23	0	315	-35000	0	37	0	3100	1600
25	Gracefield 2	-75000	0	32	0	existing					3500	2000
26	Normandale Road (western hills)	-55000	0	18	0	150	-18000	2000	30	18	3300	2000
28	Harbour View Road	-60000	0	23	0	460	-30000	65000	20	28	2400	1100
		Access to this site will be very challenging requiring crossing two gullies and will require a large amount of earthworks volumes in the order of 95,000m3. This site has been discounted in favour of the Normandale site which appears to have an easier access route. Both sites provide a representative example of the challenges associated with siting a reservoir on the western hills.										

3.9 Long List Sites

Seven sites were longlisted for further consideration.

Table 6. Long List sites

Site Number	Site Name
6	Page Grove
8	Cambridge Terrace
10	Patricia Grove
19	Naenae 2
24	Mawson Street
25	Gracefield 2
26	Normandale Road

Three dimensional representations of the favoured sites have been prepared to help visualise the scope and scale of the various site options. See Figures 16 to 22. These are indicative only and are based on early conceptual modelling which can be expected to change as further investigations, survey and design development is undertaken. The brown shaded areas indicate the extend of earthworks cut and fill required to form a suitable reservoir foundation pad and access road.

Figure 16. Page Grove site

Figure 17. Cambridge Terrace site

Figure 18. Patricia Grove site

Figure 19. Naenae 2 site

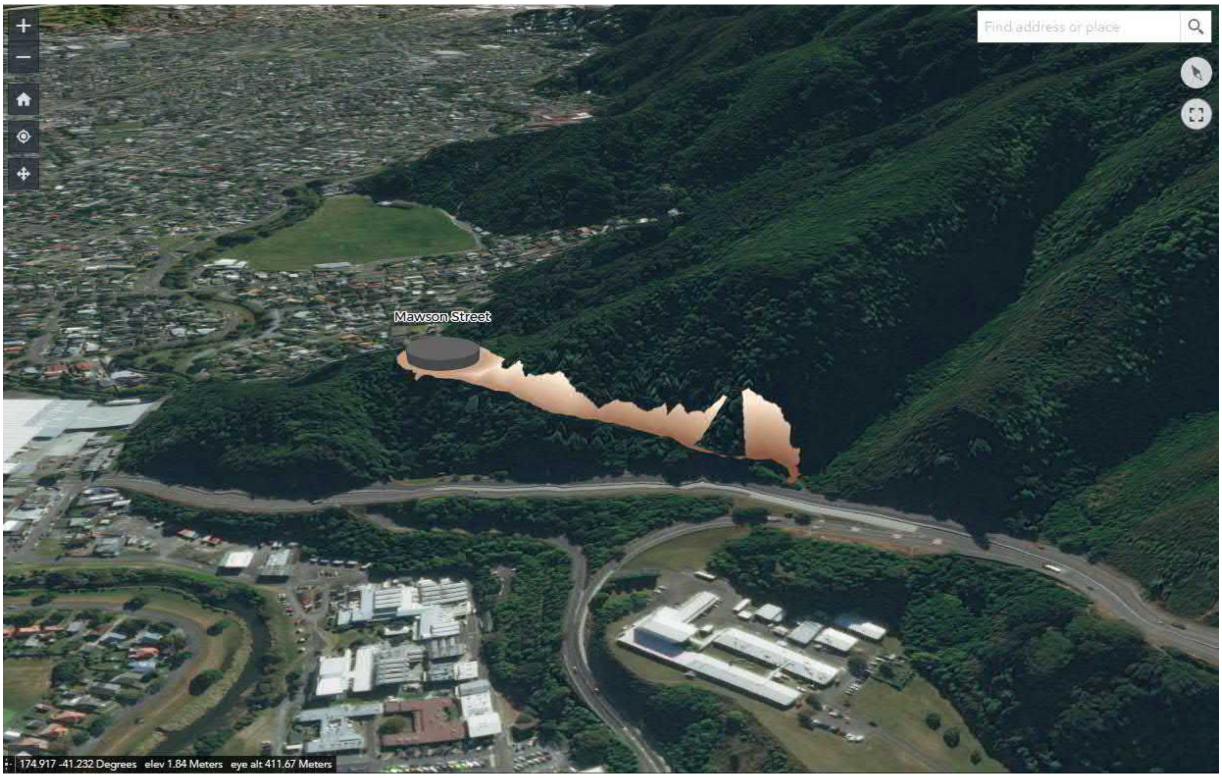

Figure 20. Mawson Street site

Figure 21. Gracefield 2 site

Figure 22. Normandale Road site

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4 Shortlisting of Preferred Sites

4.1 Overview

A variety of other factors have been considered at a relatively high level across the longlisted sites in order to identify a short list of preferred sites for more detailed evaluation and multicriteria analysis (MCA). This desktop exercise draws on publicly available information with some interpretation and observations from subject matter experts.

The GIS map viewer was used extensively for this assessment. The following sections summarise the findings in each category and include selected extracts from GIS but the map viewer (refer section 3.1) will need to be used if the reader wishes to view detailed spatial information for a particular site.

A tabulation of the sites with qualitative scoring across a range of factors (excluding cost) has been prepared and used as the basis for shortlisting preferred sites. High level cost estimates have been prepared to provide a relative comparison of option costs. These will be refined for the shortlisted options.

Land ownership has been identified to highlight risk of private property impacts that may be associated with each option. No engagement with landowners has been initiated, engagement in regard to specific property impacts relating to the identified preferred option will be initiated in subsequent design stages.

Wellington Water is building strategic relationships and engaging with mana whenua across an extensive portfolio of projects. Mana whenua representatives from Taranaki Whanui, have met with Wellington Water supported by the project team, to share project information and knowledge of potential cultural value impacts.

4.1.1 Geotechnical conditions and hazards

None of the sites under consideration, or their access corridors are in close proximity to recorded landslides.

The **sites on the western hills** are close to the Wellington Fault and are likely to experience a higher seismic load in an event compared to sites on the eastern hills. Road access to the western hills crosses the Wellington Fault and is therefore likely to be severely disrupted. The pipeline routes for the Normandale site also would cross the fault.

Pipelines to **Patricia Grove, Mawson Street, Gracefield 2 and Normandale Road** pass through moderate-high and high risk combined earthquake hazard zones. This is due to a combination of high ground shaking and liquefaction potential. The local roads in these areas will also be susceptible to damage and disruption from liquefaction further impacting access to the sites.

The **Page Grove, Mawson Street and Gracefield 2** sites are in close proximity to slopes classified as moderate-high slope failure susceptibility. Access to the **Mawson Street** site will require formation of cut slopes downhill from erosion prone land and will be at risk from disruption due to landslides or debris flows.

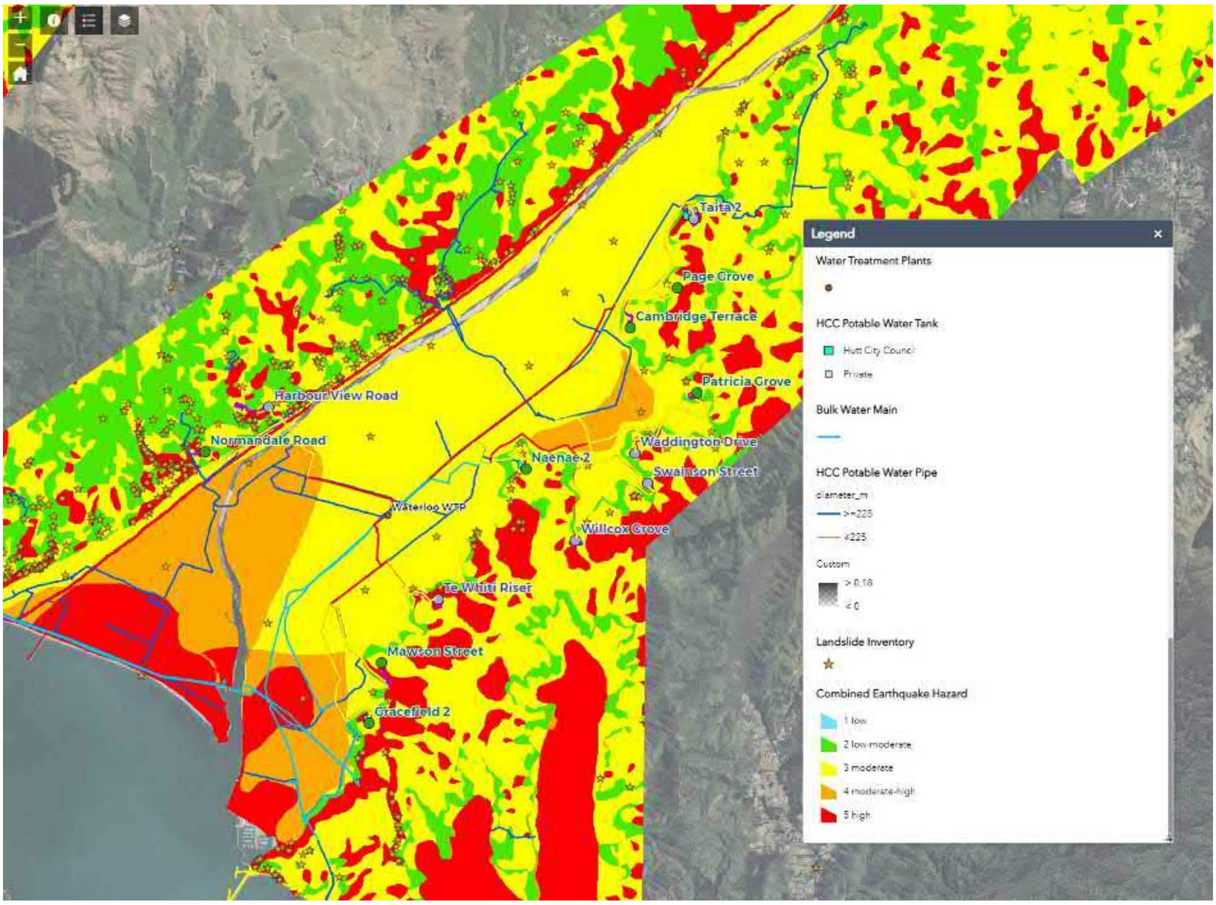

Figure 23. Combined earthquake hazard map and known landslide locations (denoted by stars)

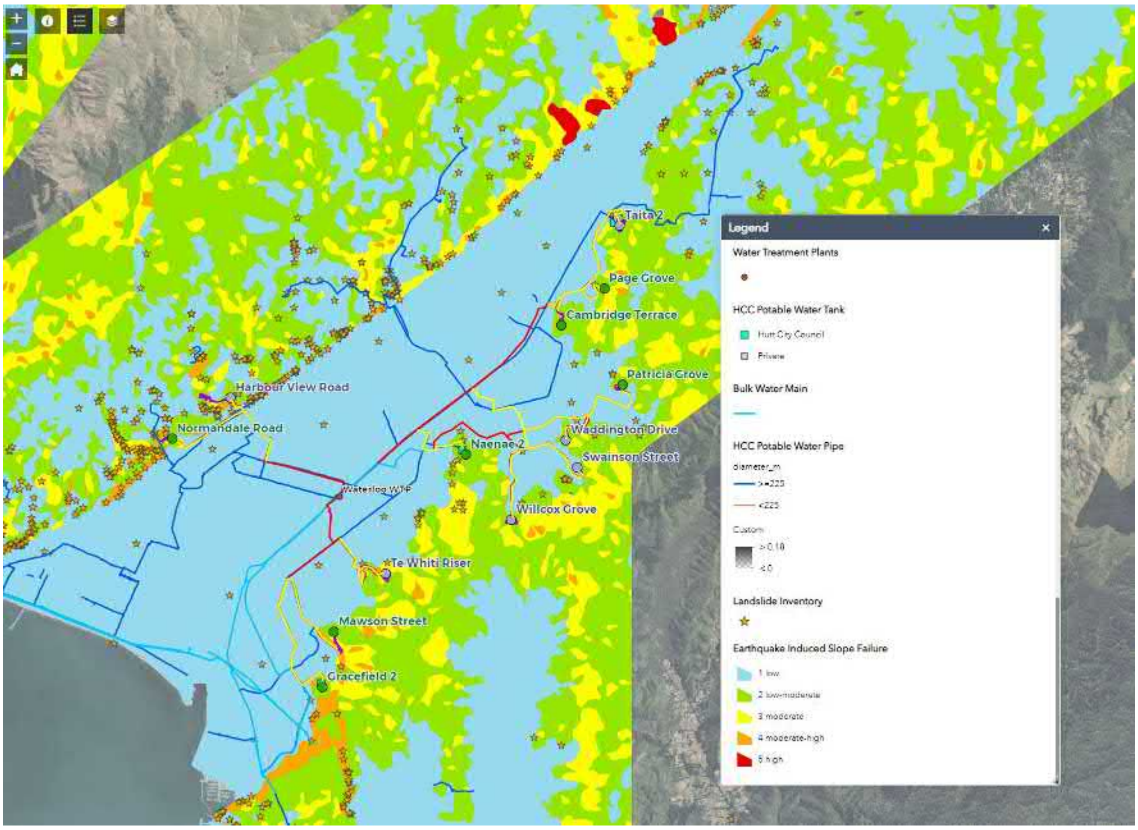

Figure 24. Earthquake induced slope failure risk

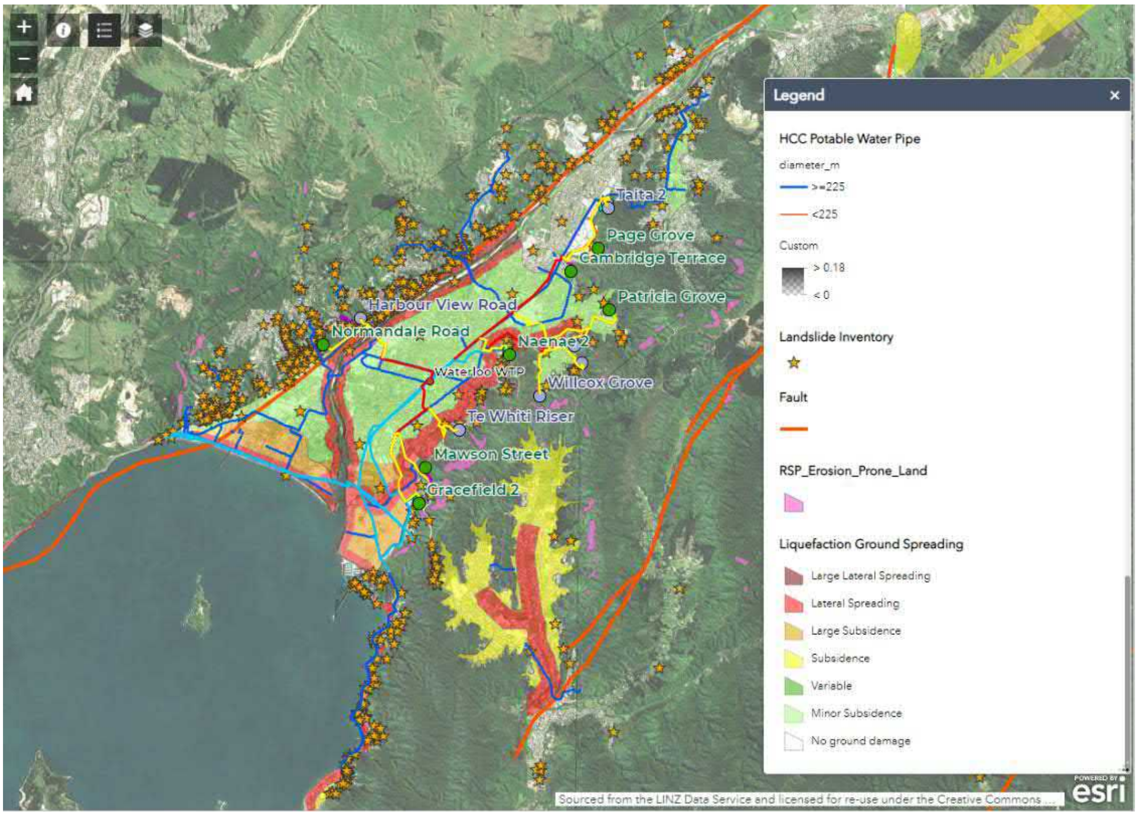

Figure 25. Liquefaction ground spreading potential map

4.1.2 Selected Land Use Register (SLUR) sites (contaminated land)

Sites with a known history of land use with potential for land contamination are recorded in the SLUR. Sites on or adjacent to SLUR sites will require further assessment to understand the associated risk and need for specific investigation if shortlisted.

The pipeline routes to all sites predominately follow the existing roads and have instances where SLUR sites are adjacent to the pipe routes. Areas with a high number of SLUR sites are the Naenae shopping area and the Gracefield industrial area.

Page Grove would be located on the former Wingate Landfill. Pipelines to and from the reservoir would also require construction through the landfill. This is likely to have significant construction cost implications in relation to foundation conditions and earthworks management and disposal.

The access road and pipelines for the **Cambridge Terrace** site would be constructed through a noted SLUR site. The site is occupied by Pick-A-Part (car wreckers) which meets the requirements of a hazardous activity. The site is subcategorised under scrap yards including automotive dismantling, wrecking or scrap metal yards.

There are two noted SLUR sites near the **Patricia Grove** reservoir site. The proposed pipe alignments would pass close to these locations. The first site contained an underground storage tank for the purpose of storing diesel. The other nearby site is used for the formulation of chemicals and hazardous substances are stored in bulk.

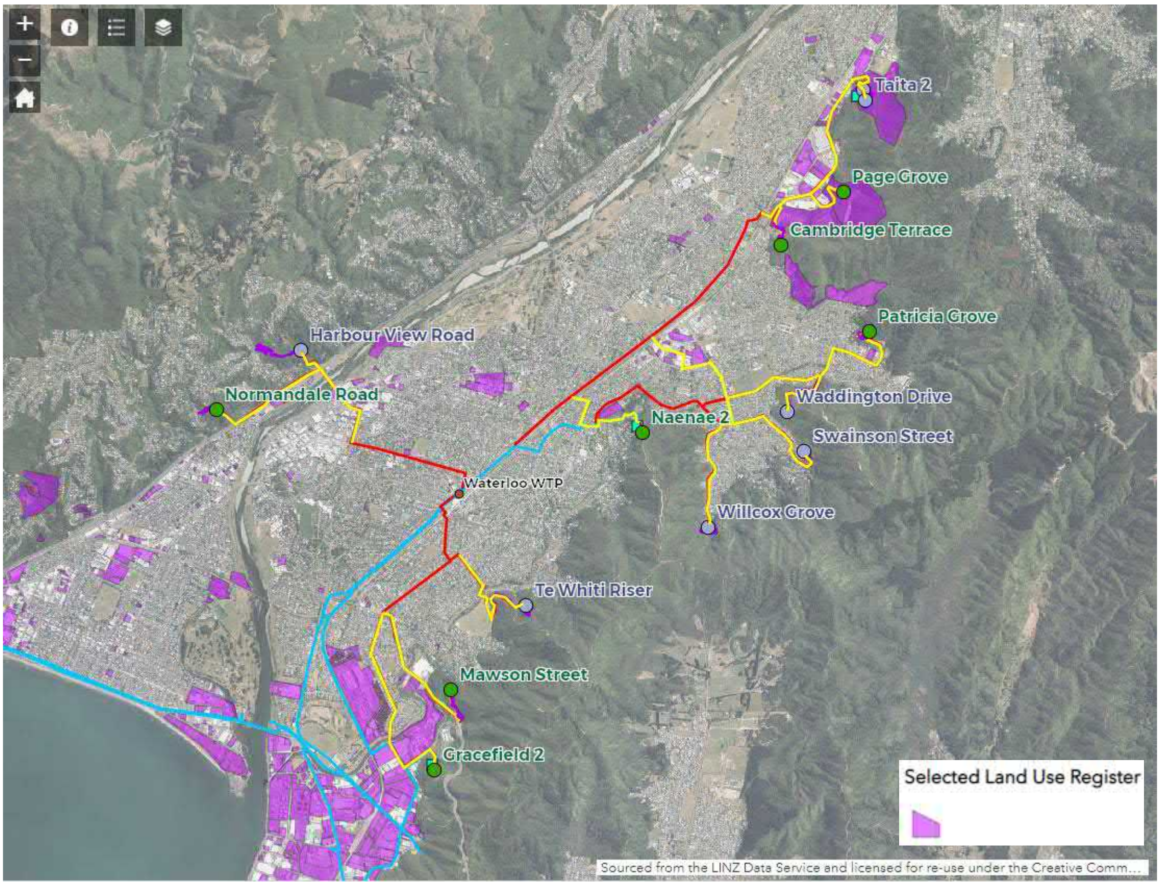

Figure 26. Potential contaminated land hazards (SLUR sites)

4.1.3 Planning

The sites under consideration are all either on reserve land and/or a significant natural resource site identified in the District Plan. The sites **Page Grove, Patricia Grove, Gracefield 2 and Normandale Road** are in reserves and would require permission under the reserves act which is a process that does not have statutory timescales. This means that there is no time limit on consenting timeframe, and thereby, presenting potential risks of delay to the construction programme.

Sites in proximity to residential areas (**Patricia Grove, Naenae 2** and **Normandale**) would be less favourable to those in a more commercial/industrial environment (**Gracefield 2**) or those located adjacent to existing reservoirs (**Naenae 2, Gracefield 2**). This is because locating new reservoirs in a commercial/industrial environment introduces similar land use activities and avoids any potential adverse effects on residential areas. Furthermore, locating new reservoirs near existing reservoirs is favourable because the proposed activity is already established.

The **Patricia Grove, Naenae 2, Mawson Street and Cambridge Terrace** sites have moderate to high vegetation cover and would likely require mitigation for vegetation removal.

Sites or access corridors in private ownership (**Cambridge Terrace and Patricia Grove**), particularly where multiple landowners are involved, would typically be less favourable than those controlled by Hutt City Council. This is because affected party approval is required from private landowners as part of the consenting process. In the event that affected parties do not provide their approval, the application will be subject to limited notification, which extends the consenting timeframe by a minimum of 65 working days.

Of the considered sites most can be expected to have similar consenting challenges. The **Gracefield 2** site would appear more favourable as it is located beside an existing reservoir and is away from residential areas. The **Patricia Grove** site is less favourable, with higher risk due to private property and adjacent residential land use. The **Normadale** site is also less favourable, being a significant resource site and reserve likely to require significant mitigation for vegetation removal and is close to residential areas.

It is noted that this initial planning assessment has not considered the associated pipe work required to connect the new reservoir to the Waterloo treatment plant.

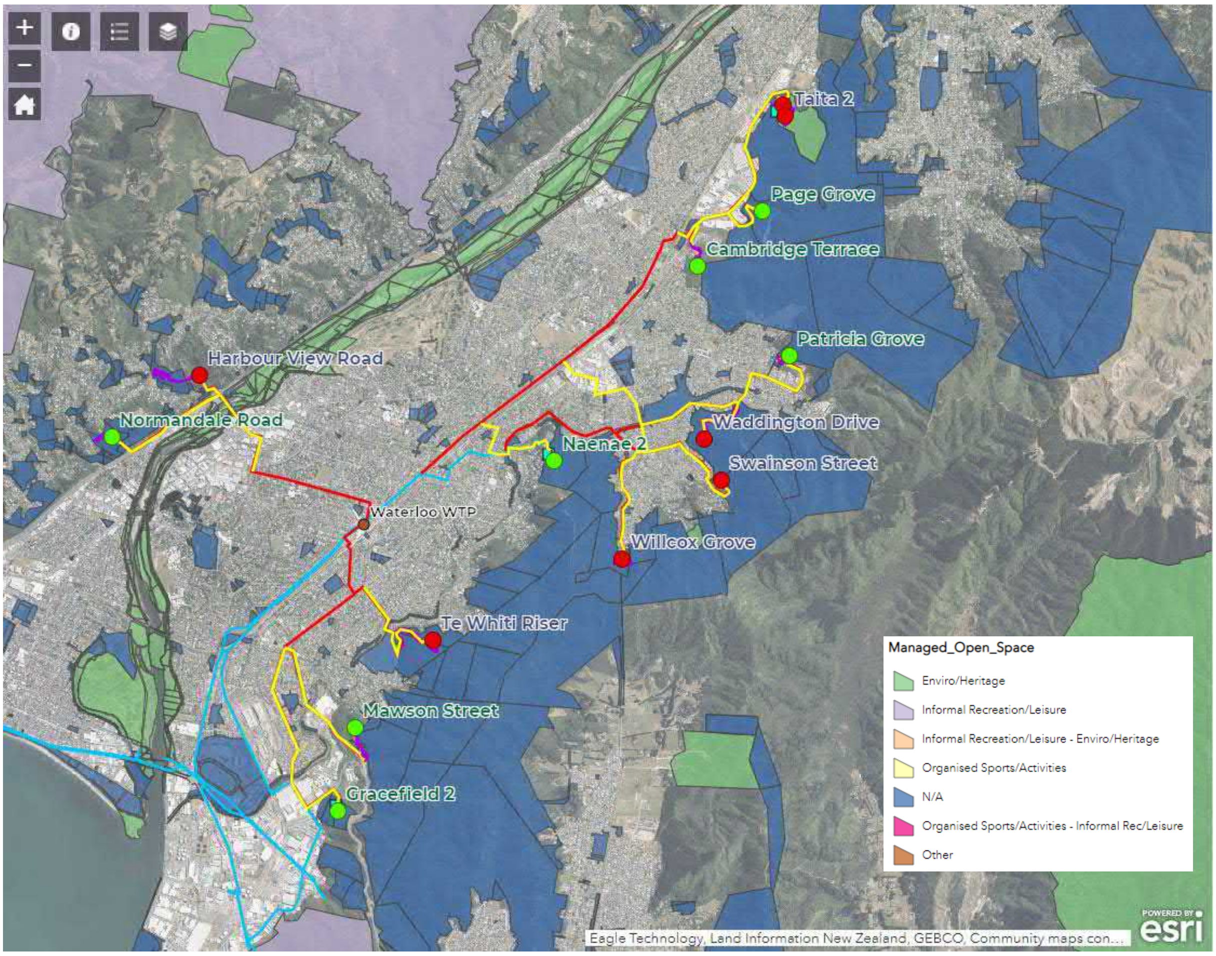

Figure 27. Reservoir site options in relation to Managed Open Space (GWRC)

4.1.4 Ngā Taonga Nui a Kiwa (Treasured inheritance of Kiwa)

- Te Awa Kairangi and Waiwhetu are waterbodies of most importance to mana whenua. This is recorded in Schedule B of the PNRP for Ngāti Toa Rangitira and Taranaki Whānui.
- For Ngāti Toa these relationships include mahinga kai, ara waka and Te Awa Kairangi as a source of mana for Ngāti Toa. Despite its current condition as a river, it remains integral to Ngāti Toa's identity, and their primary objective is environmental restoration for this river.
- For Taranaki Whanui this relationship with both Te Awa Kairangi and Waiwhetu includes connection to a number of Pā sites, mahinga kai and a source of mana for Taranaki Whanui. Both waterbodies have a strong connection to the harbour as a breeding ground for whale species. Te Awa Kairangi and Waiwhetu Stream is noted in Schedule B as a place for wananga, the locations of battles that are part of the Te Ātiawa/Taranaki Whānui story.
- Schedule C (sites with significant mana whenua values) relates to specific sites and do not incorporate the whole water body. The sites identified in the attached plan include a number of Pā sites and the areas around where they were located. In addition, the area where Te Awa Kairangi meets the harbour (Hutt River Mouth) has been identified.
- The values associated with these sites include Pā sites, Tauranga waka (canoe landing), mahinga kai, ara waka (traditional canoe route), wāhi tapu (battle sites), urupā (burial grounds), taunga ika (fishing grounds)

The information presented in the adjacent map will need to be considered in partnership with mana whenua who can bring their expertise and local knowledge to the selection process and support delivery of a transparent, robust shortlist. There may be values that are not recorded in publicly available information or a matter of public record. Engagement with mana whenua may also provide insights that bring Te Ao Maori perspectives to the site selection and enhance the water supply outcomes for the people of Hutt City.

Wellington Water Ltd and the Connect Water Project Team met with representatives of Taranaki Whānui on 10 May 2022. This meeting covered work on project to that date, including process undertaken to review 25 potential locations throughout Hutt City, the narrowing down of options to 3 sites on the Eastern Hills. Based on this overview meeting Taranaki Whānui provided verbal feedback that two of the options had potential for higher adverse effects on mana whenua values, and one site, Option 2, Naenae had lowest risk of significant impacts on mana whenua values out of the three shortlisted options.

Taranaki Whānui confirmed their requirement for a Cultural Impact Assessment (CIA) for the preferred option 2, Naenae. This CIA will be supported by further information as the design is developed through the subsequent concept development phase.

Further details of correspondence are included in Section 6 and Appendix N.

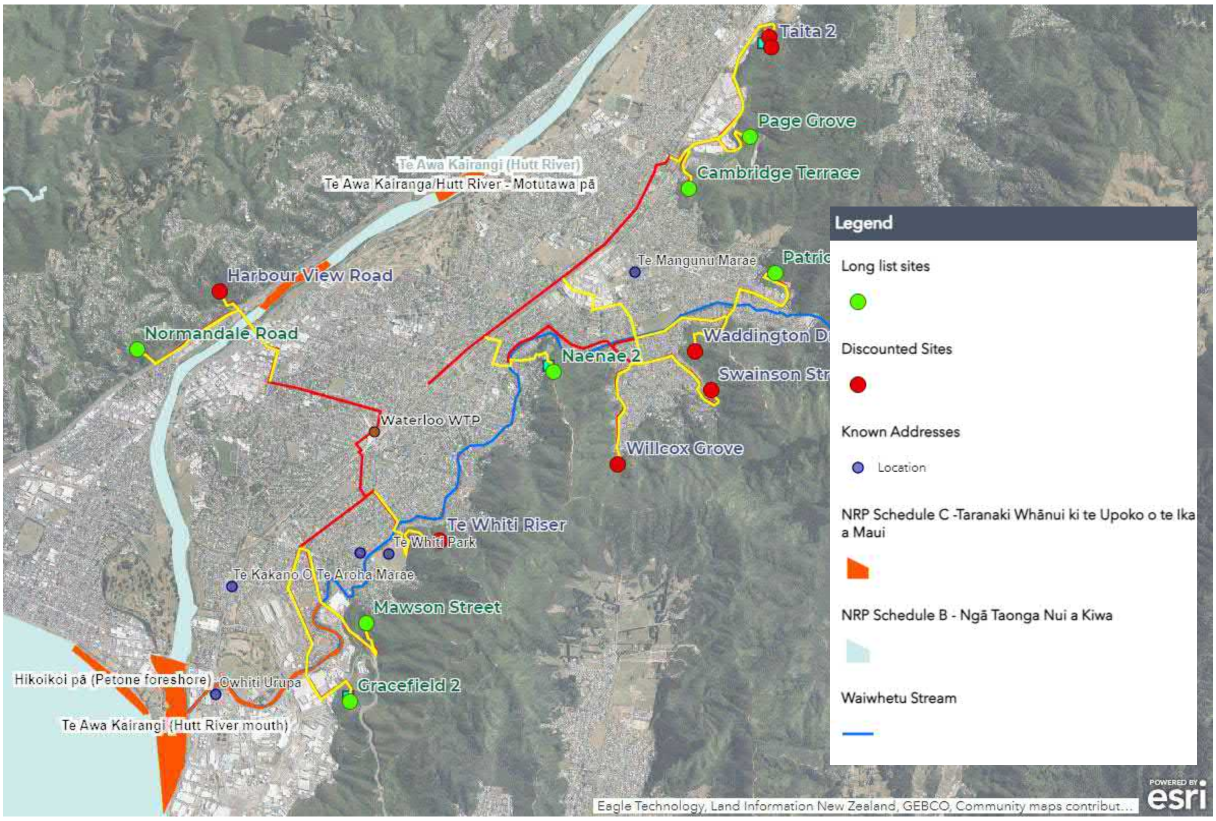

Figure 28. Known sites of significance to mana whenua

4.1.5 Ecology

Waiwhetu Stream

- The Waiwhetu Stream, starry waters, is a heavily channelised stream with poor water quality and affected by wastewater overflows. It is connected to both the local stormwater and overflows from the wastewater network, and there are a significant number of existing service crossings that bridge or pass under the stream.
- The Waiwhetu Stream is noted under GWRC Schedule F1b as an Inanga spawning habitat (whitebait). Pipelines to the **Gracefield 2** and **Mawson Street** site will cross this habitat. Ecological investigations would be required for these sites prior to construction with the risks to the species managed during construction.
- The stream and estuary of the Waiwhetu where it meets Te Awa Kairangi / Hutt River were regarded as important inanga spawning habitat, this is recorded in Schedule F1b of the PNRP. Linked to this it is a source of mahinga kai and freshwater for mana whenua, the mouth of the river is still recognised for its indigenous biodiversity and habitat values. The stream is also identified in schedule B of the PNRP as a waterbody of importance to mana whenua.
- Other ecological values and impacts of a reservoir construction on animal and plant species will need to be considered for shortlisted sites.

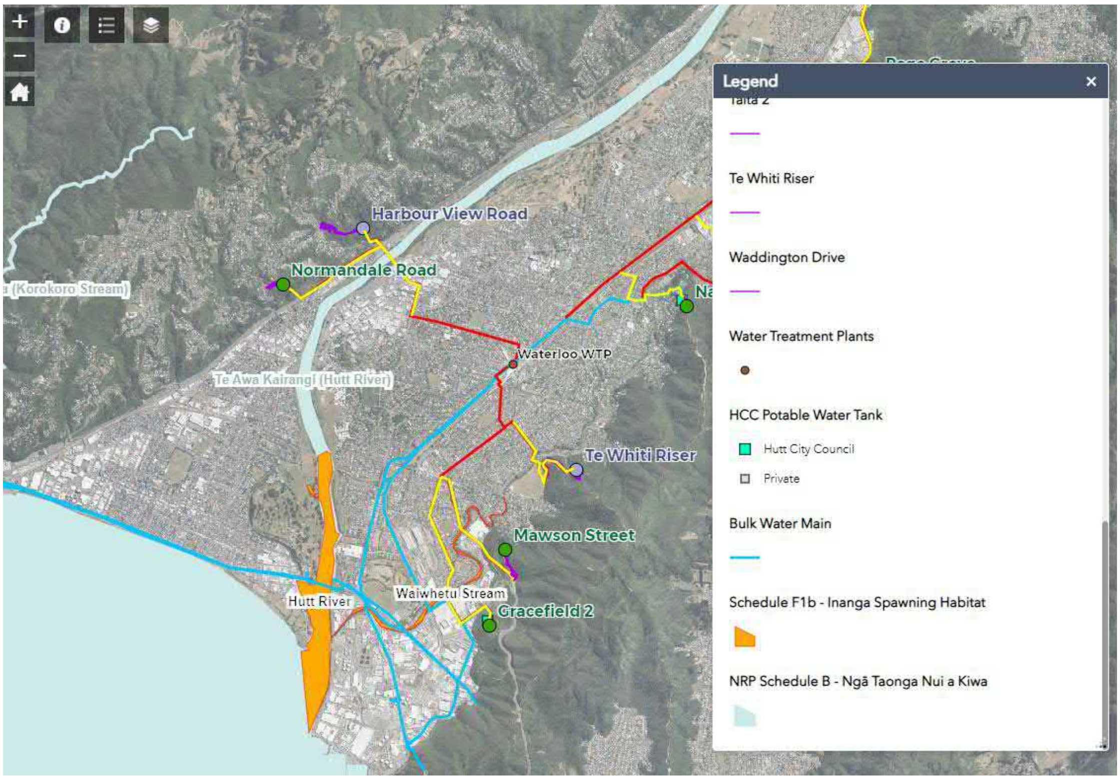

Figure 29. Known sites of ecological significance

4.1.6 Recreation and Education

- Te Awa Kairangi / Hutt River is identified in the Proposed Natural Resources Plan as having regionally significant primary contact recreation value (high chance of becoming immersed in water). Water based activities include kayaking, rafting, fishing, and swimming.

- Te Awa Kairangi is recognised both as a taonga (treasure) and awa tupua (ancestral river) by mana whenua. Despite its degraded state it still retains parts of its character and value that it once held, and it is still one of the largest freshwater bodies in the region. It is a place for wānanga (learning) through contact with place, history and environment. In particular learning related to Pā sites, wetlands and mahinga kai.

- The areas immediately around the river are managed in a similar manner to Regional Parks, and include a number of recreation opportunities including the Hutt River Trail (a popular walking and cycling track), linkages to Avalon Park, and support a number of community group delivering environmental projects including stream and wetland restoration.

- The **Gracefield 2, Mawson Street, Naenae 2** and **Normandale** sites are likely to impact existing recreational tracks/MTB routes.

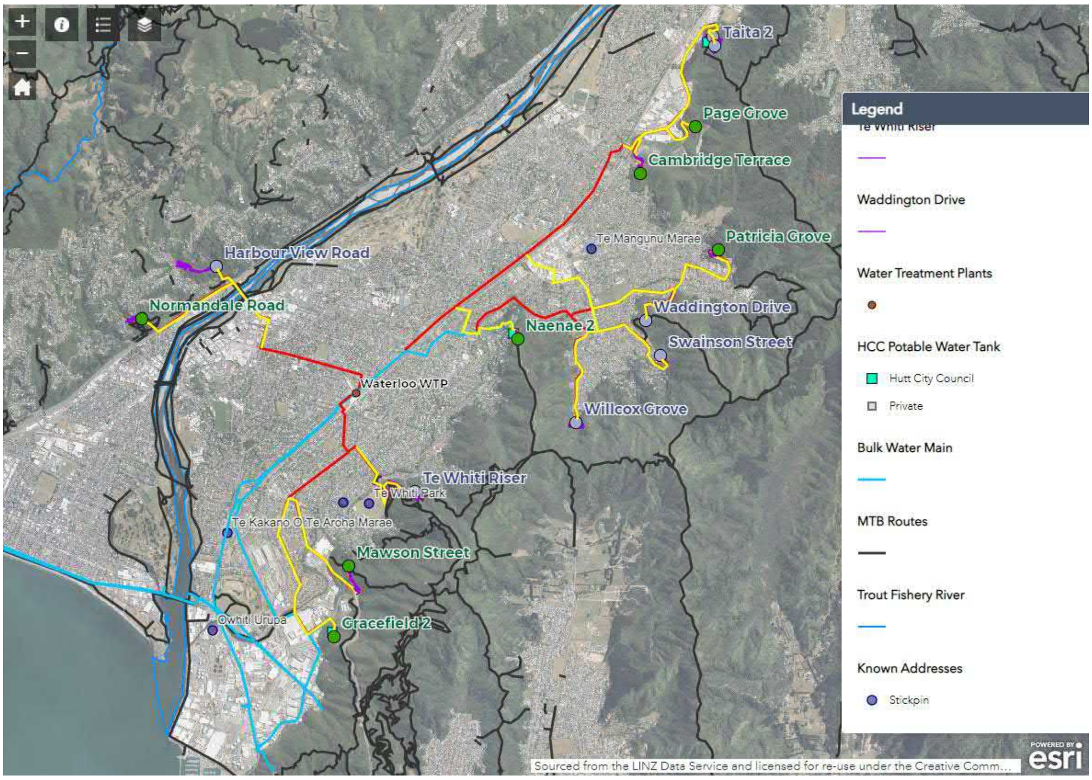

Figure 30. MTB and recreational track route

4.1.7 Archaeology

A known archaeological site is recorded in proximity to **Gracefield 2** and it is likely that an Archaeological Authority would be required for works at this location. This would be a 'business as usual approach' but it is recommended further research is undertaken to confirm this if this site is taken to a shortlist.

The likely pipe corridor to **Normandale** passes a historic site of 1890s buildings.

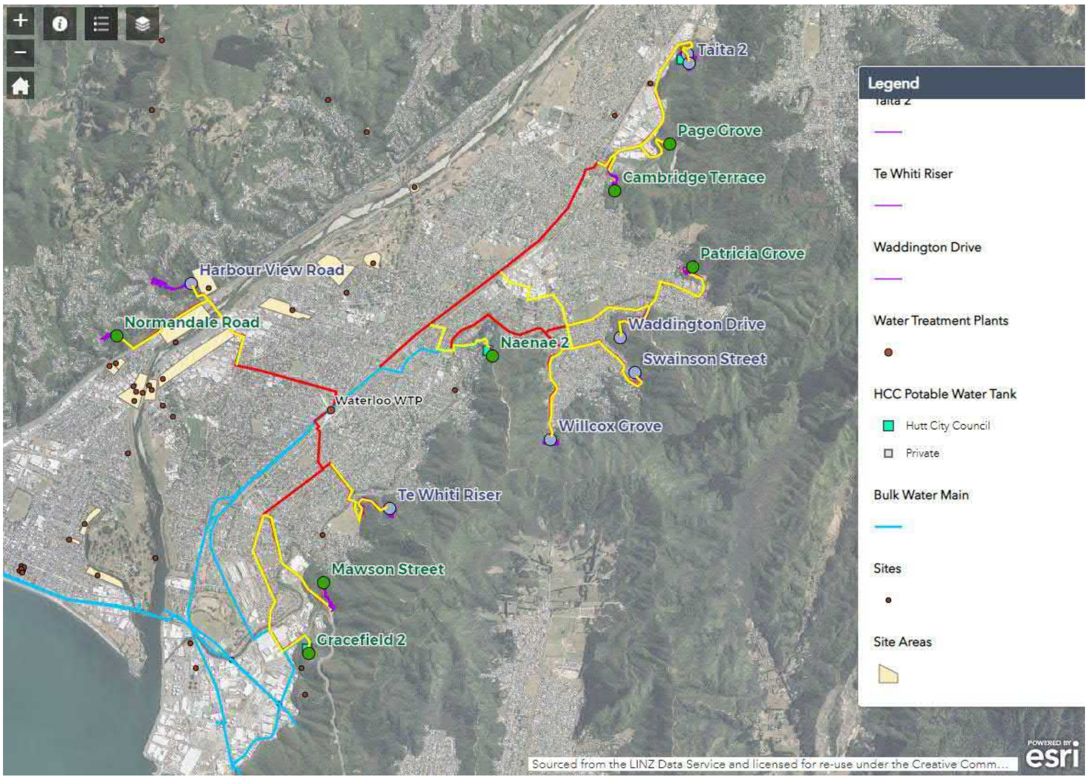

Figure 31. Archaeological Sites

4.2 Assessment of Long List Sites

Each of the long list sites has been assessed against a range of factors and qualitative scoring applied in order to guide the selection of several sites for more detailed consideration, costing and multi-criteria analysis (MCA). This is presented in Appendix A.

This assessment included:

- Earthworks (site and access road)
- Pipeline route challenges
- Geotechnical resilience and risks
- Structural considerations
- Planning/consenting/legal requirements
- Archaeological risk
- Potential recreational impacts (public access/walking/cycle tracks)
- Proximity to SLUR (potentially contaminated) sites
- Land ownership

Each aspect has been scored from 1 (very unfavourable) through to 5 (very favourable). This scoring is qualitative and has been used to give an overall impression of the site suitability. No weightings have been applied. Summation or averaging of these scores is not appropriate. The advantages and disadvantages for each site are summarised in Table 7.

Table 7. Summary of advantages and disadvantages for the longlisted options

Site	Advantages	Disadvantages
Page Grove ***Overall score** 0* *ie Discounted*	• There is an existing access road that crosses the required bottom water level. • Lower total earthworks volume when compared to other long listed sites. • Land is owned by HCC.	• High earthwork cut heights. • Long pipelines required. • Former landfill site which has unfavourable geotechnical considerations.
Cambridge Tce *Overall score 4*	• Low earthworks volumes when compared to other long listed sites. • Low earthworks cut heights. • Favourable geotechnical conditions.	• Long pipelines required • Part of the site area is under private land ownership.
Patricia Grove *Overall score 2*		• High earthworks cuts. • Very long pipelines. • Unfavourable for consenting - Reserve Act applies. • Part of the site area is under private land ownership.
Naenae 2 *Overall score 5*	• Moderate earthworks quantities and cut heights. • Existing road access leads close to the site. • Existing bulk water inlet main could be used. • Shorter outlet pipeline. • Land owned by HCC. • Existing reservoir site.	• Walking tracks impacted
Gracefield 2 *Overall score 3*	• Existing road access (but steep) • Favourable for consenting • Land owned by HCC • Existing reservoir site	• High earthwork cut heights • Long pipelines required • Less favourable for geotechnical considerations. • Site is close to a known archaeological site. • Restricted access (one way from Wainuiomata to Lower Hutt).
Mawson St *Overall score 2*	• Land owned by HCC	• Very high earthworks cut heights on the access road. • High earthworks volumes. • Long pipelines required. • Less favourable for geotechnical considerations. • Restricted access (one way to Wainuiomata).

Site	Advantages	Disadvantages
Normandale Rd *Overall score 0 ie discounted*		• Location on western hills is unfavourable for construction of pipelines across river, fault, SH, through CBD etc. • Long pipelines required. • Proximity to fault will lead to high seismic loads. • Adverse geotechnical considerations • Adverse consenting considerations- Reserves Act will apply.

This qualitative assessment **concluded that the Naenae 2 site is most favourable**, primarily due to the advantages of being an existing reservoir site with established road access and existing bulk water inlet main that can be utilised. The site is well situated in close proximity to the Waterloo water treatment plant and near the middle of the water distribution zone.

Other favoured sites were Cambridge Terrace and Gracefield 2.

The Page Grove site has been discounted as this is a former landfill site and has unfavourable geotechnical characteristics. The Normandale Road site has also been discounted due to the high level of risk and cost associated with pipeline crossings of the Hutt River, Wellington Fault, state highway and rail corridor.

4.3 Cost Assessment

Level 0 cost estimates (using a 40% contingency and a 60% funding risk following the Wellington Water cost estimation manual guidance for L1 estimates) have been prepared to allow relative cost comparison of the longlisted options. The estimates are included in Appendix B and summarised in Table 8. *(Note: These estimates are now superseded – refer Section 7 for revised estimates for shortlisted options.)*

Table 8. Comparative cost estimates for the longlisted options

Site	Level 0 Cost Estimate	Non-cost Assessment Outcome (refer Section 4.2)
Naenae 2	$52,000,000.00	Most favoured
Cambridge Terrace	$90,000,000.00	Favoured
Mawson Street	$100,000,000.00	
Page Grove	$101,000,000.00	Discounted - landfill
Normandale Road	$107,000,000.00	Discounted – pipeline risk
Swainson Street	$109,000,000.00	
Gracefield 2	$109,000,000.00	Favoured
Waddington Drive	$118,000,000.00	
Patricia Grove	$131,000,000.00	

Cost estimates have been based on the expected earthworks quantities, access road lengths, pipe lengths and reservoir construction. The estimates have been prepared for comparative purposes and are not intended to inform project budgets or forecasts.

The Naenae 2 cost estimate ($52m) is roughly half of that of the other site options (typ $90m-$110m). This reflects the benefits of utilising a site with existing road access and bulk water supply (inlet) main and in close proximity to the water distribution network.

4.4 Stakeholder Feedback

4.4.1 Wellington Water

The assessment findings to this point were presented to Wellington Water staff and a Hutt City Council representative at a site selection workshop on 2 December 2021. The purpose of this workshop was to outline the long listing approach and to identify three preferred sites for further development and multicriteria analysis. The workshop attendees agreed that the three most preferred sites are Cambridge Terrace, Naenae 2 and Gracefield 2.

4.4.2 Hutt City Council

A project update meeting for Hutt City Council elected members was held on 9 February 2022 prior to confirmation of the shortlisted options. This update confirmed the importance of the project in Council's infrastructure investment programme. A summary of the site identification process was presented, along with the three preferred site options - Naenae 2, Cambridge Terrace and Gracefield 2. This included a question and answer session to assist with greater understanding of the project and potential impacts.

4.5 Short List Sites

The following three site options were confirmed for further development, assessment and multicriteria analysis.

Table 9. Short List sites

Site Number	Site Name	
8	Cambridge Terrace	*Taken forward as MCA Option 1*
19	Naenae 2	*Taken forward as MCA Option 2*
25	Gracefield 2	*Taken forward as MCA Option 3*

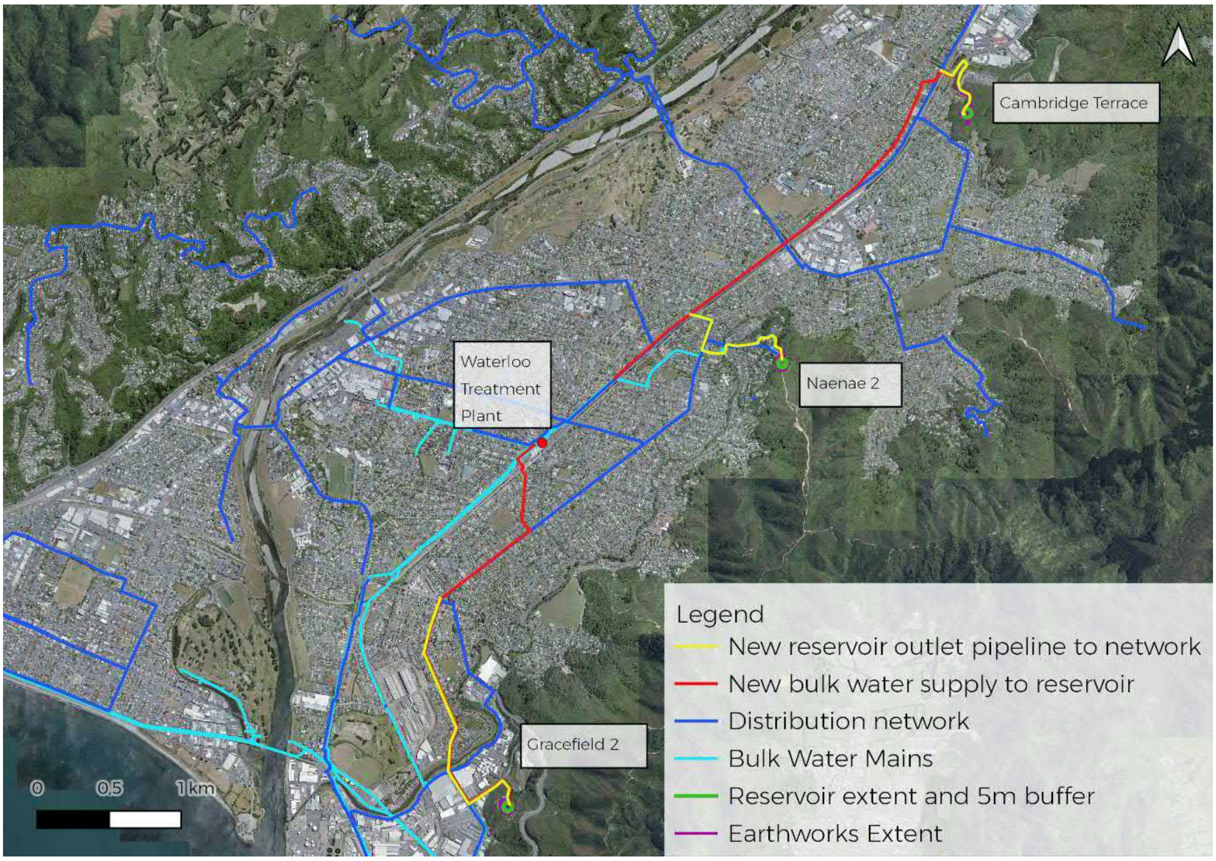

Figure 32. Short List Sites

5 Multi Criteria Analysis

The preceding sections of this document identify potential reservoir sites and present the evaluation of those sites to confirm a short list of site options. Section 5 (this section) documents the multicriteria analysis process used to compare the three short listed options and has been written such that it can be read as a standalone document. For this reason, there is some duplication of content presented elsewhere in this report.

5.1 Overview

A multicriteria analysis (MCA) framework has been used to evaluate the shortlisted reservoir site options. This provides an open and explicit way of supporting complex decision making where there may be conflicting objectives or multiple stakeholders with diverse views.

The MCA approach involves establishing the criteria, assessing relative importance weights, and judging the contribution of each option to each performance criteria.

The assessment process is:

1. Establish the decision context – the purpose of the MCA, identify the decision maker(s) and other key players, and design the assessment system
2. Identify the options to be assessed to achieve the objectives
3. Identify the criteria
4. Weighting – assign weights and scores to each option to reflect their relative importance to the decision
5. Scoring – describe the consequences of the options, score the options on the criteria, check the consistency of the scores on each criteria
6. Combine the weights and scores for an overall value
7. Examine the results
8. Sensitivity analysis

5.2 Decision Context

The purpose of the MCA is to evaluate the three shortlisted options for siting a new 15 ML potable water reservoir to serve the Lower Hutt Central and Taita Water Storage Areas.

The decision maker(s) are:
- Wellington Water Limited
- Hutt City Council

Other parties that have been or will be involved in the Project are:
- Mana whenua – Taranaki Whānui, Ngāti Toa Rangitira, Ngāti Tama (other iwi may be identified during more detailed cultural impact assessment work)
- Stakeholders –Directly affected parties, Landowners

- Community benefiting from the proposed works
- Community affected by proposed works (but not directly affected by land acquisition)

The key players are anyone who can make a useful and significant contribution to the MCA. Key players are chosen to represent all the important perspectives on the subject of the analysis. The key players represent:

- Mana whenua and te Ao Maori
- Engineering – structural, geotechnical, civil, hydraulics
- Ecology
- Landscape
- Planning / Consenting
- Cost estimating and carbon assessment
- Legal
- Archaeology
- Contaminated land

5.3 Project Outcomes

The Project is required to:

1. Deliver 15.0 ML of potable water storage,
2. Deliver a sustainable, enduring and resilient storage solution,
3. Deliver a value for money solution,
4. Ensure mana whenua, the community and key stakeholders are fully engaged throughout the project's lifecycle.

In doing so the Project must:

- Provide sufficient additional potable water storage to meet customer outcomes and service goals as follows.

Primary customer outcome		Outcome 3: Resilient networks support our economy
Primary goal		3.3 We plan to meet future growth and manage demand
Secondary customer outcome		Outcome 3: Resilient networks support our economy
Secondary goal		3.4 We provide reliable services to customers

- Meet the timelines imposed on the project. These are:
  - Commence construction by January 2025
  - Complete construction by June 2026
- Obtain Resource Management Act (RMA) and Building Act approvals to undertake the works
- Maintain compliance with RMA and building consents

- Secure property and access required for the project
- Work within a budget
- Meet the requirements of the Wellington Water Regional Standard for Water Services

5.4 Options to be Assessed

Three site options have been identified for further assessment and multicriteria analysis (MCA) to inform the selection of a preferred site option.

1. **Cambridge Terrace**
2. **Naenae 2**
3. **Gracefield 2**

These site locations and potential access road and inlet/outlet pipeline routes are shown in Figure 33 and briefly described below.

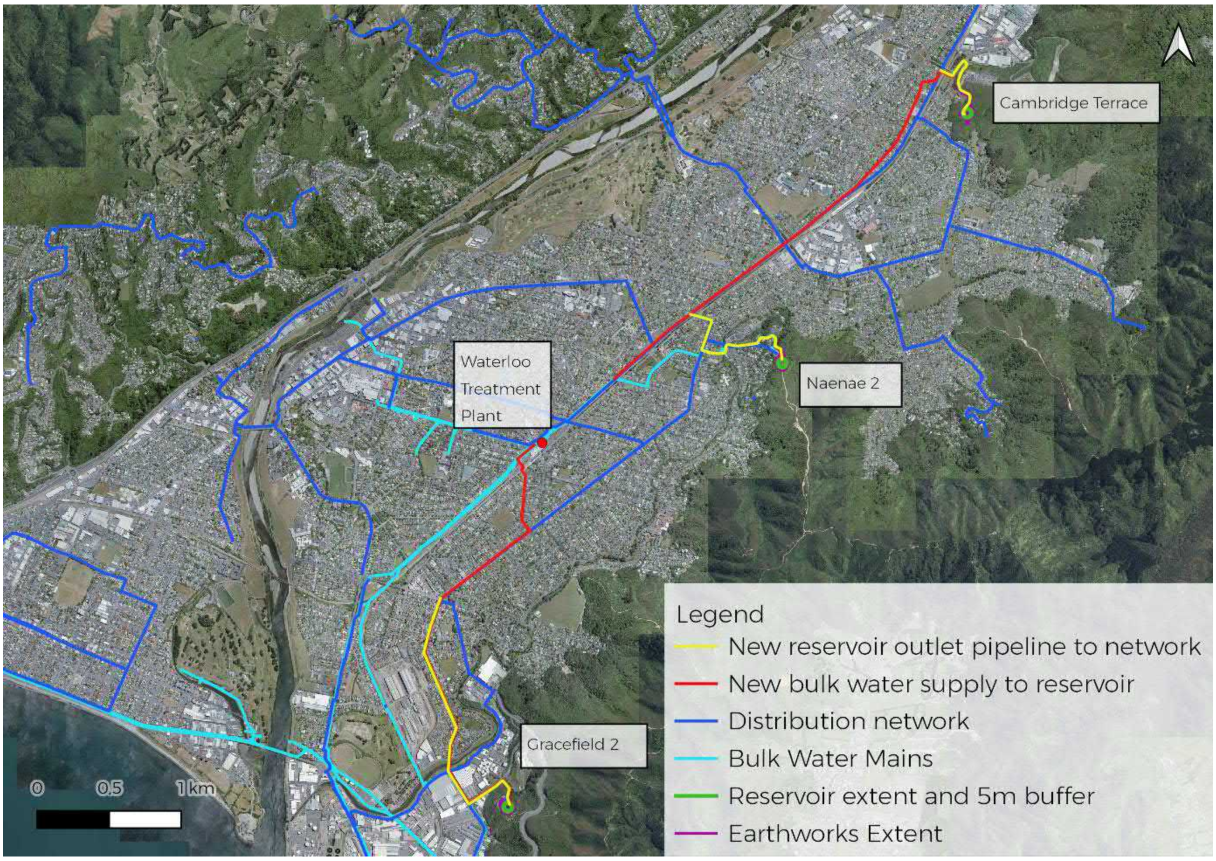

Figure 33. Site options for MCA

All three options involve construction of a 15 ML, above ground, circular, precast concrete reservoir at a top water level of 72.9 m to match the levels of existing reservoirs at Taita, Naenae and Gracefield. The reservoir component of the project is essentially the same for all options, with the exception of the extent and scale of earthworks needed to form a suitable platform, which will differ according to site characteristics. Access road requirements vary between site options.

The new reservoir will require an incoming pipeline from the bulk treated water network, an outgoing pipeline to the distribution network and an overflow/drain pipeline to a stormwater drainage system. The lengths of these pipelines vary between options depending on the relative location of the site to the water treatment plant, distribution network and stormwater systems.

5.4.1 Option 1: Cambridge Terrace

The site is situated on a spur above Cambridge Terrace/Kowhai Street approximately 3.8 km northeast of the Waterloo water treatment plant. A 250 m access road would need to be constructed off an existing private road serving the nearby Pick A Part (car wreckers). The road would be formed through a vegetated gully and up to the reservoir platform. The site area is within private ownership; easements or land acquisition would be required for access and pipeline construction. Approximately 4.6 km of DN750 pipeline would be required to connect the reservoir to the bulk water and distribution networks.

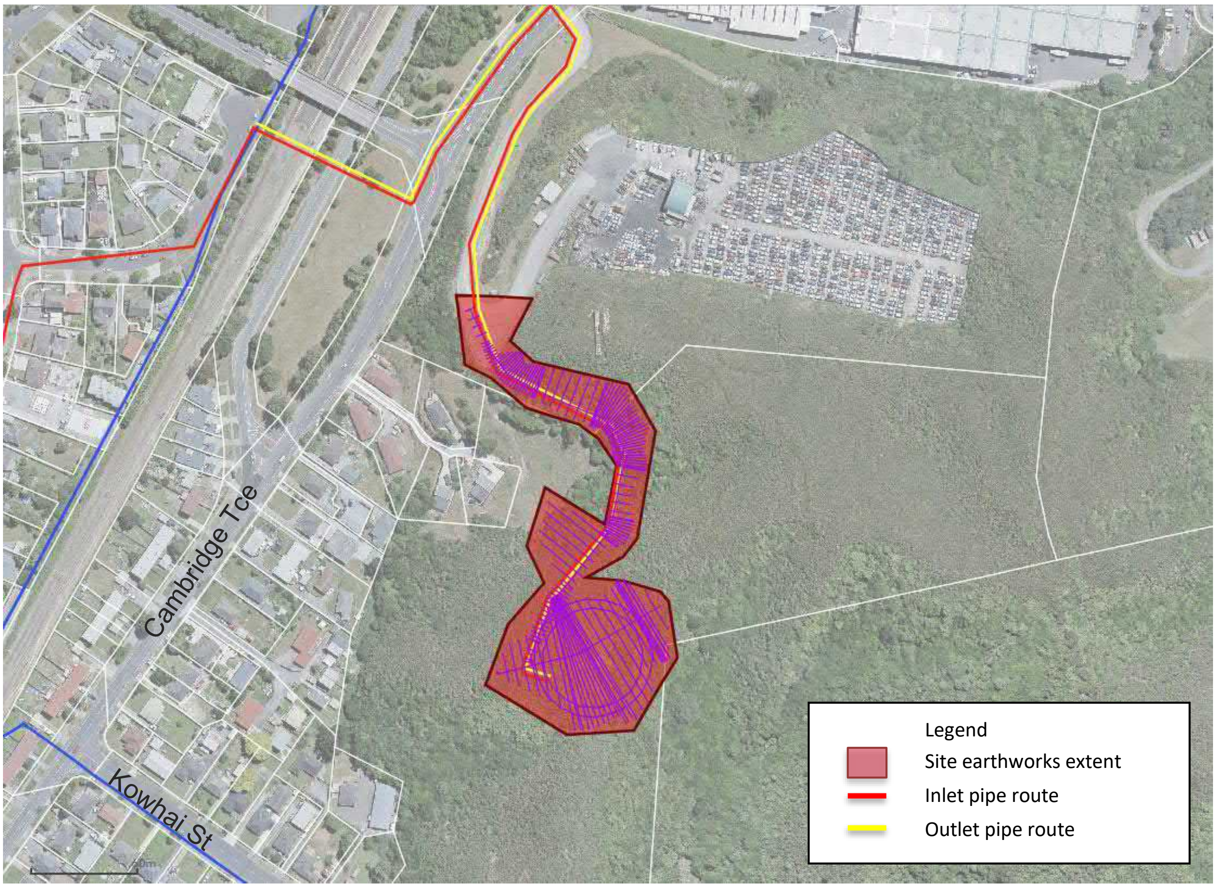

Figure 34. Indicative site layout - Cambridge Terrace

Figure 35. Indicative view of Cambridge Terrace site
(brown shading indicates extent of earthworks)

5.4.2 Option 2: Naenae 2

The site is located approximately 1.8 km northeast of the Waterloo treatment plant beside the existing Naenae reservoir. Construction of the reservoir would require excavating the ridgeline to create a flat construction platform. The cuttings for this platform would be approximately 20 m high.

Summit Road leads close to the Naenae site so a short 100 m improvement to an existing access road would be required.

Being situated close to the Naenae reservoir is advantageous as the existing bulk inlet main to Naenae can be utilised to accommodate the new reservoir. Approximately 1200 m of DN750 pipe would be required to connect the reservoir to the bulk water and distribution networks.

Sizing of the proposed new reservoir (15 ML) has assumed that the next capacity increase (for future demand growth) will be provided in conjunction with end-of-life renewal of the existing Naenae reservoir (mid-2040s). To accommodate this, the initial design layout for a second reservoir at the Naenae site allows a nominal 20 m buffer from the existing reservoir.

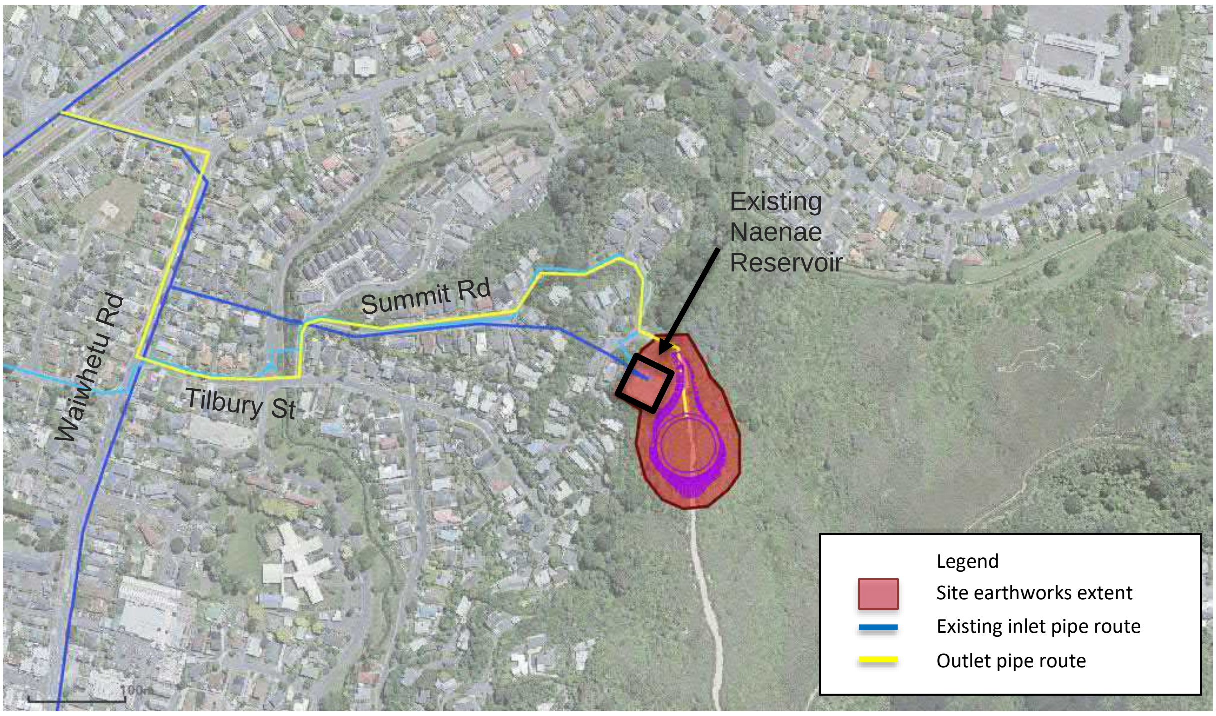

Figure 36. Indicative site layout – Naenae 2

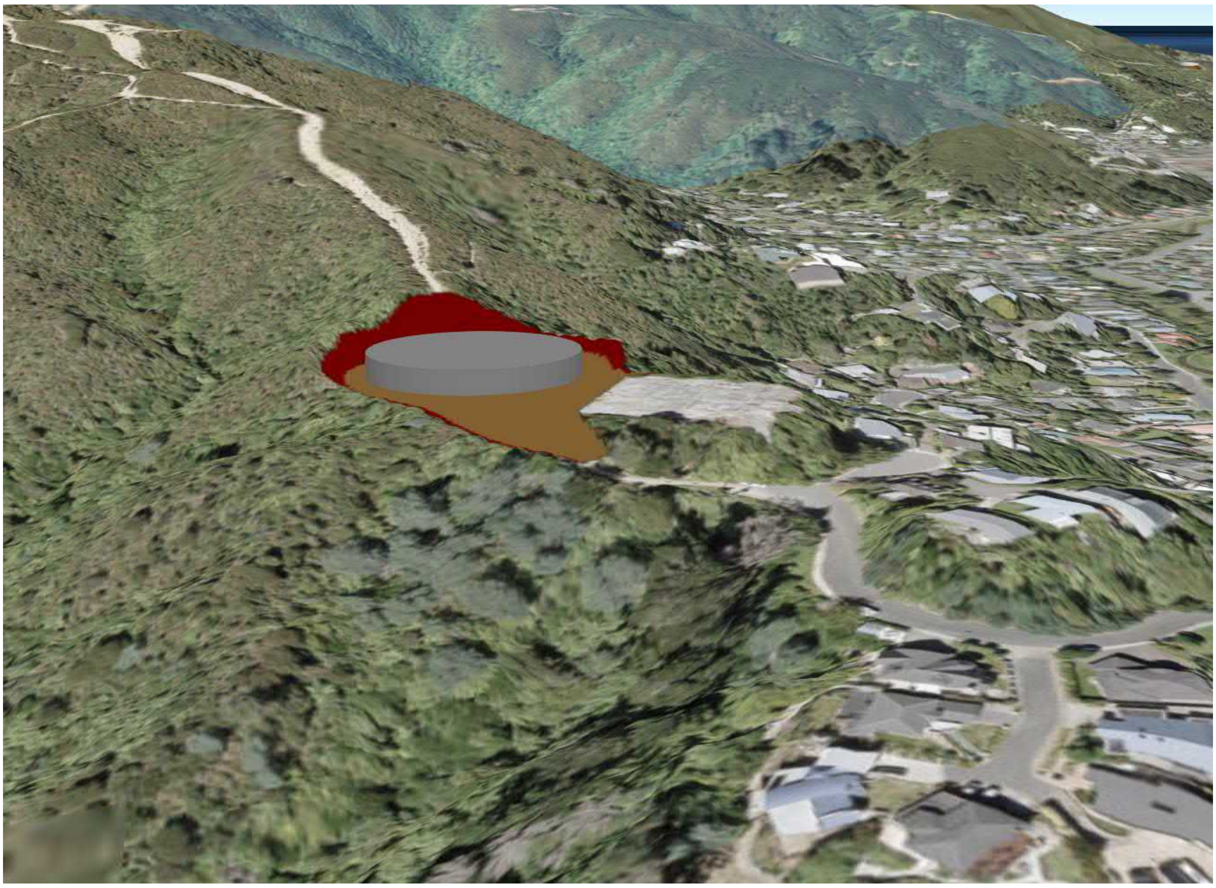

Figure 37. Indicative view of Naenae 2 site.
Red denotes the cut batters and brown denotes the construction platform.

Note: The proposed (circular) reservoir is at the same elevation as the existing (square) reservoir. This may not be apparent in the above figure.

5.4.3 Option 3: Gracefield 2

The site is located approximately 2.5 km south of the Waterloo Treatment Plant, beside the existing Gracefield reservoir. The reservoir platform would be cut into the hillside below an existing access road. The cuts would be approximately 25m high.

Some improvement to the existing reservoir access road may be required. There is only one-way access to the site from the Wainuiomata road (divided carriageway).

The existing pipework to/from the existing Gracefield reservoir is too small to serve an additional reservoir. Approximately 5.5 km of DN750 pipeline would be required to connect a new reservoir to the bulk supply and distribution networks.

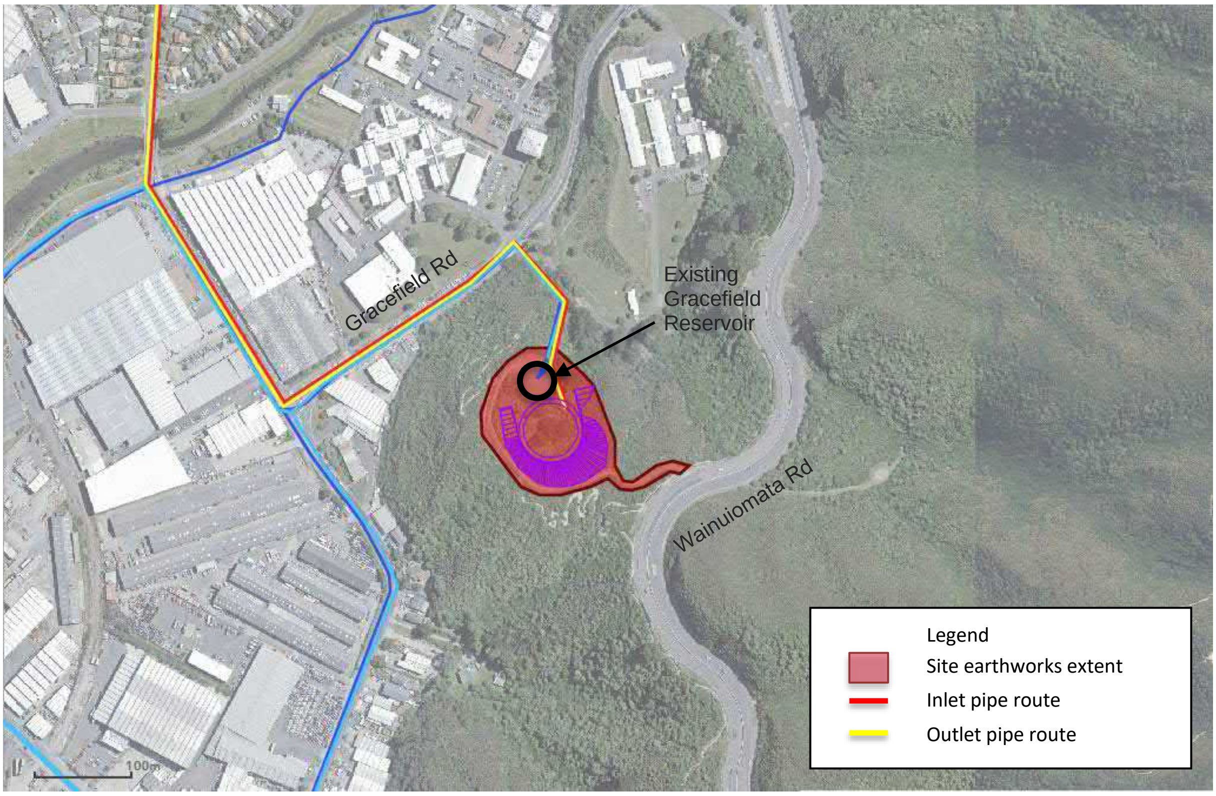

Figure 38. Indicative site layout – Gracefield 2

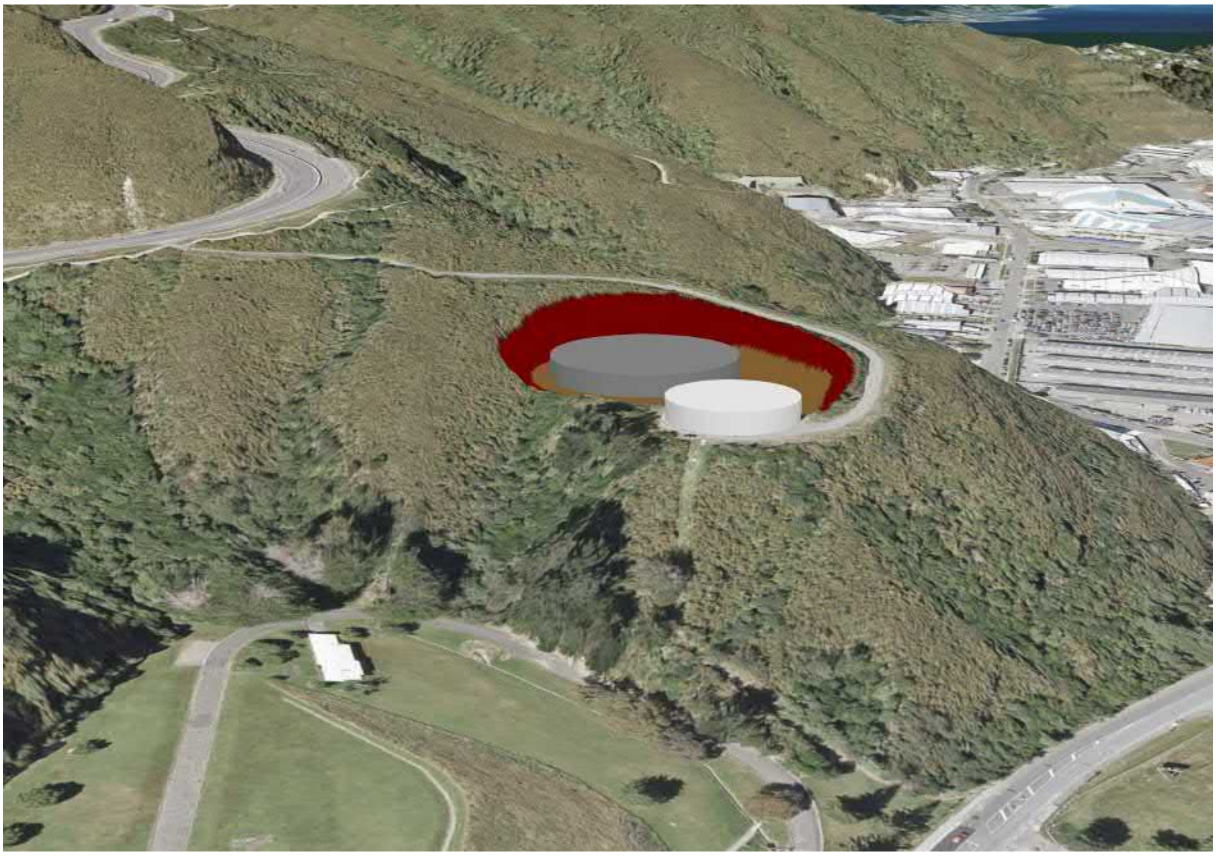

Figure 39. Indicative view of Gracefield 2 site.
Red denotes the cut batters and brown denotes the construction platform.

5.5 Criteria

A range of criteria have been identified, against which each option can be assessed and scored. These criteria cover cost, non-cost and design related outcomes to ensure a comprehensive, balanced assessment of the options. Scoring and weighting of the criteria is discussed in the following sections.

Table 10. Criteria

Criteria Grouping	Criteria	Description
Environmental	Ecology	Impact of the option (reservoir, access road and pipelines) on vegetation, watercourses, habitat, and fauna, both during and following construction.
	Landscape	Impact of the option on the character and aesthetic values of the site and wider landscape (includes landscape and visual effects).
	Heritage and Culture	Impact of the option on features of historical and cultural significance.
Social	Mana Whenua Values	Impact of the option on values of significance to mana whenua, and opportunities for enhancement.
	Noise, vibration and dust	Short-term impact of construction noise, vibration and dust on residents, businesses and the wider public.
	Traffic and Access	Short-term impact of temporary traffic management on residents, businesses and the wider public including disruption to public transport and access restrictions.
	Recreation	Short-term impact of construction activities on access to or use of existing recreational facilities (walking, biking tracks etc).
Technical	Vulnerability and Resilience	Degree of vulnerability to external impacts and ability to withstand and recover from such impacts (including repairability), considered at both site (reservoir) and network (WSA) level.
	Operability and Maintainability	Ability to safely and effectively operate and maintain the system to reliably deliver service outcomes while meeting compliance obligations.
	Performance and Opportunity	Ability to effectively meet required performance objectives, opportunity to enhance network functionality and improve service delivery, and adaptability to accommodate future needs (where not considered in assessment against the two previous criteria).
	Regulatory Framework	Degree of risk in relation to regulatory requirements that could impact delivery of project on time and within budget. (This criterion is not intended to revisit or duplicate the assessment of effects under other criteria.)

Criteria Grouping	Criteria	Description
	Property	Degree of risk in relation to land acquisition that could impact delivery of project on time and within budget.
	Construction Risk	Degree of risk in relation to geotechnical conditions, potential for contaminated land, and other environmental conditions that could impact delivery of project safely, on time and within budget.
Financial	Capital Cost	Capital cost of the project including design, consenting and construction (excluding property).
Carbon	Embodied Carbon	Estimate of embodied carbon in the supply of key materials (concrete, steel, pipes) and the offsite disposal of surplus earthwork volumes.

5.5.1 Consideration of Other Criteria

Community

This project (regardless of which of the final three site options is chosen) will deliver community benefits associated with a reliable supply of safe drinking water irrespective of the location of the reservoir. The impacts (if any) on people's wellbeing and sense of community, including opportunities for health, recreation and education, are not applicable or will not differ between site options so all would be scored neutrally/equally. Short-term impacts (eg potential disruption to recreational access) can be evaluated under the social criteria grouping . None of the options have a long-term impact on recreational activities. As such, a specific 'Community' criterion has not been included in this assessment.

Operational Impacts

The ongoing impacts (noise, vehicle movements etc) associated with operating and maintaining the proposed reservoir will be less than minor, common across all site options, and insignificant relative to the impacts during construction.

5.5.2 Mana Whenua Engagement

Wellington Water recognises the importance and value of early engagement with mana whenua in relation to significant projects in order to understand and address potential impacts on mana whenua values and initiate a collaborate approach to design. A strategic relationship with mana whenua is being developed and this has identified the need to prioritise demand on mana whenua engagement resources across the wider Wellington Water project portfolio. Accordingly, mana whenua input has not directly been sought or provided for this MCA process and no mana whenua values criterion has been developed or scored.

An advisor to Taranaki Whanui joined the MCA scoring workshop to observe the process and gain familiarity with the project prior to specific engagement to follow the workshop. This is documented in Section 6 of this report.

5.5.3 Capital Cost

MCA will often adopt whole of life cost as the measure for the financial criterion. It is not considered necessary in this particular case as once installed, the costs of maintaining and operating the reservoirs at the three different sites were considered to be very similar.

One differentiating factor would be pumping costs to the reservoirs due the difference in pipe lengths. An initial assessment found that the Net Present Value (NPV) of the difference in pumping costs between the best and worst options was only $170,000. This is negligible relative to the difference in capital costs (tens of millions).

Another consideration is the existing DN750 inlet main to Naenae reservoir that would be utilised in Option 2 and require renewal ahead of the new inlet pipelines proposed for Options 1 and 3. As the pipe renewal would not be required for about 60 years (concrete lined steel, installed 1983, useful life 100 years) the present worth of this future cost is only ~5% of the current replacement cost. Again, this is negligible relative to the capital cost different between options.

For simplicity, the Financial criterion has been assessed on the basis of capital cost alone.

5.5.4 Embodied Carbon

Given the similarity of the options it is sufficient to make a comparative assessment of carbon embodied in the manufacture and supply of primary construction materials (concrete, steel, pipes) and the offsite disposal of surplus earthwork volumes. All options will have similar life-cycle energy inputs, so it is not considered necessary to complete a whole of life carbon assessment at this point. More detailed assessments through the design process would be of value for identifying carbon reduction opportunities but are not necessary at this point to consider the relative merits of site options.

5.6 Weighting

Weightings are used to express the relative importance of each criteria to the decision that is being made.

5.6.1 Weighting of Criteria

A percentage based 'weight' has been assigned to each of the criteria. This was initially based on the distribution of weightings adopted for similar projects, and other considerations discussed in section 5.6.2. Attention was also paid to the relative overall weight of each 'criteria grouping' (Environmental, Social, Technical, Financial, and Carbon), in order to avoid the overall balance of considerations being skewed by the number of individual criteria in each category.

The proposed weightings were discussed in a workshop setting with Wellington Water and HCC prior to scoring of the criteria. This resulted in a minor adjustment of the Carbon weighting (from 10% to 5%) in favour of the financial weighting (from 20% to 25%). The MCA process provides opportunity for sensitivity analysis to help understand how sensitive the outcome is to the adopted weightings.

Table 11. Agreed Criteria Weightings

Criteria Grouping	Group Weighting (%)	Criteria	Sub Weighting (%)	Criteria Weighting (%)
Environmental	20	Ecology	40	8
		Landscape	30	6
		Heritage and Culture	30	6
Social	15	Mana Whenua Values	0*	0
		Noise, Vibration and Dust	40	6
		Traffic and Access	40	6
		Recreation	20	3
Technical	35	Vulnerability and Resilience	20	7
		Operability and Maintainability	20	7
		Performance and Opportunity	10	3.5
		Regulatory Framework	10	3.5
		Property Risk	20	7
		Construction Risk	20	7
Financial	25	Capital Cost	100	25
Carbon	5	Embodied Carbon	100	5

* Excluded from assessment by assigning 0% weighting on basis of inability to score. Refer section 5.5.2. Details of engagement with mana whenua are included in section 6

5.6.2 General Comments on Proposed Weightings

A high weighting (35%) is placed on the Technical grouping of criteria on the basis that the project must deliver the required outcomes well (or it is not worth doing), is a major/critical piece of intergenerational infrastructure so must be as robust and reliable as possible, and risks that may jeopardise timely or efficient delivery of the project need to be minimised.

The impacts of the proposed works are generally captured under the Environmental and Social criteria groupings (35% in total) which provides a balance to the technical criteria grouping.

Carbon, which could be included in the Environmental grouping, has been kept separate to signify the importance of this criteria in relation to wider strategic objectives.

Cost has been weighted slightly lower than in similar previous assessments (eg Bell Road Replacement Reservoir, Porirua City Centre Wastewater Storage Tank). One of the options under consideration has a significant cost advantage that would be further reinforced by a higher weighting. Cost sensitivity is considered further in Section 0.

5.7 Scoring

The scoring of the site options against each criterion was debated and agreed at the MCA workshop on 24 March 2022, attended by representatives of Wellington Water and HCC and supported by subject matter experts from Connect Water. Minutes from the workshop are included in Appendix M. The following sections explain how the criteria was scored and the outcome of the agreed scoring.

5.7.1 Scale

A seven-point scale has been adopted for scoring the options against each criterion. A score of 4 reflects a neutral assessment of the option - middle of the road, business as usual.

A lower score indicates some drawbacks or compromises associated with the option, but only to the extent that such dis-benefits can be tolerated and potentially offset by advantages with respect to other criteria. The option short listing process would be expected to have eliminated most, if not all options scoring at the lowest end of the scale. If an adverse outcome cannot be tolerated, then this would be considered a fatal flaw and the option eliminated from contention. A higher score indicates advantages and opportunities associated with the option. Only options with outstanding benefits would score at the highest end of the scale.

Multiple impacts or benefits may be identified in relation to a given criterion. These will need to be considered collectively, along with the magnitude and duration of the impacts/benefits to arrive at a single score.

A generic scoring scale is presented in

Table 12, with a more specific scale descriptions for each criterion presented in the following sections. It is acknowledged that scoring is subjective and involves weighing multiple factors to arrive at an appropriate score. The generic scoring scale is a guide, and some discretion is needed in the application of this to differentiate between the relative merits of each option across a variety of criteria.

Table 12. Generic MCA scoring scale

Score		Description		
		Impacts and Opportunities (typ. Environmental and Social criteria)	Risks	Cost and Carbon
7	**Strong positive**	Significant long-term benefits or enhancement will be achieved	Negligible	< 50% of median value
6	**Moderate positive**	Long-term, widespread benefit or multiple shorter-term benefits expected	Very low	50 – 75 % of median value
5	**Slight positive**	Short term benefits or enhancement, possibly localised	Low	75 – 90 % of median value
4	**Neutral**	Short term, localised impacts that can be confidently mitigated	Moderate – tolerable	90 - 110 % of median value
3	**Slight negative**	Short term, localised impacts with some mitigation risk	High	110 - 125% of median value
2	**Moderate negative**	Longer term, or more extensive impacts, or multiple short-term impacts with some mitigation risk	Very high	125 - 150% of median value
1	**Strong negative**	Significant long-term and/or extensive impacts that are unlikely to be adequately mitigated	Extreme – unacceptable	> 150% of median value

5.7.2 Scoring Guidance

Options should be assessed with respect to the existing environment/values in the affected area(s) and the degree of change expected as a result of the proposed works, both during and following construction. The scoring descriptions, particularly for impacts and opportunities, may be tailored to suit specific criterion while maintaining relativity to the generic scale in

Table 12.

Scoring should commence from a neutral starting point (Score 4). This would include options where effects are less than minor or are short-term, localise and can reasonably mitigated. Benefits or enhancement push the score up while impacts and risks push the score down. Scoring of Environmental criteria will generally be in the range of 1 to 4 depending on the nature of adverse effects. If an option includes environmental enhancement, eg stream restoration, this may lift the score into the 5 to 7 range. Similarly for Social criteria.

Where the assessment identifies the need for mitigation to address adverse effects then such mitigation is included within the option definition and allowed for in the option cost assessment. Scoring assumes that the identified mitigation is implemented. Where the option and/or proposed mitigation provides a beneficial outcome then this is to be recognised with a higher score.

For a given criterion, the best option will get the highest score, but that will not necessarily be a high (>4) score. Two or more options may be scored the same for a given criterion if there is little discernible difference between them.

A neutral risk score is not intended to signify the absence of risk, but rather a typically acceptable level of risk for a project of this nature.

The objective is to promote options where adverse effects, risks, costs, and embedded carbon are minimised, with impacts mitigated and beneficial outcomes achieved.

5.7.3 Preliminary Scoring and Scoring Workshop

A variety of investigations and assessments were undertaken to inform scoring of the options. A preliminary score assessment was prepared by Connect Water and presented to the stakeholder workshop. Stakeholders had to opportunity to question the Connect Water subject matter experts and share bring their own knowledge, experience and preferences to inform a collectively agreed score for each option against each of the MCA criteria.

Assessment reports and minutes of the Workshop are appended.

5.7.4 Environmental Criteria

Ecology

Impact of the option (reservoir, access road and pipelines) on vegetation, watercourses, habitat, and fauna, both during and following construction.

The sites have been visited and assessed by an ecologist to identify existing ecological values and the magnitude of anticipated impacts in order to evaluate the level of effect of each option. This assessment considers vegetation, avifauna (birds) and herpetofauna (lizards) at the three reservoir sites and several potential pipe crossing locations along Waiwhetu stream where inanga spawning has also been considered.

The assessment concluded a similar ecological impact of minor adverse ecological effects for each of the three sites. The ecological impacts for each site are summarised in Table 13; for the full assessment refer to Appendix C.

Table 13. Summary of ecological assessment factors for each site

▲= more favourable, ○ = neutral, ▽ = less favourable

Option 1: Cambridge Terrace	Option 2: Naenae 2	Option 3: Gracefield 2
○ Similar ecological impact for each site ▽ At risk species – lizards ▲ Limited extent of work. ▲ No stream crossing	○ Similar ecological impact for each site ▽ At risk species – lizards ▲ Limited extent of work. ○ Impacts of stream crossing were considered minimal.	○ Similar ecological impact for each site ▽ At risk species – lizards ▲ Limited extent of work. ○ Impacts of stream crossing were considered minimal.

The workshop participants agreed that the ecological impacts for each site are similar and that the sites should score the same. There was some discussion whether a score of 3 or 4 would be appropriate but this is immaterial to the overall outcome when all options are scored equally.

Table 14. MCA scoring – Ecology

○ = preliminary score, ✓ = agreed score

Score		Description	Cambridge	Naenae 2	Gracefield 2
7	Strong positive	Significant long-term benefits or enhancement will be achieved			
6	Moderate positive	Long-term, widespread benefit or multiple shorter-term benefits expected			
5	Slight positive	Short term benefits or enhancement, possibly localised			
4	Neutral	Short term, localised impacts that can be confidently mitigated	○ ✓	○ ✓	○ ✓
3	Slight negative	Short term, localised impacts with some mitigation risk			
2	Moderate negative	Longer term, or more extensive impacts, or multiple short-term impacts with some mitigation risk			
1	Strong negative	Significant long-term and/or extensive impacts that are unlikely to be adequately mitigated			

Landscape

Impact of the proposed option on the character and aesthetic values of the site and wider landscape.

A landscape and visual impact assessment has been prepared to describe the potential landscape effects and visual effects of the three options. This includes GIS mapping of the zone of theoretical visibility to understand the extent to which the reservoir sites will be visible. The key landscape and visual assessment factors for each site is summarised in Table 15. Refer to Appendix D for the full assessment.

Table 15. Summary of landscape and visual assessment factors for each site option

▲= more favourable, ○ = neutral, ▽ = less favourable

Option 1: Cambridge Tce	Option 2: Naenae 2	Option 3: Gracefield 2
▽ Landscape effects = moderate-high ▽ Earthworks = extensive (incl road) ▽ Visual effects (0-7 yrs) = moderate-high ▲ Visual effects (7+ yrs) = low ▽ New site – no existing reservoir ▽ Extensive viewshed ▽ Nearby dwellings	○ Landscape effects = moderate-low ○ Earthworks = moderate ▽ Visual effects (0-7 yrs) = moderate-high ▲ Visual effects (7+ yrs) = low ▲ Existing reservoir site ▽ Extensive viewshed ▽ Adjacent dwellings	▽ Landscape effects = moderate ▽ Earthworks = high ▽ Visual effects (0-7 yrs) = moderate-high ▲ Visual effects (7+ yrs) = low ▲ Existing reservoir site ▲ Visible to least number of people ▲ Dwellings >500m away ▲ Landscape Architect ranking = most favourable

The landscape and visual assessment identified Gracefield 2 as the most favourable option in terms landscape and visual impacts. However, the workshop participants noted that Gracefield 2 has the highest and steepest cut slopes out of each option. These cuts may require greater engineering interventions such as rock bolts and shotcrete/mesh with limited opportunity for revegetation. The workshop participants agreed that Gracefield scoring should reflect this.

Table 16. MCA scoring – Landscape

○ = preliminary score, ✓ = agreed score

Score		Description	Cambridge	Naenae 2	Gracefield 2
7	Strong positive	Significant long-term benefits or enhancement will be achieved			
6	Moderate positive	Long-term, widespread benefits or multiple shorter-term benefits expected			
5	Slight positive	Short term benefits or enhancement, possibly localised			○
4	Neutral	Short term, localised effects that can be rapidly mitigated		○	
3	Slight negative	Short term, localised effects, mitigation effective in the short-medium term	○	✓	✓
2	Moderate negative	Longer term, or more extensive effects, or multiple short-term effects, mitigation effective in the medium-long term	✓		
1	Strong negative	Significant long-term and/or extensive effects, mitigation effective in the long term only			

Heritage and Culture

Impact of the option on features of historical and cultural significance.

An archaeological screening assessment has not identified any known sites of cultural or historical importance that will be adversely impacted by any of the proposed options. However, a previous archaeological find in the general vicinity of the Option 3 site (Gracefield 2) does suggest a higher risk associated with works in this area. An Archaeological Authority would likely be required for Gracefield 2. The risk of project cost increases and programme delays is a consideration.

Table 17. MCA scoring – Heritage and Culture (Risk)

○ = preliminary score, ✓ = agreed score

Score		Description	Cambridge	Naenae 2	Gracefield 2
7	Strong positive	Negligible			
6	Moderate positive	Very low			
5	Slight positive	Low			
4	Neutral	Moderate –tolerable	○ ✓	○ ✓	
3	Slight negative	High			○ ✓
2	Moderate negative	Very high			
1	Strong negative	Extreme – unacceptable			

5.7.5 Social Criteria

Construction Impacts - Noise, Dust and Vibration

Short-term impact of construction noise, vibration and dust on residents, businesses and the wider public.

A geotechnical assessment has been undertaken to confirm appropriate assumptions for option design and construction methodology development. This contributes to evaluation of construction impacts and risks associated with each of the sites. Refer Appendix G

A structural design assessment considered the appropriate design approach for the reinforced concrete tank and preliminary sizing of precast elements to allow development of construction methodologies and inform cost estimates.

The three options were assessed from a construction perspective (refer Appendix I) to understand the potential extent and magnitude of construction related impacts and risks and to inform the associated cost and carbon estimates.

The impact of noise, dust and vibration will relate to the duration of works and proximity of worksites to residential and other sensitive activities. This includes construction of the reservoir itself (extended period at a discrete location), and construction of the pipelines (moving workfront along the pipe corridor). Haul routes for removal of surplus earthworks material are also considered under this criterion.

Cambridge Terrace has residential development in the general vicinity of the proposed reservoir which could be impacted by noise, dust and vibration. Extensive pipeline installation would impact many more adjacent landowners for shorter period as pipelaying progresses. Lower earthwork volumes compared to the other sites means that there will be fewer construction vehicle movements (in the order of 9,000).

Naenae 2 has residential development immediately adjacent to the reservoir site and on Summit Road. An acoustic barrier may be required to mitigate impacts on adjacent properties. There are also vulnerable residents at the Laura Fergusson Facility. This facility is accessed via Laura Fergusson Grove which connects to Summit Road. There is expected to be a high number of construction vehicle movements past residences along Summit Road (in the order of 14,000) based on anticipated earthworks volumes. Fewer landowners will be affected by pipe laying operations than the other two site options.

Gracefield 2 has no residential properties in the vicinity of the proposed reservoir. There is expected to be a high number of construction vehicle movements (in the order of 14,000) due to the expected earthworks volumes, however, vibration issues are unlikely to impact local stakeholders. The longer pipe route impacts more landowners.

The assessment proposed a scoring of Cambridge (2), Naenae 2 (2) and Gracefield 2 (3). However, the workshop participants felt that Naenae 2 should score be lower than Cambridge due to the immediate proximity of residential properties and the nearby Laura Fergusson facility. Participants also agreed that the scoring should primarily focus on the reservoir construction effects, with reduced consideration of pipelaying impacts which will be more transient. This reduced the adverse scoring initially assigned to the Cambridge and Gracefield 2 sites which have very long associated lengths of pipeline.

Table 18. MCA scoring – Construction Impacts - Noise, Dust and Vibration

○ = preliminary score, ✓ = agreed score

Score		Description	Cambridge	Naenae 2	Gracefield 2
7	**Strong positive**	NA			
6	**Moderate positive**	NA			
5	**Slight positive**	NA			
4	**Neutral**	Localised impacts that can be confidently mitigated			✓
3	**Slight negative**	Localised impacts with some mitigation risk	✓		○
2	**Moderate negative**	More severe impacts, or more parties impacted, with some mitigation risk	○	○ ✓	
1	**Strong negative**	Extensive impacts that are unlikely to be adequately mitigated			

Construction Impacts - Traffic and Access

Short-term impact of temporary traffic management on residents, businesses and the wider public including disruption to public transport and access restrictions.

Refer to comments regarding assessments completed for previous criteria (Construction impacts – noise dust and vibration).

The constructability assessment (Appendix I) identifies areas over which traffic management impacts are likely to occur, which may include parking restrictions and access limitations in some residential areas.

Cambridge Terrace has a long pipeline construction length and will have a wide community impact from increased and prolonged vehicle movements. Approximately 9000 heavy vehicle movements would be required. There would be disruption to the Pick-A-Part car wreckers with shared access.

Naenae 2 would require full road closures on Summit Rd and Tilbury Street and permanent parking restriction during the construction of the outlet main. This is to allow sufficient room for construction plant to work alongside the trench safely. The bus route through Waiwhetu Road would need to be diverted during the construction of the outlet main. Approximately 14,000 heavy vehicle movements would be required through residential areas.

Gracefield 2 would create significant disruption to commuters along Wainuiomata Road during construction. Access for trucks would be via the westbound lane only due to a concrete median barrier separating the lanes. Construction vehicles will have to travel from Lower Hutt to Wainuiomata and then back up the hill to the construction site. Closure of one of the westbound lanes would be required to facilitate safe heavy vehicle access to the site road. All Wainuiomata traffic, including cyclists, would be affected over an extended period of time. Approximately 14,000 heavy vehicle movements would be required based on anticipated earthworks quantities.

Table 19. MCA scoring – Construction Impacts - Traffic and Access

○ = preliminary score, ✓ = agreed score

Score		Description	Cambridge	Naenae 2	Gracefield 2
7	**Strong positive**	NA			
6	**Moderate positive**	NA			
5	**Slight positive**	NA			
4	**Neutral**	Localised impacts that can be confidently mitigated	○		
3	**Slight negative**	Localised impacts with some mitigation risk	✓	○	
2	**Moderate negative**	More severe impacts, or more parties impacted, with some mitigation risk		✓	○
1	**Strong negative**	Extensive impacts that are unlikely to be adequately mitigated			✓

Construction Impacts - Recreation

Short-term impact of construction activities on access to or use of existing recreational facilities (walking, biking tracks etc).

Refer to comments regarding assessments completed for previous criteria (Construction impacts – noise dust and vibration).

The constructability assessment (Appendix I) identifies where the construction site extents or access arrangements will disrupt or preclude the use of existing recreational facilities during construction.

The construction of Naenae 2 would alter an existing firebreak. The firebreak is a popular walking track. An alternative route could be formed around the site, but safety considerations would likely mean closure of public access via Summit Road.

A downhill mountain biking track traverses the access road to the Gracefield 2 site. This track would likely require closure during construction for public safety.

Table 20. MCA scoring – Construction Impacts – Recreation

○ = preliminary score, ✓ = agreed score

Score		Description	Cambridge	Naenae 2	Gracefield 2
7	Strong positive	NA			
6	Moderate positive	NA			
5	Slight positive	NA			
4	Neutral	Localised impacts that can be confidently mitigated	○ ✓	○	
3	Slight negative	Localised impacts with some mitigation risk		✓	○ ✓
2	Moderate negative	More severe impacts, or more parties impacted, with some mitigation risk			
1	Strong negative	Extensive impacts that are unlikely to be adequately mitigated			

5.7.6 Technical Criteria

Vulnerability and Resilience

Degree of vulnerability to external impacts and ability to withstand and recover from such impacts, considered at both site (reservoir) and network (WSA) level.

The vulnerability of a reservoir to external impacts will be influenced by its location, in particular the geotechnical setting. The geotechnical assessment (Appendix G) contributes to assessment against this criterion. The location of the reservoir may also be a consideration in relation to system-wide resilience. Wellington Water Ltd technical staff contributed to understanding of any difference in outcomes that may arise from the different site options. The associated pipelines and access roads may also contribute to differing levels of vulnerability between sites.

The Cambridge Terrace option would offer some resilience advantage by adding an addition reservoir location. Four reservoir sites, compared to three for the other options, provides some additional redundancy to the network if a reservoir or pipeline is damaged.

Vulnerabilities of each option consider the proximity of the site to the Wellington fault. Long pipelines have potentially more locations to break and have a potential longer restoration time. The pipelines to Naenae 2 and Gracefield 2 require crossing the Waiwhetu Stream which may pose a lateral spreading risk.

Table 21. Summary of vulnerability and resilience considerations for each site.

▲= more favourable, ○ = neutral, ▽ = less favourable

Option 1: Cambridge Tce	Option 2: Naenae 2	Option 3: Gracefield 2
▲ Separation from existing storage introduces some resilience ▽ Long pipelines introduce some vulnerability. ○ Similar geological setting for all three sites ▽ 1.5 km from Wellington Fault (closest) ▽ High cuts and fills along access route	○ Utilises existing 1983 DN750 STCL inlet main – similar resilience to modern pipe, no drawbacks ○ Similar geological setting for all three sites ▽ 2 km from Wellington Fault ▽ Lateral spread risk where pipe crosses Waiwhetu Stream	○ Long pipelines introduce some vulnerability ○ Similar geological setting for all three sites ○ 3.5 km from Wellington Fault ▽ Lateral spread risk where pipe crosses Waiwhetu Stream ▽ Pipeline route traverses increased thicknesses of soft sediment compared to other two sites ▽ Access route close to top of cut slope

Table 22. MCA scoring - Vulnerability and Resilience

○ = preliminary score, ✓ = agreed score

Score		Description	Cambridge	Naenae 2	Gracefield 2
7	Strong positive	Highly resilient design solution allowing for rapid recovery from wide range of adverse events			
6	Moderate positive	Resilient design solution allowing for rapid recovery from typical adverse events			
5	Slight positive	Low level of vulnerability to external impacts which are readily manageable	○ ✓		
4	Neutral	Some vulnerabilities that can be managed with minimal disruption to service delivery		○ ✓	
3	Slight negative	Vulnerable to external impacts with some disruption during recovery			○ ✓
2	Moderate negative	Vulnerable to external impacts with some disruption during and extended recovery period			
1	Strong negative	Vulnerable to external impacts with extensive disruption over a long recovery period			

Operability and Maintainability

Ability to safely and effectively operate and maintain the system to reliably deliver service outcomes while meeting compliance obligations

The location of the reservoir will generally not have a significant influence on the ability to develop a reliable design that can be safely and effectively operated, apart from differences related to access, pipeline routes and environmental compliance conditions (eg drain discharges). The planning assessment (Appendix K) has been used to understand potential compliance obligations.

Differences between the sites in terms of operability and maintainability were discussed with Wellington Water at the MCA workshop. There is no appreciable difference between the site options for ease of operation and maintenance.

Table 23. MCA scoring - Operability and Maintainability

○ = preliminary score, ✓ = agreed score

Score		Description	Cambridge	Naenae 2	Gracefield 2
7	**Strong positive**	Negligible operation, maintenance, and compliance requirements			
6	**Moderate positive**	Few operation, maintenance, and compliance requirements			
5	**Slight positive**	Typical operation and maintenance requirements with negligible compliance obligations			
4	**Neutral**	Operation and maintenance requirements typical for this asset	○ ✓	○ ✓	○ ✓
3	**Slight negative**	Typical operation and maintenance requirements with some additional compliance obligations			
2	**Moderate negative**	Some onerous operation, maintenance and compliance requirements			
1	**Strong negative**	Several onerous operation, maintenance and compliance requirements			

Performance and Opportunity

Ability to effectively meet required performance objectives, opportunity to enhance network functionality and improve service delivery, and adaptability to accommodate future needs (where not considered in assessment against the two previous criteria).

All options under consideration have been developed with the intention of meeting the required performance objectives. However, the specific location of the reservoir storage relative to the distribution network may present some benefits or disadvantages. Wellington Water Ltd technical staff were consulted to understand any difference in performance outcomes that may arise from the different site options. It was concluded that there is no appreciable difference between the site options for wider network performance benefits or opportunities.

Table 24. MCA scoring – Performance and Opportunity

○ = preliminary score, ✓ = agreed score

Score		Description	Cambridge	Naenae 2	Gracefield 2
7	**Strong positive**	Achieves all performance objectives with significant improvement to network functionality, service delivery, adaptability			
6	**Moderate positive**	Achieves all performance objectives with some improvement to network functionality, service delivery, adaptability			
5	**Slight positive**	Achieves all performance objectives with minor additional benefits			
4	**Neutral**	Achieves all performance objectives	○ ✓	○ ✓	○ ✓
3	**Slight negative**	Generally achieves performance objectives but with some compromises			
2	**Moderate negative**	Risk that some performance objectives may not be fully achieved			
1	**Strong negative**	Some performance objectives will not be achieved			

Regulatory Framework

Degree of risk in relation to regulatory requirements that could impact delivery of project on time and within budget. (This is not a measure of consentability.)

A planning assessment for each of the sites considered a range of factors including the activity status of reservoirs in relevant Statutory plans, applicable objectives and policies (both Resource Management Act and Town Belt Management Plan), land ownership, and the number and nature of applications that would be required for the project. Refer Appendix K.

Scoring of this criterion must not consider 'consentability' of the option in terms of the anticipated impacts or environmental effects, which are evaluated under other scoring criteria. This criterion is intended to reflect the regulatory requirements that will be applicable to each option and the associated risks to programme and budget.

The land parcel for the **Cambridge Terrace** option is located within a significant natural resource site. There are potentially more issues to address in the consent applications due to multiple landownership and mixed land uses in the vicinity. A single application to each authority is required (HCC and GWRC).

This land parcel for **Naenae 2** is located within a significant natural resource site. Whilst the site is located in the vicinity of an established residential area, the proposed activity is not considered to deviate from its current land use because there is an existing underground reservoir within the site. However, an existing walking track traverses the site and mitigation to minimise effects on amenity and recreational values will likely be required. Despite the presence of planning risks at this location, its proximity to a similar existing use may provide a level of acceptance for a new reservoir. A single application is required to both HCC and GWRC.

The proposed construction area for the **Gracefield 2** site is located within a significant natural resource site and is also subject to the Conservation Act and Reserves Act. In addition to the resource consent applications to HCC and GWRC, approval is required from Department of Conservation and Hutt City Council's Parks and Reserves team. There are no residential properties nearby. The site contains an existing reservoir and is surrounded by established commercial land uses. Despite the presence of the above planning risks at this location, mitigation required to minimise potential adverse impacts is comparatively low. It is also noted that the applications to DOC and HCC's Parks and Recreation team are not subject to any statutory timeframes.

Table 25. MCA scoring – Regulatory Framework Risks

○ = preliminary score, ✓ = agreed score

Score		Description	Cambridge	Naenae 2	Gracefield 2
7	**Strong positive**	This option meets regulatory requirements. No statutory approvals required.			
6	**Moderate positive**	The option presents few difficulties in terms of meeting regulatory requirements and obtaining statutory approvals. Likely that only one application will need to be made to each statutory authority.			
5	**Slight positive**	The option presents minor areas of difficulty in terms of meeting regulatory requirements and obtaining statutory approvals. Likely that only one application will need to be made to each statutory authority.		○	
4	**Neutral**	This option presents some difficulties in terms of meeting regulatory requirements and obtaining statutory approvals.	○	✓	
3	**Slight negative**	This option presents some difficulties in terms of meeting regulatory requirements and obtaining statutory approvals. Likely that more than one application will need to be made to each statutory authority.	✓		○
2	**Moderate negative**	This option presents extensive difficulties in terms of meeting regulatory requirements and obtaining statutory approvals. Likely that more than one application will need to be made to each statutory authority.			✓
1	**Strong negative**	This option contradicts regulatory requirements and presents extreme difficulties obtaining statutory approvals. Likely that more than one application will need to be made to each statutory authority.			

Property

Degree of risk in relation to land acquisition that could impact delivery of project on time and within budget.

Option 1 (Cambridge Terrace site) would require acquisition of private property. Access and pipelines would traverse one property and the reservoir itself would be constructed on a second land parcel. Engagement with landowners need only be initiated if this option is identified as the preferred site. Land acquisition would need to be on a 'willing seller, willing buyer' basis. Compulsory purchase may not be justifiable where alternatives are available.

The **Cambridge Terrace** site would need approval from two separate landowners. The public works act is unlikely to be appropriate due to viable alternative options. There is a high risk of project delay and additional costs associated with property negotiations.

Naenae 2 and **Gracefield 2** are within public land ownership.

Table 26. MCA scoring – Property Risks

○ = preliminary score, ✓ = agreed score

Score		Description	Cambridge	Naenae 2	Gracefield 2
7	Strong positive	Negligible			
6	Moderate positive	Very low			
5	Slight positive	Low		✓	✓
4	Neutral	Moderate –tolerable		○	○
3	Slight negative	High			
2	Moderate negative	Very high	○ ✓		
1	Strong negative	Extreme – unacceptable			

Construction Risk

Degree of risk in relation to geotechnical conditions, potential for contaminated land, and other environmental conditions that could impact delivery of project safely, on time and within budget.

The constructability assessment (Appendix I), geotechnical assessment (Appendix G) and contaminated land assessment (Appendix J) identify risks associated with each site that could potentially result in adverse outcomes.

Table 27. Summary of construction risks associated with each site

▲= more favourable, ○ = neutral, ▽ = less favourable

Option 1: Cambridge Tce	Option 2: Naenae 2	Option 3: Gracefield 2
○ Typical construction risks	○ Typical construction risks	○ Typical construction risks
○ Access road crosses SLUR site (Pick-a-Part). There is no evidence any vehicle dismantling has taken place in the access road area. Unlikely to pose increased risk or require specific disposal of material.	○ Potential to encounter some groundwater along pipe route	▽ Higher geotechnical risks due to height of cut face and high slope angle required within constraint of existing access road. Additional stabilisation may be required.
▲ Unlikely to encounter groundwater along pipe route		▽ Very likely to encounter groundwater along much of pipeline route

Table 28. MCA scoring – Construction Risk

○ = preliminary score, ✓ = agreed score

Score		Description	Cambridge	Naenae 2	Gracefield 2
7	Strong positive	Negligible			
6	Moderate positive	Very low			
5	Slight positive	Low			
4	Neutral	Moderate –tolerable	○ ✓	○ ✓	
3	Slight negative	High			○ ✓
2	Moderate negative	Very high			
1	Strong negative	Extreme – unacceptable			

5.7.7 Financial

Capital Cost

Capital cost of the project including design, consenting and construction (excluding property).

A capital cost estimate has been prepared for each of the options and is presented in Appendix L . The Level 1 estimates for each of the site options are Cambridge Terrace ($135M), Naenae 2 ($75M) and Gracefield 2 ($170M). The previous capital cost estimates prepared for option short listing have been further developed utilising inputs from other MCA assessments identified above and refined construction quantities. Costs vary markedly between the options due to the differing quantum of works needed to provide site access and pipeline connections.

Note: The Level 1 cost estimates presented here significantly exceed those presented previously (Level 0) and the project budget. While these estimates have been developed with reference to Wellington Water estimating guidelines, closer examination has found that they are overstated due to the blanket application of contingency and risk percentage markups and allowance for cost escalation. A relative comparison of the three estimates for the purpose of MCA scoring is valid, but these estimates should not be used for other purposes. The estimating approach has been refined and a revised estimate is presented in Section 7. This does not affect the MCA scoring below.

Table 29. MCA scoring – Capital Cost

○ = proposed score, ✓ = agreed score

Score		Description	Cambridge	Naenae 2	Gracefield 2
7	Strong positive	< 58% of median value		✓	
6	Moderate positive	58 – 75 % of median value		○	
5	Slight positive	75 – 92 % of median value			
4	Neutral	92 - 108 % of median value	○ ✓		
3	Slight negative	108 - 125% of median value			
2	Moderate negative	125 - 142% of median value			○ ✓
1	Strong negative	> 158% of median value			

5.7.8 Carbon

Embodied Carbon

Estimate of embodied carbon in the supply of key materials (concrete, steel, pipes) and the offsite disposal of surplus earthwork volumes.

An embodied carbon estimate has been prepared for each of the options. Refer Appendix L . The key differentiator between options is the additional embodied carbon associated with the significantly greater length of pipelined required to and from the Cambridge and Gracefield 2 sites.

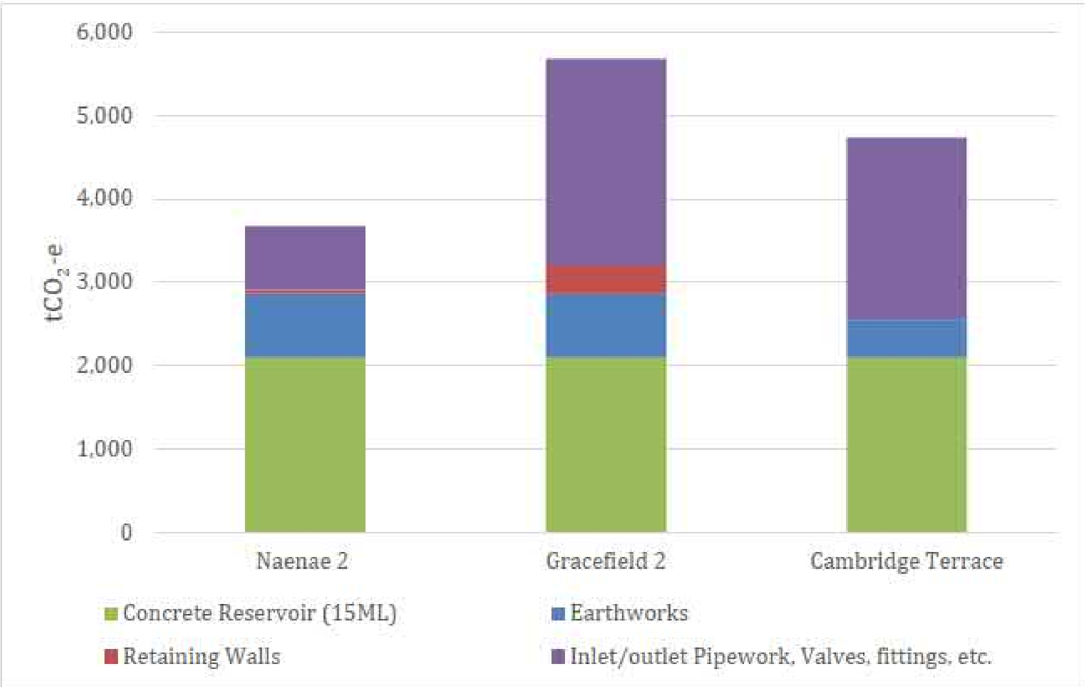

Figure 40. Embodied carbon assessment by component

Table 30. MCA scoring – Embodied Carbon

○ = preliminary score, ✓ = agreed score

Score		Description	Cambridge	Naenae 2	Gracefield 2
7	Strong positive	< 58% of median value			
6	Moderate positive	58 – 75 % of median value			
5	Slight positive	75 – 92 % of median value		○ ✓	
4	Neutral	92 - 108 % of median value	○ ✓		
3	Slight negative	108 - 125% of median value			○ ✓
2	Moderate negative	125 - 142% of median value			
1	Strong negative	> 158% of median value			

5.8 Analysis

The weighted scores summed for each option, are presented in Table 31. Using the full set of criteria and agreed weightings Naenae 2 is the highest scoring site option. A full scoring summary is presented in Table 33

Table 31. Overall MCA scoring

Option Name	MCA score	MCA Rank
Cambridge Terrace	3.7	2nd
Naenae 2	**4.5**	**1st**
Gracefield 2	3.0	3rd

Table 32 presents the weighted MCA scores within each criteria group. The Naenae 2 site option scored highest in all criteria groupings except for the social grouping which covers construction period impacts. Poor scoring in this grouping reflects the proximity of the Naenae 2 site to existing residential property and site access being via residential streets. This outcome indicates that particular consideration will need to be given to managing construction impacts on the local community should the Naenae 2 site be adopted. Sensitivity testing of the weighting assigned to this criteria grouping is needed to understand how this may affect the overall scoring outcome.

Table 32. MCA scoring and option rank by criteria group

	Cambridge Terrace		Naenae 2		Gracefield 2	
Criteria Group	**Score**	**Rank**	**Score**	**Rank**	**Score**	**Rank**
Environmental	3.4	2nd	**3.7**	**1st**	3.4	2nd
Social	**3.2**	**1st**	2.2	3rd	2.6	2nd
Technical	3.7	2nd	**4.2**	**1st**	3.6	3rd
Financial	4.0	2nd	**7.0**	**1st**	2.0	3rd
Carbon	4.0	2nd	**5.0**	**1st**	3.0	3rd
Overall	3.7	2nd	**4.5**	**1st**	3.0	3rd

Table 33. MCA Scoring Summary

Criteria Grouping	Group Weighting (%)	Criteria	Sub Weighting (%)	Criteria Weighting (%)	MCA Scoring		
					Cambridge	Naenae 2	Gracefield 2
Environmental	20	Ecology	40	8.0	4	4	4
		Landscape	30	6.0	2	3	3
		Heritage and Culture	30	6.0	4	4	3
Social	15	Noise, Vibration and Dust	40	6.0	3	2	4
		Traffic and Access	40	6.0	3	2	1
		Recreation	20	3.0	4	3	3
Technical	35	Vulnerability and Resilience	20	7.0	5	4	3
		Operability and Maintainability	20	7.0	4	4	4
		Performance and Opportunity	10	3.5	4	4	4
		Regulatory Framework	10	3.5	3	4	2
		Property Risk	20	7.0	2	5	5
		Construction Risk	20	7.0	4	4	3
Financial	25	Capital Cost	100	25.0	4	7	2
Carbon	5	Embodied Carbon	100	5.0	4	5	3
Total	**100**			**100**	**3.7**	**4.5**	**3.0**

5.9 Sensitivity

Uncertainty is inherent in the MCA process because the decision makers' preferences, expressed as weights, are subjective values. Sensitivity analysis explores the robustness of the result(s) and how sensitive they are in changes to the model, i.e. the extent to which they result from the particular weightings that have been applied. It varies the weights and/or data to see how they affect the results. If a minor variation in one criterion significantly influences the result, that parameter should be subject to further scrutiny. This may include reconsideration of relative weightings and reconfirmation of scoring for the sensitive parameter.

5.9.1 Scenarios

The following scenarios have been tested to evaluate the effect on the overall score for each site option.

a. Remove Financial criteria from assessment (25% to zero weighting)
   This allows comparison of options without consideration of cost.

b. Increase weighting of Financial criteria (25% to 30%)

c. Increase weighting of Environmental criteria (20% to 40%)

d. Increase weighting of Social criteria (15% to 40%)
   This is of particular interest as the highest scoring option (Naenae 2) scored poorly on Social criteria.

e. Increase weighting of Technical criteria (35% to 50%)

f. Decrease weighting of Technical criteria (35% to 20%)

g. Increase weighting of Carbon criteria (5% to 10%)

h. Remove Carbon criteria from assessment (5% to zero weighting)

i. Increase weighting of Social criteria (15% to 35%) and decrease Financial criteria (25% to 5%)
   This is intended to explore the effect of skewing the assessment against the highest scoring option (Naenae 2) which scored poorly on Social and highly on Financial.

j. Increase weighting of social criteria (15% to 40%) and remove financial criteria (25% to 0%)
   This is the extreme case of sensitivity test (i) above.

The applied weightings for each of these sensitivity scenarios are presented in Table 35. Where a particular percentage weighting has been adjusted, the other weightings are adjusted in proportion.

5.9.2 Sensitivity Scoring Outcomes

The overall scores calculated using the adjusted weightings are shown in Table 34. In all scenarios the relative ranking of the site options remains unchanged, with the exception of the extreme scenario (j). This demonstrates that the MCA outcome is not sensitive to the adopted weightings.

Table 34. Sensitivity Analysis Scores

Scenario	Description	MCA weighted score totals		
		Cambridge	Naenae	Gracefield
-	**Base Weightings**	**3.7**	**4.5**	**3.0**
a	Zero Financial weighting	3.5	3.7	3.3
b	Increase Financial weighting	3.7	4.7	2.9
c	Increase Environmental weighting	3.6	4.3	3.1
d	Increase Social weighting	3.5	3.9	2.9
e	Increase Technical weighting	3.7	4.5	3.1
f	Decrease Technical weighting	3.6	4.6	2.8
g	Increase Carbon weighting	3.7	4.6	3.0
h	Decrease Carbon weighting	3.6	4.5	3.0
i	Increase Social, Decrease Financial	3.5	3.6	3.1
j	Increase Social, Zero Financial	3.5	3.3	3.1

Removal of the financial criterion (scenario a) significantly diminishes the score margin between Naenae 2 and the second ranked site, Cambridge Tce. While the lower cost of the Naenae 2 option is a strong driver, the option would still be favoured on non-financial criteria alone.

Scenario (i) was intended to explore the extent to which the Financial and Social weightings would need to be skewed to alter the overall outcome. With a 35% weighting on Social and a 5% weighting on Financial the overall scoring for the Cambridge Tce site comes close to matching the Naenae 2 score. Only in the extreme case (scenario j) with a 40% weighting on Social and a zero weighting on Financial did the Cambridge Tce option score highest.

5.10 Conclusion

The MCA process has identified Naenae 2 as the highest scoring option. Sensitivity analysis has confirmed that the MCA outcome is not sensitive to the adopted weightings.

Table 35. Sensitivty Analysis Weighting Scenarios

	Base Weightings				Zero Financial weighting			Increase Financial weighting			Increase Environmental weighting			Increase Social weighting			Increase Technical weighting		
Criteria Grouping	Group Weighting (%)	Criteria	Sub Weighting (%)	Criteria Weighting (%)	Group Weighting (%)	Sub Weighting (%)	Criteria Weighting (%)	Group Weighting (%)	Sub Weighting (%)	Criteria Weighting (%)	Group Weighting (%)	Sub Weighting (%)	Criteria Weighting (%)	Group Weighting (%)	Sub Weighting (%)	Criteria Weighting (%)	Group Weighting (%)	Sub Weighting (%)	Criteria Weighting (%)
		Ecology	40	8.0		40	10.7		40	7.5		40	16.0		40	5.6		40	6.2
Environmental	20	Landscape	30	6.0	26.7	30	8.0	18.7	30	5.6	40.0	30	12.0	14.1	30	4.2	15.4	30	4.6
		Heritage and Culture	30	6.0		30	8.0		30	5.6		30	12.0		30	4.2		30	4.6
		Noise, Vibration and Dust	40	6.0		40	8.0		40	5.6		40	4.5		40	16.0		40	4.6
Social	15	Traffic and Access	40	6.0	20.0	40	8.0	14.0	40	5.6	11.3	40	4.5	40.0	40	16.0	11.5	40	4.6
		Recreation	20	3.0		20	4.0		20	2.8		20	2.3		20	8.0		20	2.3
		Vulnerability and Resilience	20	7.0		20	9.3		20	6.5		20	5.3		20	4.9		20	10.0
		Operability and Maintainability	20	7.0		20	9.3		20	6.5		20	5.3		20	4.9		20	10.0
Technical	35	Performance and Opportunity	10	3.5	46.7	10	4.7	32.7	10	3.3	26.3	10	2.6	24.7	10	2.5	50.0	10	5.0
		Regulatory Framework	10	3.5		10	4.7		10	3.3		10	2.6		10	2.5		10	5.0
		Property Risk	20	7.0		20	9.3		20	6.5		20	5.3		20	4.9		20	10.0
		Construction Risk	20	7.0		20	9.3		20	6.5		20	5.3		20	4.9		20	10.0
Financial	25	Capital Cost	100	25.0	0.0	100	0.0	30.0	100	30.0	18.75	100	18.8	17.6	100	17.6	19.2	100	19.2
Carbon	5	Embodied Carbon	100	5.0	6.7	100	6.7	4.7	100	4.7	3.75	100	3.8	3.5	100	3.5	3.8	100	3.8
Total	100			100	100		100	100		100	100		100	100		100	100		100

	Base Weightings				Decrease Technical weighting			Increase Carbon weighting			Decrease Carbon weighting			Increase Social, Decrease Financial			Increase Social, Zero Financial		
Criteria Grouping	Group Weighting (%)	Criteria	Sub Weighting (%)	Criteria Weighting (%)	Group Weighting (%)	Sub Weighting (%)	Criteria Weighting (%)	Group Weighting (%)	Sub Weighting (%)	Criteria Weighting (%)	Group Weighting (%)	Sub Weighting (%)	Criteria Weighting (%)	Group Weighting (%)	Sub Weighting (%)	Criteria Weighting (%)	Group Weighting (%)	Sub Weighting (%)	Criteria Weighting (%)
		Ecology	40	8.0		40	9.8		40	7.6		40	8.4		40	8.0		40	8.0
Environmental	20	Landscape	30	6.0	24.6	30	7.4	18.9	30	5.7	21.1	30	6.3	20.0	30	6.0	20.0	30	6.0
		Heritage and Culture	30	6.0		30	7.4		30	5.7		30	6.3		30	6.0		30	6.0
		Noise, Vibration and Dust	40	6.0		40	7.4		40	5.7		40	6.3		40	14.0		40	16.0
Social	15	Traffic and Access	40	6.0	18.5	40	7.4	14.2	40	5.7	15.8	40	6.3	35	40	14.0	40	40	16.0
		Recreation	20	3.0		20	3.7		20	2.8		20	3.2		20	7.0		20	8.0
		Vulnerability and Resilience	20	7.0		20	4.0		20	6.6		20	7.4		20	7.0		20	7.0
		Operability and Maintainability	20	7.0		20	4.0		20	6.6		20	7.4		20	7.0		20	7.0
Technical	35	Performance and Opportunity	10	3.5	20.0	10	2.0	33.2	10	3.3	36.8	10	3.7	35.0	10	3.5	35.0	10	3.5
		Regulatory Framework	10	3.5		10	2.0		10	3.3		10	3.7		10	3.5		10	3.5
		Property Risk	20	7.0		20	4.0		20	6.6		20	7.4		20	7.0		20	7.0
		Construction Risk	20	7.0		20	4.0		20	6.6		20	7.4		20	7.0		20	7.0
Financial	25	Capital Cost	100	25.0	30.8	100	30.8	23.7	100	23.7	26.3	100	26.3	5	100	5.0	0	100	0.0
Carbon	5	Embodied Carbon	100	5.0	6.2	100	6.2	10.0	100	10.0	0.0	100	0.0	5	100	5.0	5	100	5.0
Total	100			100	100		100	100		100	100		100	100		100	100		100

6 Mana Whenua Engagement

Wellington Water Ltd and the Connect Water Project Team met with representatives of Taranaki Whānui on 10 May 2022. This meeting covered work on project to that date, including process undertaken to review 25 potential locations throughout Hutt City, the narrowing down of options to 3 sites on the Eastern Hills. Based on this overview meeting Taranaki Whānui provided verbal feedback that two of the options had potential for higher adverse effects on mana whenua values, and one site, Option 2, Naenae had lowest risk of significant impacts on mana whenua values out of the three shortlisted options.

Taranaki Whānui confirmed their requirement for a Cultural Impact Assessment (CIA) for the preferred option 2, Naenae. This CIA will be supported by further information as the design is developed through the subsequent concept development phase.

Further details of correspondence are included in Appendix N.

6.1 Opportunities

At the meeting on 10 May 2022, opportunities for further development were discussed. These suggestions included;

- Development of information and education material relating to the shortlisted sites that could be installed at or near those locations to raise awareness of the values associated with the sites, including former historic pā and urupa.
- Development of information and educational material about Te Ao Maori with a focus on water and the water cycle.
- Incorporation of cultural design and practices in development and delivery of the concept design, procurement and construction of the new reservoir.

Ongoing engagement with Taranaki Whanui would enable further development of these opportunities.

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7 Revised Estimate

Revised estimates have been prepared for the three shortlisted options. These estimates supersede the Level 1 estimate prepared for MCA scoring purposes. The underlying physical works estimate remains unchanged, but a more considered approach to the calculation of contingency and risk amounts was applied, as agreed with Wellington Water. This change in approach does not affect the MCA outcome as scoring was based on a comparative assessment of the previous estimates that had all been prepared in the same manner.

	Cambridge Terrace	Naenae 2	Gracefield 2
Base Estimate	$81.0m	$45.8m	$101.5m
plus Contingency	$22.5m	$13.2m	$28.7m
Expected Estimate	**$103.5m**	**$59.0m**	**$130.2m**
plus Funding Risk	$32.3m	$15.0m	$38.4m
95th Percentile Estimate	$135.8m	$74.0m	$168.6m

Estimates include Wellington Water Management Fee but exclude allowance for escalation

The revised estimate is presented as a 'Level 1.5' estimate on the basis that option development and assessment completed for the site selection MCA has allowed refinement of the estimate beyond 'Level 1', but a full concept design has not been completed, as needed to support a 'Level 2' estimate.

The revised estimating report, setting out inclusions, exclusions and assumptions, is supplied in Appendix O.

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8 Site Recommendation

The MCA process has identified Naenae 2 as the highest scoring option.

Feedback from Taranaki Whanui, following initial engagement and discussion of site options, confirmed that the Naenae 2 site presents the lowest risk of significant impacts on mana whenua values out of the three location options presented.

It is recommended that the Naenae 2 site be adopted as the preferred option for concept design. It is recommended that a Cultural Impact Assessment is completed during the next design phase when sufficient information has been prepared to enable completion of the assessment.

Appendix A

Longlisted Site Assessment

Lower Hutt Central Reservoir Site Identification and Asessment

Summary, Site Earthworks (at 1V:1H) and Access Road at 1H:1V

Site	Summary: Pros	Summary: Cons	Site Earthworks: Cut volume (m3)	Fill volume (m3)	Total volume (m3)	Fill height (m)	Cut height (m)	Earthworks Summary	Access Road: Length (m)	Grade (%)	Cut volume (m3)	Fill volume (m3)	Total volume (m3)	Fill height (m)	Cut height (m)	Access Road Summary
Page Grove	Existing access road Lower total earthworks volume HCC ownership	High earthworks cuts Long pipelines Former landfill site Unfavourable geotechnical considerations	-50000	0	50000	0	30	Earthworks quantities are moderate but a significant cut height would be required.	existing	10%	0	0	0	0	0	This site could be accessed from an existing access road.
Scoring	2		3	5	3	5	2	2	5	3						5
Cambridge Terrace	Low earthworks volumes Low earthworks cuts Favourable geotechnical conditions	Long pipelines Private land ownership (part)	-30000	0	30000	0	13	Earthworks quantities are favourable and cut height is modest, making this site attractive from an earthworks perspective.	250	11%	-11000	2000	13000	15	19	An access road to this site looks favourable with comparatively low earthworks volumes and managable cut heights.
Scoring	4		4	5	4		4	4	3	2	4	5	4	3	2	3
Patricia Grove		High earthworks cuts Very long pipelines Unfavourable for consenting Reserve Act applies Private land ownership (part)	-70000	0	70000	0	26	Earthworks quantities are moderate but a significant cut height would be required.	180.00	11%	2500	4500	7000	15	15	An access road to this site looks favourable with comparatively low earthworks volumes and managable cut heights.
Scoring	2		3	5	3		2	2	4	2	5	5	5	3	3	3
Naenae 2	Moderate earthworks quantities and cut heights Existing road access Existing bulk water inlet main Shorter outlet pipeline Land owned by HCC Existing reservoir site	Walking tracks impacted	-70000	0	70000	0	20	Earthworks quantities and cut heights moderate.	existing	10%	0	0	0	0	0	The existing road leads very close to the proposed site.
Scoring	5		3	5	3		3	3	5				5			4
Gracefield 2	Existing road access (but steep) Favourable for consenting Land owned by HCC Existing reservoir site	High earthworks cuts Long pipelines Less favourable geotechnical considrations Archaeological risk Restricted access (one way from Wainui to Lower Hutt)	-75000	0	75000	0	32	High earthworks volumes and cut heightst make earthworks at this site unattractive.	Existing road	14%	0	0	0	0	0	This site has an existing access road. However, the road appears to be steep at around 14% grade. This may be challenging for construction equipment to access.
Scoring	3		2	5	2		2	2	5	1						3
Mawson Street	Land owned by HCC	Very high earthworks cuts (access road) High earthworks volumes Long pipelines Less favourable geotechnical consideration Resticted access (one way to Wainui)	-45000	0	45000	0	23	Earthworks quantities are favourable but there is still significant cut height required.	315	5%	-35000	0	35000	0	37	Access across steep terrain would require very high cuts.
Scoring	2		4	5	4		3	3	3	4	2	5	2	5	1	1
Normandale Road		Location on western hills is unfavourable for construction of pipelines across river, fault, SH, through CBD etc. Long pipelines Proximity to fault - high seismic loads Adverse geotechnical considerations Adverse consenting considerations Reserves Act will apply	-55000	0	55000	0	18	This site has modrate earthworks volumes and managable fill heights.	150	6%	-18000	2000	20000	18	30	An access road to this site is unfavourable requiring cut heights up to 30m high.
Scoring	Discounted		3	5	3		3	3	4	4	4	5	3		1	2
Taita 2	Existing access road	High earthworks volume Very high earthworks cuts/fills Very long pipelines	-35000	45000	80000	30	47	While there may be opportunity for cut / fill balancing, the high total earthworks volume and significant cut and fill heights make this site unattractive.	50	11%	*included in site earthworks quantities*					This site could be accessed from an existing access road.
Scoring	Discounted		4	4	2	2	1	1	5	2						5
Taita 3	Lower earthworks volume Existing access road to be realigned	Very high earthworks cuts/fills Large site footprint Imported fill Very long pipelines	0	30000	30000	67	5	Earthworks quantities at this site are favourable but the requires a significant depth of fill and large site footprint. Imported fill would be required which may not be practicable.	~150	11%	*access road not modelled*					This site would require realigning the existing access road.
Scoring	Discounted		5	4	4	1	5	2	4	2						4
Waddington Drive		Very high earthworks volumes High earthworks cuts Long access road Long pipelines	-45000	0	45000	0	22	Earthworks quantities are favourable but there is still significant cut height required.	550	8%	-51000	600	52000	9	28	A long access road to the site requires large earthworks volumes with very high cut faces.
Scoring	Discounted		4	5	4		3	3	2	3	1	5	1	4	1	1
Swainson Street		Site access not feasible due to topography, levels and drainage considerations. Long pipelines Unfavourable for consenting	-65000	0	65000	0	32	Earthworks quantities are moderate but there is still significant cut height required.	140	5%	-22000	0	22000	0	28	While the short access route is attractive it would require a deep, incised cuttng (both sides of road) an introduce the need for significant drainage works. This site is discounted on this basis.
Scoring	Discounted		3	5	3		2	2	4	4	3		3		1	0
Willcox Grove		Very high earthworks volumes (130,000 m3) Very high earthworks cuts (74m) Long pipelines	-130000	0	130000	0	74	Earthworks at this site are not considered to be feasible.	existing	0	0	0	0	0	0	The existing road leads close to the reservoir site.
Scoring	Discounted		1	5	1		0	0	5							5
Te Whiti Riser		Very high earthworks volumes (120,000 m3) Very high earthworks cuts (74m)	-120000	0	120000	0	74	Earthworks at this steep site are not considered to be feasible.	580	11%	-50000	500	50500	4	24	The long access road introduces significant additional earthworks volumes and unfavourable cut heights.
Scoring	Discounted		1	5	1		0	0	2	2	1	5	1	5	2	1
Harbour View Road		Location on western hills is unfavourable for construction of pipelines across river, fault, SH, through CBD etc. Proximity to fault - high seismic loads Adverse geotechnical considerations Adverse consenting considrations Reserves Act will apply	-60000	0	60000	0	23	This site has cut volumes of around 60000m3 and cut heights up to 23m high.	460	-5%	-30000	65000	95000	28	20	An access road to this site would require very large amounts of earthworks and requires crossing 2 valleys. This site does not appear to have a viable access route.
Scoring	Discounted		3	5	3		3	3	2	4	2	1	0	2	2	0

Total earthworks, Inlet Pipeline, Outlet Pipeline, Total Pipeline and Pipelines Summary

Site	Total earthworks: Reservoir pad and access road (m3)	Inlet Pipeline: Length (m)	Inlet Pipeline: Route Difficulty	Outlet Pipeline: Length (m)	Outlet Pipeline: Route Difficulty	Total Pipeline: Length (m)	Pipelines Summary
Page Grove	50000	4300	Rail crossing	1100	Rail crossing	5400	Long pipelines required.
Scoring	4		3		3	2	2
Cambridge Terrace	50000	3900	Rail crossing	700	Rail crossing	4600	Long pipelines required.
Scoring	5		3		3	2	2
Patricia Grove	80000	3600	Waiwhetu Stream crossing	3300	Waiwhetu Stream crossing Rail crossing	6900	Very long pipelines required.
Scoring	2		3		2	1	1
Naenae 2	70000	100	The bulk main could connect to the existing bulk main at Naenae.	1100	Rail crossing	1200	Existing inlet pipeline to Naenae Reservoir can be utilised and only a short outlet connection is required to the distribution network
Scoring	3		5		3	5	5
Gracefield 2	75000	3500	Waiwhetu Stream crossing Rail crossing	2000	Waiwhetu Stream crossing	5500	Long pipelines required.
Scoring	3		2		2	2	2
Mawson Street	80000	3100	Waiwhetu Stream crossing Rail crossing	1600	Waiwhetu Stream crossing	4700	Long pipelines required.
Scoring	2		2		3	2	2
Normandale Road	75000	3300	Lower Hutt CBD Hutt River crossing State Highway 2 Rail crossing Wellington Fault crossing	2000	Lower Hutt CBD Hutt River crossing State Highway 2 Rail crossing Wellington Fault crossing	5300	Long pipelines required. Multiple factors indicate that pipeline construction would be disruptive, challenging and costly. Pipelines would be particulary vulnerable to any seismic activity on the Wellington Fault.
Scoring	3		1		1	2	0
Taita 2	80000	5300	Rail crossing	2200	Rail crossing	7500	Very long pipelines required.
Scoring	2		3		3	1	1
Taita 3	30000	5300	Rail crossing	2200	Rail crossing	7500	Very long pipelines required.
Scoring	5		3		3	1	2
Waddington Drive	100000	3000	Waiwhetu Stream crossing	2600	Waiwhetu Stream crossing Rail crossing	5600	Long pipelines required.
Scoring	1		3		2	2	2
Swainson Street	90000	2700	Waiwhetu Stream crossing	2500	Waiwhetu Stream crossing Rail crossing	5200	Long pipelines required.
Scoring	2	3	3	3	2	2	2
Willcox Grove	130000	2500	Waiwhetu Stream crossing	2500	Waiwhetu Stream crossing Rail crossing	5000	Long pipelines required.
Scoring	1		3		2	2	2
Te Whiti Riser	180000	2100	Waiwhetu Stream crossing Rail crossing	1300	Waiwhetu Stream crossing	3400	Moderate length of pipelines required.
Scoring	1		2		3	3	3
Harbour View Road	160000	2400	Hutt River crossing State Highway 2 Rail crossing Wellington Fault crossing	1100	Hutt River crossing State Highway 2 Rail crossing Wellington Fault crossing	3500	Long pipelines required. Multiple factors indicate that pipeline construction would be disruptive, challenging and costly. Pipelines would be particulary vulnerable to any seismic activity on the Wellington Fault.
Scoring	1		0		0	3	0

Geotechnical and Structural

Site	Geotechnical: Seismic hazard	Foundation conditions	Earthworks at reservoir pad	Access	Slopes at/around reservoir pad	Resilience of road access to site	Geotechnical Summary	Structural Summary
Page Grove	1.6 km SE of Wellington Fault, landfill underlying	Old landfill beneath - GNS 50k geology	Significant earthworks with high cuts required	Existing access road	Average slope about 30 deg west	Possible disruption to road access from building damage in adjacent commercial area	The site is very unfavourable due to underlying landfill and would have significant cost implications to remove refuse or install pile foundations. Site also has high cuts and 30 degree average slopes surrounding the site.	Precast circular reservoir, located above ground: most efficient structure and use of materials Semi-industrial zoning, so construction noise/dust less of an impact Existing access road, asphalt sealed. Some sharp bends may be difficult for long precast sections. Laydown area available immediately above proposed site Site drainage requirements minimal
Scoring	2	1	2	5	2	3	1	4
Cambridge Terrace	1.6 km SE of Wellington Fault, greywacke bedrock	Underlain by greywacke bedrock (likely with some surficial colluvium)	Earthworks not too significant, no high cuts required	Access road with 19m high cuts required, will create localised and short hanging gullies	Ridgetop location, average slope <20 deg	Generally good resilience of road access through Avalon / Taita / Naenae	The site is favourable and is likely to be underlain by greywacke bedrock and relatively shallow surrounding slopes.	Precast circular reservoir, located above ground: most efficient structure and use of materials Semi-industrial zoning, so construction noise/dust less of an impact Access road required. Steep grades required, need to ensure alignment has no sharp bends. No laydown area available immediately adjacent. Need to store materials at base of access road. Site drainage requirements minimal
Scoring	3	4	4	3	4	4	4	2
Patricia Grove	2.7 km SE of Wellington Fault, greywacke bedrock	Underlain by greywacke bedrock (likely with some surficial colluvium)	Significant earthworks with moderate cuts required at northern end	Access road with significant earthworks required, alignment could be optimised to reduce cut height and instead use reinforced fill	Ridgetop location but platform extends beyond width of ridgetop, average slope to either side >30 deg	Generally good resilience of road access through Naenae	The site is likely to be underlain by greywacke bedrock. Site has unfavourable surrounding slopes greater than 30 degrees.	Precast circular reservoir, located above ground: most efficient structure and use of materials Semi-industrial zoning, so construction noise/dust less of an impact Access road required. Moderate grades only, possible sharp bend on most direct alignment. No laydown area available immediately adjacent. Need to store materials at base of access road. Site drainage requirements minimal
Scoring	4	4	3	2	2	4	3	3
Naenae 2	2.2 km SE of Wellington Fault, greywacke bedrock	Underlain by greywacke bedrock (likely with some surficial colluvium)	Significant earthworks but ridgetop platform with only moderate cuts required at southern end of pad	Existing access road, may need widening with minor earthworks	Ridgetop location, but extends beyond width of ridge, avg slope to either side about 40 deg (east) and 30 deg (west)	Resilience of road access through Naenae / Fairfield may be disrupted by local liquefaction alongside streams	The site is likely to be underlain by greywacke bedrock. Site has unfavourable slopes steeper than 30 degrees below the platform on both sides.	Precast circular reservoir, located above ground: most efficient structure and use of materials Mainly residential zoning, so construction noise/dust more of an impact Existing access road, asphalt sealed. No sharp bends. No laydown area available immediately adjacent - roof of existing reservoir is not suitable. Site drainage requirements minimal
Scoring	4	4	4	4	3	3	3	4
Gracefield 2	3.5 km SE of Wellington Fault, greywacke bedrock with some melange	Underlain by greywacke bedrock (likely with some surficial colluvium). Melange mapped within southern extent of pad.	Significant earthworks with high cuts required	Existing access road, but will be impacted / undermined by cut for reservoir pad, requiring slope stabilisation or new access	Ridgetop location, with average slopes at proposed pad location about 20 deg. Gully slopes of >40 deg further downslope to the NE, and steep cut slope below platform to the NW.	Poor resilience of road access through Seaview; access to Wainui Hill Rd may be affected by liquefaction and slope failures	The exisiting road will be impacted by the reservoir cut, requiring slope stabilisation or new access. High cuts required. Resilience of access to Wainui Hill Road may be affected by liquefaction and slope failures.	Precast circular reservoir, located above ground: most efficient structure and use of materials Semi-industrial zoning, so construction noise/dust less of an impact Existing access road, asphalt sealed. No sharp bends. Only accesible one-way (coming down the hill from Wainui) No laydown area available immediately adjacent. Site drainage requirements minimal
Scoring	3	3	2	2	3	2	2	4
Mawson Street	3.1 km SE of Wellington Fault, greywacke bedrock	Underlain by greywacke bedrock (likely with some surficial colluvium)	Significant earthworks with high cuts required	Access road with significant earthworks required, crossing steep slopes creating hanging gullies in erosion-prone terrain.	Ridgetop location, but extends beyond width of ridge, avg slope to either side about 40 deg	Only single road access (Wainui Hill Rd); no redundancy and may be prone to closure from landslides	The site is likely to be underlain by greywacke bedrck. Site has unfavourable surrounding slopes greater than 40 degrees. Access road will create hanging gullies which risks landslides and debris flows.	Precast circular reservoir, located above ground: most efficient structure and use of materials Semi-industrial zoning, so construction noise/dust less of an impact Access road required. Steep grades required, need to ensure alignment has no sharp bends. Only accesible one-way (going up the hill to Wainui) No laydown area available immediately adjacent. Need to store materials at base of access road. Site drainage requirements moderate
Scoring	4	4	2	1	2	2	2	1
Normandale Road	About 250m NW of Wellington Fault, will be much higher seismic load from Wgtn Fault due to near-fault (directivity) and hanging wall amplification effects	Underlain by greywacke bedrock (likely with some surficial colluvium)	Significant earthworks with high cuts required	Access road with significant earthworks required, crossing steep slopes and gullies	Average slopes at proposed pad location about 25-30 deg	Poor resilience of road access up Normandale Rd - prone to landslides and damage from Wellington Fault rupture	The site is 250m northwest of the Wellington Fault, will have much higher seismic load. Unfavourable slopes of around 25-30 degrees. Access via Normandale road may be vulnerable to landslides/damage from Wellington Fault.	Precast circular reservoir, located above ground: most efficient structure and use of materials Mainly residential zoning, so construction noise/dust more of an impact Access road required. Steep grades required, need to ensure alignment has no sharp bends. Steep valley adjacent proposed location. No laydown area available immediately adjacent. Need to store materials at base of access road. Site drainage requirements moderate
Scoring	1	4	2	2	2	2	1	1
Taita 2	Site discounted prior to assessment						Site discounted prior to assessment	Site discounted prior to assessment
Taita 3	Site discounted prior to assessment						Site discounted prior to assessment	Site discounted prior to assessment
Waddington Drive	Site discounted prior to assessment						Site discounted prior to assessment	Site discounted prior to assessment
Swainson Street	3.2 km SE of Wellington Fault, 2.5 km NW of Whitemans Valley Fault, greywacke bedrock	Underlain by greywacke bedrock (likely with some surficial colluvium)	Significant earthworks with high cuts required	Access road with significant earthworks (high cuts) required, hanging gullies and steep hillslopes above cuts	Average slope at NW extent of pad is about 30 deg	Generally good resilience of road access through Naenae	Site is likely to be underlain by greywacke bedrock. Site has unfavourable surrounding slopes greater than 30 degrees.	Precast circular reservoir, located above ground: most efficient structure and use of materials Mainly residential zoning, so construction noise/dust more of an impact Access road required. Steep grades unlikely, need to ensure alignment has no sharp bends. No laydown area available immediately adjacent. Need to store materials at base of access road. Site drainage requirements minimal
Scoring	4	4	2	2	2	4	3	4
Willcox Grove	Site discounted prior to assessment						Site discounted prior to assessment	Site discounted prior to assessment
Te Whiti Riser	Site discounted prior to assessment						Site discounted prior to assessment	Site discounted prior to assessment
Harbour View Road	Site discounted prior to assessment						Site discounted prior to assessment	Site discounted prior to assessment

Planning / Legal, Cultural / Heritage / Community, SLUR, Stakeholders/Community and Manawhenua

Site	Planning / Legal: District plan zoning	District plan overlays (protected features)	Reserve status	Proximity to sensitive receptors	Consenting pathway	Planning / Legal: Planning summary	Cultural / Heritage / Community: Archaeological	Recreation	Selected Land Use Register (SLUR) sites (contaminated land)	Stakeholders/Community: Ownership	Manawhenua: Questions and items to discuss with Manawhenua. Comments included below reflect our current awareness.
Page Grove	The proposed development is classified as a Network Utility, meaning that the rules within the Utilities chapter take precedence to those within the chapter of the underlying zone. The most onerous rule relates to noise levels, which, if breached, will trigger a Discretionary activity application. Otherwise, the application would likely be Restricted Discretionary. Note that the relevant city wide provisions relating to Passive Recreation zone will still apply.	Whilst land parcel is identified as a significant natural resource site - Taita Scientific Bush (SNR:53), the construction area itself is not.	Land parcel is subject to reserves act.	Proposed construction area is in the vicinity of modified site. There is established commercial land use (zoned general business) to the west, with significant natural resource site to the east and general recreation zone to the south. No residential properties are situated nearby.	Works will require reserves act application and resource consent application from Hutt City Council. Regional consent application is also required from Greater Wellington City Council.	This land parcel is located adjacent to a significant natural resource site. It is also within a reserve, which means that it will require permission under the Reserves Act (which is a process that does not have statutory timescales). Aerial photography suggests that existing vegetation is of low value (grass with small amounts of bushes), therefore mitigation for vegetation removal is comparatively low. In addition, it is adjacent to a modified site and business development area, therefore proximity to sensitive receptors is low. Therefore whilst this site presents some resource consent challenges these are likely to be of compartively lower risk.	Low risk of archaeological sites within project area	Proposed area in vicinity to modified site	Noted on the selected land use register - Wingate Landfill HAIL: Cemeteries and waste recycling, treatment and disposal HAIL Sub: Landfill sites Category: Verified History of Hazardous Activity or Industry	Site owned by Hutt City Council. Would require approval from parks and reserves department within council as part of reserves act application.	
Scoring						3	5	4	1	4	
Cambridge Terrace	As above. It is noted that the relevant city wide provisions relating to General Business (north); Hill Residential (south) and Passive Recreation (east) will still apply.	Land parcel is identified as a significant natural resource site - Eastern Hills Bush (SNR:12). Mitigation will likely be required for any vegetation removal.	No	Proposed construction area is in the vicinity of residential area (zoned General Residential) to the west; a cemetery located to the south; and commercial activity (zoned General Business) to the north. The construction area is also heavily vegetated.	Works will require a resource consent application from Hutt City Council. Regional consent application is also required from Greater Wellington City Council.	This land parcel is located within a significant natural resource site. Aerial photography indicates that the proposed construction area is densely vegetated, and therefore, mitigation for vegetation removal will likely be required. There are potentially more issues to address in the consent applications due to multiple landownership and mixed land uses in the vicinity. However, scoring is not affected because the different underlying zoning city-wide provisions will not change the activity status of the consent. It is also noted that the applications will be subject to the statutory processing timeframes. If noise levels determined that a Discretionary application would be required, the score would be reduced as there would then be an increased risk of challenge.	Low risk of archaeological sites within project area		Adjacent to SLUR site - Site Name: PICK-A-PART, 2 Eastern Hutt Road HAIL: Cemeteries and waste recycling, treatment and disposal HAIL Sub: Scrap yards including automotive dismantling, wrecking or scrap metal yards Category: Verified History of Hazardous Activity or Industry	Sue Lynette Green, Smith & Partners Trustee (north); John lawrence Havler (south); The Lower Hutt City Council (east)	Proximity to Naenae cemetary in relation to mauri of drinking water supply water Discharge from outflow pipe of clean drinking water into Waiwhetu Stream
Scoring						3	5	3	2	2	
Patricia Grove	As above. It is noted that the relevant city wide provisions relating to Passive Recreation (north); General Recreation (mid); General Residential (west); General Business (south) will still apply.	Land parcel is identified as a significant natural resource site - Eastern Hills Bush (SNR:12).	Land parcels are subject to reserves act. One land parcel is also subject to the reservation as to coal, gold and silver but this is to be considered by property and building.	Proposed construction area is located in the vicinity of established residential area to the west and industrial land use to the south. The area is heavily vegetated.	Works will require reserves act application and resource consent application from Hutt City Council. Regional consent application is also required from Greater Wellington City Council.	The proposed construction site is located within a significant natural resource site. It is also within a reserve which means that it will require permission under the Reserves Act (which is a process that does not have statutory timescales). Aerial photography also indicates that the site is heavily vegetated, therefore mitigation for vegetation removal will likely be required. In addition, the proposed construction area crosses one private property and the surrounding environment consists of residential and industrial land uses. Therefore, proximity to sensitive receptors is higher than alternative options. Together, these issues present numerous consenting risks which could lead to delays or even refusal.	Low risk of archaeological sites within project area		Site is not located on a SLUR site	Hutt City Council (north); The Lower Hutt City Council (south west); Patricia Holdings Limited (southeast)	Proximity to Naenae cemetary in relation to mauri of drinking water supply water Discharge from outflow pipe of clean drinking water into Waiwhetu Stream
Scoring						1	5	3	3	2	
Naenae 2	As above. It is noted that the relevant city wide provisions relating to Passive Recreation zone will still apply.	Land parcel is identified as a significant natural resource site (SNR:12).	No	Proposed construction area is in the vicinity of established residential properties to the west and north. It is noted that the proposed site is adjacent to an existing underground reservoir.	Works will require a resource consent application from Hutt City Council. Regional consent application is also required from Greater Wellington City Council.	This land parcel is located within a significant natural resource site. Aerial photography indicates that the proposed construction area is modified and moderately vegetated. Whilst the site is located in the vicinity of an established residential area, the proposed activity is not considered to deviate from its current land use because there is an existing underground reservoir within the site. However, an existing walking track traverses the site and mitigation to minimise effects on amenity and recreational values will likely be required. Despite the presence of planning risks at this location, it's proximity to a similar existing use may provide a level of acceptance for a new reservoir.	Low risk of archaeological sites within project area	Walking tracks transverses the site. Modified site adjacent to proposed site.	Site is not located on a SLUR site	Site owned by Lower Hutt City Council	Signifigance or name association with this hill side spur Origin of name Naenae Discharge from outflow pipe of clean drinking water into Waiwhetu Stream
Scoring						3	5	2	3	4	
Gracefield 2	As above. It is noted that the relevant city wide provisions relating to Passive Recreation zone will still apply.	Land parcels are identified as significant natural resource site - Mt Hawtrey Bush (SNR:36)	One land parcel is subject to conservation act, reserves act and crown minerals act. Another land parcel is subject to reserves act.	The proposed construction area is adjacent to an existing reservoir. The proposed site is also in the vicinity of established commercial activity. There are no residential properties nearby.	Works will require reserves act application and resource consent application from Hutt City Council. A conservation act application is required from Department of Conservation. Approval is also required from A regional resource consent is also required from Greater Wellington City Council.	The proposed construction area is located within a significant natural resource site and is subject to the Conservative Act, Reserve Act and Crown Minerals Act. As a result, approval is required from Department of Conservation, Ministry of Business, Innovation and Employment and Hutt City Council. Aerial photography suggests that the existing vegetation is of low value (grass with small number of bushes) with no residential properties nearby. The site contains an existing reservoir and is surrounded by established commercial land uses. Mitigation required to minimise potential adverse is comparitively low. Whilst this site presents some resource consent challenges, it's proximity to an existing reservoir is reflected favourably in the scoring.	It is likely that an Archaeological Authority would be required for this location. This would be a 'business as usual approach' but it is recommended further research is undertaken to confirm this.	Mountain bike track traverses access road	Site is not located on a SLUR site	Hutt City Council (west) and The Lower Hutt City Council (east)	Historical impacts in this area linked to reclamation to form Seaview Industrial area. Is there any name or signifigance attributed to this hill spur. New pipeline crossing of Waiwhetu Stream that may be required and discharge potential to stream.
Scoring						4	2	2	3	4	
Mawson Street	As above. It is noted that the relevant city wide provisions relating to Passive Recreation zone will still apply.	Land parcel is identified as significant natural resource site - Eastern Hills Bush (SNR:12).	No	There are no development in immediate vicinity and the site is separated by Wainuiomata Road. However, the area is heavily vegetated.	Works will require resource consent application from Hutt City Council and Greater Wellington City Council.	This land parcel is located within a significant natural resource site. There is no development in the immediate vicinity of the site and proximity to sensitive receptors is low. However, aerial photgrpahy indicates that the proposed construction area is densely vegetated, and therefore, mitigation for vegetation removal will likely be required.	Low risk of archaeological sites within project area	Mountain bike track traverses site	Site is not located on a SLUR site	The Lower Hutt City Council	Historical impacts in this area linked to reclamation to form Seaview Industrial area. Is there any name or signifigance attributed to this hill spur. New pipeline crossing of Waiwhetu Stream that may be required and discharge potential to stream.
Scoring						3	5	2	3	4	
Normandale Road	As above. It is noted that the relevant city wide provisions relating to General Recreation zone will still apply.	Land parcel is identified as significant natural resource site (SNR:21).	Land parcel is subject to reserves act. It is noted that the land parcel is also subject to water rights created by two conveyance.	There are residential properties situated to the west and north of the proposed site. The site is also heavily vegetated.	Works will require reserves act application and resource consent application from Hutt City Council. Regional consent application is also required from Greater Wellington City Council.	This land parcel is located within a significant natural resource site. It is also within a reserve, which means that it will require permission under the Reserves Act (which is a process that does not have statutory timescales). Aerial photography indicates that the proposed construction area is heavily vegetated and that the site is located in the vicinity of a residential area. Therefore, proximity to sensitive receptors is higher and mitigation for vegetation removal will likely be required. These consenting risks together with the unpredictable timescales for reserves act applications are reflected in the scoring	Low risk of archaeological sites within project area	Recreational tracks on the proposed site	Site is not located on a SLUR site	The Lower Hutt City Council	
Scoring						1	5	2	3	4	
Taita 2						Site discounted prior to assessment	Low risk of archaeological sites within project area		Site is noted on the selected land use register - Site name: Institute of Geological and Nuclear Sciences This site was formerly the Soil Bureau of DSIR where testing of radioactive substances on soil was undertaken. An investigation in 2001 into the dumping of material concluded that it was likely some radioactive isotopes (14C and 32P and 36S) material was disposed of at the site. However it was thought that the only isotope that would still be present in any measurable quantity would be 14C, the remainder would have decayed to more stable atoms. Carbon 14 is a naturally occurring isotope and if it were present at higher concentrations the decay products do not have sufficient energy to impact on the environment. The site is not therefore considered to pose any significant threat to the environment or human health.	Site discounted prior to assessment	
Scoring							5	3	2		
Taita 3						Site discounted prior to assessment	Low risk of archaeological sites within project area		Site is noted on the selected land use register - Site name: Institute of Geological and Nuclear Sciences This site was formerly the Soil Bureau of DSIR where testing of radioactive substances on soil was undertaken. An investigation in 2001 into the dumping of material concluded that it was likely some radioactive isotopes (14C and 32P and 36S) material was disposed of at the site. However it was thought that the only isotope that would still be present in any measurable quantity would be 14C, the remainder would have decayed to more stable atoms. Carbon 14 is a naturally occurring isotope and if it were present at higher concentrations the decay products do not have sufficient energy to impact on the environment. The site is not therefore considered to pose any significant threat to the environment or human health.	Site discounted prior to assessment	
Scoring							5	3	2		
Waddington Drive						Site discounted prior to assessment	Low risk of archaeological sites within project area		Site is not located on a SLUR site	Site discounted prior to assessment	Name or associations with this hill spur
Scoring							5	3	3		
Swainson Street	As above. It is noted that the relevant city wide provisions relating to Passive Recreation zone will still apply.	Land parcel is identified as a significant natural resource site - Eastern Hills Bush (SNR:12).	No. It is also noted that the land parcel is subject to reservations as to coal, gold and silver (which is to be considered by property and building)	Proposed construction area is in the vicinity of established residential properties located to the immediate south. Accessway also appears to encroach on private property to the east of the site. The area is also heavily vegetated.	Works will require a resource consent application from Hutt City Council. Regional consent application is also required from Greater Wellington City Council.	This land parcel is located within a significant natural resource site. Aerial photography indicates that the proposed construction area is densely vegetated therefore mitigation for vegetation removal will likely be required. In addition, the area is located in the vicinity of a residential area meaning that proximity to sensitive receptors is high. If noise levels determined that a Discreationary application would be required, the score would be reduced as there would then be an increased risk of challenge. Note that the accessway appears to encroach on one of the property's boundaries. Together, these issues present consenting risks.	Low risk of archaeological sites within project area	Walking tracks located to the north	Site is not located on a SLUR site	Site owned by Hutt City Council	Name or associations with this hill spur
Scoring						2	5	3	3	4	
Willcox Grove						Site discounted prior to assessment	Site discounted prior to assessment		Site is not located on a SLUR site	Site discounted prior to assessment	
Scoring									3		
Te Whiti Riser						Site discounted prior to assessment	It may be that an Archaeological Authority would be required for this location. This would likely be a 'business as usual approach' but it is recommended further research is undertaken to confirm this.		Site is not located on a SLUR site	Site discounted prior to assessment	Association with Te Whiti and impacts on his mana in relation to this site. Proximity to marae and centred in close proximity to community. Aquifer standpipe at the marae and links to drinking water. New pipeline crossing of Waiwhetu stream.
Scoring							3	3	3		
Harbour View Road						Site discounted prior to assessment	Low risk of archaeological sites within project area		Site is not located on a SLUR site	Site discounted prior to assessment	
Scoring							5	3	3		

Appendix B

Level 0 Cost Estimates

Refer Appendix O for revised estimates

Beca Cost Advisory

Lower Hut Reservoir - Reservoir Optioneering

Notes, Assumptions & Exclusions

Feasibility Estimate	
	Below we summarise principle notes, assumptions, clarifications and exclusions to the cost estimate:
1	**BASIS OF ESTIMATE**
1.1	This estimate is based on the following:
1.2	Estimate is based on quantities supplied by WSP, email received 4/11/2021 "RE: Lower Hut Reservoir - cost estimates for Long-List sites"
1.3	All options include 15ML Capacity reservoir
1.4	Escalation to the 4th Quarter of 2024 has been included in the Cost Summary
2	**CLARIFICATIONS**
2.1	A contingency to cover items of unforeseen detail and design development has been included in the estimate. This contingency is expected to be converted to scope, and therefore should not be regarded as discretionary.
2.2	It is important to note that New Zealand is currently experiencing significant movement in pricing across many sub-trades due to the current buoyant construction market coupled with supply issues due to, amongst other reasons Covid-19. This is putting pressure on resources which is resulting in unpredictable and generally escalating pricing.
2.3	These estimates are in the order of -40% to +60% accuracy and are to be read in conjunction with the notes, assumptions and exclusions following this summary.
2.4	The accuracy range indicated above reflects the accuracy after and including the estimating contingency.
2.5	For the purpose of this exercise only priority 1 Reservoir locations have been included.
2.6	As this is a Level 0 estimate, the Contingency has been increased to reflect the level of design currently
2.7	Some of the proposed sites still have significant uncertainty, specifically with regards to the constructability of the proposed access roads and is subject to further design investigation
2.8	The cost estimates presented have been developed for the purposes of comparing options and should not be used for any other purpose.
3	**ASSUMPTIONS**
3.1	Elements of cost included within this estimate are based on costs from similar projects and other Beca cost benchmarks.
3.2	Reservoir to be concrete construction
3.3	Reservoir to be on the same IL as Naenae 1
3.4	Work during normal hours only.
3.5	Professional fees and consent fees are to be developed and subsequently an allowance has been applied to the estimate to cover these anticipated costs.
3.6	The working space is sufficient for temporary works
3.7	The project will be procured on a competitive basis.
3.8	We assume that all of the work will be carried out in a single phase
3.9	No allowance has been made for the impacts of extraordinary global events (such as the current COVID-19 outbreak) within the base estimate
3.10	The Contractor will be given free access to the Contract Works site.
3.11	Single lane access road
3.12	All fill to be imported fill
4	**EXCLUSIONS**
4.1	Excavation in rock
4.2	Unfavourable ground and soil conditions e.g. ground water (excluded).
4.3	Contaminated material removal and/or replacement
4.4	Fast track or accelerated programme
4.5	GST
4.6	Capitalised interest
4.7	Costs to date
4.8	Operation and maintenance costs
4.9	Insurance costs
4.10	Legal and finance fees
4.11	Property costs
4.12	Protection to native flora and fauna

LEVEL 0 ESTIMATE

Project Name:	Naenae 2
Current Phase:	Feasibility
Base Date:	Nov-21

Phase	Description	Base Estimate	Escalation (3rd Q 2024)	Total
Professional Costs				
	Development	$ 782,000	$ 98,000	$ 880,000
	Consenting	$ 782,000	$ 98,000	$ 880,000
	Detailed design	$ 1,694,000	$ 213,000	$ 1,907,000
	Procurement	$ 130,000	$ 16,000	$ 146,000
	Construction	$ 1,303,000	$ 164,000	$ 1,467,000
	Total Project Professional Costs	$ 4,691,000	$ 589,000	$ 5,280,000
Wellington Water Management Fee				
	WWL Management Fee	$ 2,085,000	$ 262,000	$ 2,347,000
	Total WWL Management Fee	$ 2,085,000	$ 262,000	$ 2,347,000
Construction				
	Physical Works			
	Demolition & Site Clearance	$ 400,000	$ 50,000	$ 450,000
	Site & Road Earthworks	$ 4,550,000	$ 572,000	$ 5,122,000
	Access Road			$ -
	Pipework	$ 7,100,000	$ 893,000	$ 7,993,000
	15ML Reservoir, Electrical, Instruments & Controls, Testing and Commissioning, Inlet & outlet internal piping	$ 8,550,000	$ 1,075,000	$ 9,625,000
	SubTotal	$ 20,600,000	$ 2,590,000	
	On Site Overheads (15%)	$ 3,090,000	$ 389,000	$ 3,479,000
	Off Site O/H & Profit (10%)	$ 2,369,000	$ 298,000	$ 2,667,000
	Total Physical Works	$ 26,059,000	$ 3,277,000	$ 29,336,000
Base Estimate				
	Base Estimate	$ 32,835,000		
	Escalation (4th Quarter 2024)	12.6%	$ 4,128,000	
	Escalated Base Estimate			$ 36,963,000
Expected Estimate				
	Contingency	40.0%	14,785,000	$ 14,785,000
	Expected Estimate			**$ 51,748,000**
95th Percentile Estimate				
	Funding Risk	60.0%	22,178,000	$ 22,178,000
	95th Percentile Estimate			**$ 73,926,000**

Notes: This estimate is exclusive of GST.

Approvals			
	Name	Signature	Date
Prepared by:	Dirk Jansen van Vuuren		18/11/2021
Verified by:	Audrina Stanley		23/11/2021

LEVEL 0 ESTIMATE

Project Name:	Cambridge Terrace 1
Current Phase:	Feasibility
Base Date:	Nov-21

Phase	Description	Base Estimate	Escalation (3rd Q 2024)	Total
Professional Costs				
	Development	$ 1,366,000	$ 172,000	$ 1,538,000
	Consenting	$ 1,366,000	$ 172,000	$ 1,538,000
	Detailed design	$ 2,960,000	$ 372,000	$ 3,332,000
	Procurement	$ 228,000	$ 29,000	$ 257,000
	Construction	$ 2,277,000	$ 286,000	$ 2,563,000
	Total Project Professional Costs	$ 8,197,000	$ 1,031,000	$ 9,228,000
Wellington Water Management Fee				
	WWL Management Fee	$ 3,643,000	$ 458,000	$ 4,101,000
	Total WWL Management Fee	$ 3,643,000	$ 458,000	$ 4,101,000
Construction				
	Physical Works			
	Demolition & Site Clearance	$ 400,000	$ 50,000	$ 450,000
	Site & Road Earthworks	$ 2,845,000	$ 358,000	$ 3,203,000
	Access Road	$ 500,000	$ 63,000	$ 563,000
	Pipework	$ 23,700,000	$ 2,980,000	$ 26,680,000
	15ML Reservoir, Electrical, Instruments & Controls, Testing and Commissioning, Inlet & outlet internal piping	$ 8,550,000	$ 1,075,000	$ 9,625,000
	SubTotal	$ 35,995,000	$ 4,526,000	
	On Site Overheads (15%)	$ 5,399,000	$ 679,000	$ 6,078,000
	Off Site O/H & Profit (10%)	$ 4,139,000	$ 520,000	$ 4,659,000
	Total Physical Works	$ 45,533,000	$ 5,725,000	$ 51,258,000
Base Estimate				
	Base Estimate	$ 57,373,000		
	Escalation (4th Quarter 2024)	12.6%	$ 7,214,000	
	Escalated Base Estimate			$ 64,587,000
Expected Estimate				
	Contingency	40.0%	25,835,000	$ 25,835,000
	Expected Estimate			**$ 90,422,000**
95th Percentile Estimate				
	Funding Risk	60.0%	38,752,000	$ 38,752,000
	95th Percentile Estimate			**$ 129,174,000**

Notes: This estimate is exclusive of GST.

Approvals	Name	Signature	Date
Prepared by:	Dirk Jansen van Vuuren		18/11/2021
Verified by:	Audrina Stanley		23/11/2021

LEVEL 0 ESTIMATE

Project Name:	Gracefield C
Current Phase:	Feasibility
Base Date:	Nov-21

Phase	Description	Base Estimate	Escalation (3rd Q 2024)	Total
Professional Costs				
	Development	$ 1,513,000	$ 190,000	$ 1,703,000
	Consenting	$ 1,513,000	$ 190,000	$ 1,703,000
	Detailed design	$ 3,279,000	$ 412,000	$ 3,691,000
	Procurement	$ 252,000	$ 32,000	$ 284,000
	Construction	$ 2,522,000	$ 317,000	$ 2,839,000
	Total Project Professional Costs	$ 9,079,000	$ 1,141,000	$ 10,220,000
Wellington Water Management Fee				
	WWL Management Fee	$ 4,036,000	$ 507,000	$ 4,543,000
	Total WWL Management Fee	$ 4,036,000	$ 507,000	$ 4,543,000
Construction				
	Physical Works			
	Demolition & Site Clearance	$ 400,000	$ 50,000	$ 450,000
	Site & Road Earthworks	$ 5,200,000	$ 654,000	$ 5,854,000
	Access Road	$ 630,000	$ 79,000	$ 709,000
	Pipework	$ 25,100,000	$ 3,156,000	$ 28,256,000
	15ML Reservoir, Electrical, Instruments & Controls, Testing and Commissioning, Inlet & outlet internal piping	$ 8,550,000	$ 1,075,000	$ 9,625,000
	SubTotal	$ 39,880,000	$ 5,014,000	
	On Site Overheads (15%)	$ 5,982,000	$ 752,000	$ 6,734,000
	Off Site O/H & Profit (10%)	$ 4,586,000	$ 577,000	$ 5,163,000
	Total Physical Works	$ 50,448,000	$ 6,343,000	$ 56,791,000
Base Estimate				
	Base Estimate	$ 63,563,000		
	Escalation (4th Quarter 2024)	12.6%	$ 7,991,000	
	Escalated Base Estimate			$ 71,554,000
Expected Estimate				
	Contingency	40.0%	28,622,000	$ 28,622,000
	Expected Estimate			**$ 100,176,000**
95th Percentile Estimate				
	Funding Risk	60.0%	42,932,000	$ 42,932,000
	95th Percentile Estimate			**$ 143,108,000**

Notes: This estimate is exclusive of GST.

Approvals	Name	Signature	Date
Prepared by:	Dirk Jansen van Vuuren		18/11/2021
Verified by:	Audrina Stanley		23/11/2021

LEVEL 0 ESTIMATE

Project Name: Page Grove
Current Phase: Feasibility
Base Date: Nov-21

Phase	Description	Base Estimate	Escalation (3rd Q 2024)	Total
Professional Costs				
	Development	$ 1,529,000	$ 192,000	$ 1,721,000
	Consenting	$ 1,529,000	$ 192,000	$ 1,721,000
	Detailed design	$ 3,314,000	$ 417,000	$ 3,731,000
	Procurement	$ 255,000	$ 32,000	$ 287,000
	Construction	$ 2,549,000	$ 321,000	$ 2,870,000
	Total Project Professional Costs	$ 9,176,000	$ 1,154,000	$ 10,330,000
Wellington Water Management Fee				
	WWL Management Fee	$ 4,078,000	$ 513,000	$ 4,591,000
	Total WWL Management Fee	$ 4,078,000	$ 513,000	$ 4,591,000
Construction				
	Physical Works			
	Demolition & Site Clearance	$ 400,000	$ 50,000	$ 450,000
	Site & Road Earthworks	$ 3,250,000	$ 409,000	$ 3,659,000
	Access Road			$ -
	Pipework	$ 28,100,000	$ 3,533,000	$ 31,633,000
	15ML Reservoir, Electrical, Instruments & Controls, Testing and Commissioning, Inlet & outlet internal piping	$ 8,550,000	$ 1,075,000	$ 9,625,000
	SubTotal	$ 40,300,000	$ 5,067,000	
	On Site Overheads (15%)	$ 6,045,000	$ 760,000	$ 6,805,000
	Off Site O/H & Profit (10%)	$ 4,635,000	$ 583,000	$ 5,218,000
	Total Physical Works	$ 50,980,000	$ 6,410,000	$ 57,390,000
Base Estimate				
	Base Estimate	$ 64,234,000		
	Escalation (4th Quarter 2024)	12.6%	$ 8,077,000	
	Escalated Base Estimate			$ 72,311,000
Expected Estimate				
	Contingency	40.0%	28,924,000	$ 28,924,000
	Expected Estimate			**$ 101,235,000**
95th Percentile Estimate				
	Funding Risk	60.0%	43,387,000	$ 43,387,000
	95th Percentile Estimate			**$ 144,622,000**

Notes: This estimate is exclusive of GST.

Approvals	Name	Signature	Date
Prepared by:	Dirk Jansen van Vuuren		18/11/2021
Verified by:	Audrina Stanley		23/11/2021

LEVEL 0 ESTIMATE

Project Name:	Normandale
Current Phase:	Feasibility
Base Date:	Nov-21

Phase	Description	Base Estimate	Escalation (3rd Q 2024)	Total
Professional Costs				
	Development	$ 1,620,000	$ 204,000	$ 1,824,000
	Consenting	$ 1,620,000	$ 204,000	$ 1,824,000
	Detailed design	$ 3,509,000	$ 441,000	$ 3,950,000
	Procurement	$ 270,000	$ 34,000	$ 304,000
	Construction	$ 2,699,000	$ 339,000	$ 3,038,000
	Total Project Professional Costs	$ 9,718,000	$ 1,222,000	$ 10,940,000
Wellington Water Management Fee				
	WWL Management Fee	$ 4,319,000	$ 543,000	$ 4,862,000
	Total WWL Management Fee	$ 4,319,000	$ 543,000	$ 4,862,000
Construction				
	Physical Works			
	Demolition & Site Clearance	$ 400,000	$ 50,000	$ 450,000
	Site & Road Earthworks	$ 4,925,000	$ 619,000	$ 5,544,000
	Access Road	$ 300,000	$ 38,000	$ 338,000
	Pipework	$ 28,500,000	$ 3,584,000	$ 32,084,000
	15ML Reservoir, Electrical, Instruments & Controls, Testing and Commissioning, Inlet & outlet internal piping	$ 8,550,000	$ 1,075,000	$ 9,625,000
	SubTotal	$ 42,675,000	$ 5,366,000	
	On Site Overheads (15%)	$ 6,401,000	$ 805,000	$ 7,206,000
	Off Site O/H & Profit (10%)	$ 4,908,000	$ 617,000	$ 5,525,000
	Total Physical Works	$ 53,984,000	$ 6,788,000	$ 60,772,000
Base Estimate				
	Base Estimate	$ 68,021,000		
	Escalation (4th Quarter 2024)	12.6%	$ 8,553,000	
	Escalated Base Estimate			$ 76,574,000
Expected Estimate				
	Contingency	40.0%	30,630,000	$ 30,630,000
	Expected Estimate			**$ 107,204,000**
95th Percentile Estimate				
	Funding Risk	60.0%	45,944,000	$ 45,944,000
	95th Percentile Estimate			**$ 153,148,000**

Notes: This estimate is exclusive of GST.

Approvals	Name	Signature	Date
Prepared by:	Dirk Jansen van Vuuren		18/11/2021
Verified by:	Audrina Stanley		23/11/2021

LEVEL 0 ESTIMATE

Project Name:	Swainson Opt B
Current Phase:	Feasibility
Base Date:	Nov-21

Phase	Description	Base Estimate	Escalation (3rd Q 2024)	Total
Professional Costs				
	Development	$ 1,646,000	$ 207,000	$ 1,853,000
	Consenting	$ 1,646,000	$ 207,000	$ 1,853,000
	Detailed design	$ 3,567,000	$ 449,000	$ 4,016,000
	Procurement	$ 274,000	$ 34,000	$ 308,000
	Construction	$ 2,744,000	$ 345,000	$ 3,089,000
	Total Project Professional Costs	$ 9,877,000	$ 1,242,000	$ 11,119,000
Wellington Water Management Fee				
	WWL Management Fee	$ 4,391,000	$ 552,000	$ 4,943,000
	Total WWL Management Fee	$ 4,391,000	$ 552,000	$ 4,943,000
Construction				
	Physical Works			
	Demolition & Site Clearance	$ 400,000	$ 50,000	$ 450,000
	Site & Road Earthworks	$ 5,655,000	$ 711,000	$ 6,366,000
	Access Road	$ 280,000	$ 35,000	$ 315,000
	Pipework	$ 28,500,000	$ 3,584,000	$ 32,084,000
	15ML Reservoir, Electrical, Instruments & Controls, Testing and Commissioning, Inlet & outlet internal piping	$ 8,550,000	$ 1,075,000	$ 9,625,000
	SubTotal	$ 43,385,000	$ 5,455,000	
	On Site Overheads (15%)	$ 6,508,000	$ 818,000	$ 7,326,000
	Off Site O/H & Profit (10%)	$ 4,989,000	$ 627,000	$ 5,616,000
	Total Physical Works	$ 54,882,000	$ 6,900,000	$ 61,782,000
Base Estimate				
	Base Estimate	$ 69,150,000		
	Escalation (4th Quarter 2024)	12.6%	$ 8,694,000	
	Escalated Base Estimate			$ 77,844,000
Expected Estimate				
	Contingency	40.0%	31,138,000	$ 31,138,000
	Expected Estimate			**$ 108,982,000**
95th Percentile Estimate				
	Funding Risk	60.0%	46,706,000	$ 46,706,000
	95th Percentile Estimate			**$ 155,688,000**

Notes: This estimate is exclusive of GST.

Approvals	Name	Signature	Date
Prepared by:	Dirk Jansen van Vuuren		18/11/2021
Verified by:	Audrina Stanley		23/11/2021

LEVEL 0 ESTIMATE

Project Name:	Gracefield A
Current Phase:	Feasibility
Base Date:	Nov-21

Phase	Description	Base Estimate	Escalation (3rd Q 2024)	Total
Professional Costs				
	Development	$ 1,644,000	$ 207,000	$ 1,851,000
	Consenting	$ 1,644,000	$ 207,000	$ 1,851,000
	Detailed design	$ 3,562,000	$ 448,000	$ 4,010,000
	Procurement	$ 274,000	$ 34,000	$ 308,000
	Construction	$ 2,740,000	$ 345,000	$ 3,085,000
	Total Project Professional Costs	$ 9,864,000	$ 1,241,000	$ 11,105,000
Wellington Water Management Fee				
	WWL Management Fee	$ 4,384,000	$ 551,000	$ 4,935,000
	Total WWL Management Fee	$ 4,384,000	$ 551,000	$ 4,935,000
Construction				
	Physical Works			
	Demolition & Site Clearance	$ 400,000	$ 50,000	$ 450,000
	Site & Road Earthworks	$ 4,875,000	$ 613,000	$ 5,488,000
	Access Road			$ -
	Pipework	$ 29,500,000	$ 3,709,000	$ 33,209,000
	15ML Reservoir, Electrical, Instruments & Controls, Testing and Commissioning, Inlet & outlet internal piping	$ 8,550,000	$ 1,075,000	$ 9,625,000
	SubTotal	$ 43,325,000	$ 5,447,000	
	On Site Overheads (15%)	$ 6,499,000	$ 817,000	$ 7,316,000
	Off Site O/H & Profit (10%)	$ 4,982,000	$ 626,000	$ 5,608,000
	Total Physical Works	$ 54,806,000	$ 6,890,000	$ 61,696,000
Base Estimate				
	Base Estimate	$ 69,054,000		
	Escalation (4th Quarter 2024)	12.6%	$ 8,682,000	
	Escalated Base Estimate			$ 77,736,000
Expected Estimate				
	Contingency	40.0%	31,094,000	$ 31,094,000
	Expected Estimate			**$ 108,830,000**
95th Percentile Estimate				
	Funding Risk	60.0%	46,642,000	$ 46,642,000
	95th Percentile Estimate			**$ 155,472,000**

Notes: This estimate is exclusive of GST.

Approvals	Name	Signature	Date
Prepared by:	Dirk Jansen van Vuuren		18/11/2021
Verified by:	Audrina Stanley		23/11/2021

LEVEL 0 ESTIMATE

Project Name:	Waddington
Current Phase:	Feasibility
Base Date:	Nov-21

Phase	Description	Base Estimate	Escalation (3rd Q 2024)	Total
Professional Costs				
	Development	$ 1,782,000	$ 224,000	$ 2,006,000
	Consenting	$ 1,782,000	$ 224,000	$ 2,006,000
	Detailed design	$ 3,860,000	$ 485,000	$ 4,345,000
	Procurement	$ 297,000	$ 37,000	$ 334,000
	Construction	$ 2,969,000	$ 373,000	$ 3,342,000
	Total Project Professional Costs	$ 10,690,000	$ 1,343,000	$ 12,033,000
Wellington Water Management Fee				
	WWL Management Fee	$ 4,751,000	$ 597,000	$ 5,348,000
	Total WWL Management Fee	$ 4,751,000	$ 597,000	$ 5,348,000
Construction				
	Physical Works			
	Demolition & Site Clearance	$ 400,000	$ 50,000	$ 450,000
	Site & Road Earthworks	$ 6,294,000	$ 791,000	$ 7,085,000
	Access Road	$ 1,100,000	$ 138,000	$ 1,238,000
	Pipework	$ 30,600,000	$ 3,848,000	$ 34,448,000
	15ML Reservoir, Electrical, Instruments & Controls, Testing and Commissioning, Inlet & outlet internal piping	$ 8,550,000	$ 1,075,000	$ 9,625,000
	SubTotal	$ 46,944,000	$ 5,902,000	
	On Site Overheads (15%)	$ 7,042,000	$ 885,000	$ 7,927,000
	Off Site O/H & Profit (10%)	$ 5,399,000	$ 679,000	$ 6,078,000
	Total Physical Works	$ 59,385,000	$ 7,466,000	$ 66,851,000
Base Estimate				
	Base Estimate	$ 74,826,000		
	Escalation (4th Quarter 2024)	12.6%	$ 9,406,000	
	Escalated Base Estimate			$ 84,232,000
Expected Estimate				
	Contingency	40.0%	33,693,000	$ 33,693,000
	Expected Estimate			**$ 117,925,000**
95th Percentile Estimate				
	Funding Risk	60.0%	50,539,000	$ 50,539,000
	95th Percentile Estimate			**$ 168,464,000**

Notes: This estimate is exclusive of GST.

Approvals	Name	Signature	Date
Prepared by:	Dirk Jansen van Vuuren		18/11/2021
Verified by:	Audrina Stanley		23/11/2021

LEVEL 0 ESTIMATE

Project Name:	Rata Street
Current Phase:	Feasibility
Base Date:	Nov-21

Phase	Description	Base Estimate	Escalation (3rd Q 2024)	Total
Professional Costs				
	Development	$ 1,982,000	$ 249,000	$ 2,231,000
	Consenting	$ 1,982,000	$ 249,000	$ 2,231,000
	Detailed design	$ 4,294,000	$ 540,000	$ 4,834,000
	Procurement	$ 330,000	$ 41,000	$ 371,000
	Construction	$ 3,303,000	$ 415,000	$ 3,718,000
	Total Project Professional Costs	$ 11,891,000	$ 1,494,000	$ 13,385,000
Wellington Water Management Fee				
	WWL Management Fee	$ 5,285,000	$ 665,000	$ 5,950,000
	Total WWL Management Fee	$ 5,285,000	$ 665,000	$ 5,950,000
Construction				
	Physical Works			
	Demolition & Site Clearance	$ 400,000	$ 50,000	$ 450,000
	Site & Road Earthworks	$ 5,117,500	$ 643,000	$ 5,760,500
	Access Road	$ 360,000	$ 45,000	$ 405,000
	Pipework	$ 37,800,000	$ 4,753,000	$ 42,553,000
	15ML Reservoir, Electrical, Instruments & Controls, Testing and Commissioning, Inlet & outlet internal piping	$ 8,550,000	$ 1,075,000	$ 9,625,000
	SubTotal	$ 52,227,500	$ 6,566,000	
	On Site Overheads (15%)	$ 7,834,000	$ 985,000	$ 8,819,000
	Off Site O/H & Profit (10%)	$ 6,006,000	$ 755,000	$ 6,761,000
	Total Physical Works	$ 66,067,500	$ 8,306,000	$ 74,373,500
Base Estimate				
	Base Estimate	$ 83,243,500		
	Escalation (4th Quarter 2024)	12.6%	$ 10,465,000	
	Escalated Base Estimate			$ 93,708,500
Expected Estimate				
	Contingency	40.0%	37,483,000	$ 37,483,000
	Expected Estimate			**$ 131,191,500**
95th Percentile Estimate				
	Funding Risk	60.0%	56,225,000	$ 56,225,000
	95th Percentile Estimate			**$ 187,416,500**

Notes: This estimate is exclusive of GST.

Approvals	Name	Signature	Date
Prepared by:	Dirk Jansen van Vuuren		18/11/2021
Verified by:	Audrina Stanley		23/11/2021

Appendix C

Ecology Assessment

Memorandum

To	George Beveridge
Copy	
From	Laura van Ginkel
Office	Hamilton
Date	30 March 2022
File/Ref	3-WW021.02
Subject	Hutt Reservoir Ecology Assessment – Short List Site Options

1 Introduction

The construction of a new water reservoir is required to supply water to the Lower Hutt area. Three potential reservoir sites have shortlisted. The reservoir will be an above ground circular structure with approximately 55m wide and 8m tall, with a water holding capacity of 15 million litres. The reservoir site will require the construction of a flat pad upon which the reservoir will be located, an access road, and a sediment pond (during construction).

Three potential reservoir sites have been identified: Naenae 2, Cambridge Terrace, and Gracefield 2. As part of the site selection process, a high-level ecological assessment has been undertaken for each of the three potential water reservoir sites to inform the Multi Criteria Analysis (MCA). Additionally, two of the three sites will require associated water pipelines to be installed across Waiwhetu Stream. Three stream sites have been assessed; with two options assessed for the Gracefield reservoir site option. Other than the stream crossings, the pipeline alignment has not been assessed within this ecological assessment.

This memo presents the results of an ecology site visit with an options assessment of the three potential reservoir sites. The findings are summarized in Table 15.

2 MCA Scoring

The assessments outlined below includes a score for each reservoir option based on a scale of 1-5. To determine a score for each reservoir option based on ecological values and likely impacts , the Environmental Institute of Australia and New Zealand (EIANZ) guidelines[1] were used. The guidelines provide an approach that uses criteria for rating the level of ecological value and magnitude of potential impact. The value rating and magnitude of impact are then combined to provide an overall level of effect and score. The scores provided for each reservoir option in this assessment assume that good practise remedy and mitigation will be undertaken during and following construction.

1. Roper-Lindsay, J., Fuller S.A., Hooson, S., Sanders, M.D., Ussher, G.T. 2018. Ecological impact assessment. EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems. 2nd edition.

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Table 1: Criteria for determining ecological values

Ecological Values	Communities	Species
Very High	Area rates High for 3 or all of the four assessment matters: representativeness, rarity, diversity, and context. Likely to be nationally important and recognised as such	Threatened (Nationally Critical, Nationally Endangered, Nationally Vulnerable)
High	Area rates High for 2 of the assessment matters, Moderate and Low for the remainder, or Area rates High for 1 of the assessment matters, Moderate for the remainder. Likely to be regionally important and recognised as such	At Risk (Declining)
Moderate	Area rates High for one matter, Moderate and Low for the remainder, or Area rates Moderate for 2 or more assessment matters Low or Very Low for the remainder. Likely to be important at the level of the Ecological District	At Risk (Recovering, Relict, Naturally Uncommon)
Low	Area rates Low or Very Low for majority of assessment matters and Moderate for one. Limited ecological value other than as local habitat for tolerant native species	Native - Not Threatened
Very Low/Negligible	Area rates Very Low for 3 matters and Moderate, Low or Very Low for remainder	Exotic species, including pests, species having recreational value.

Table 2: Criteria for describing magnitude of effect

Magnitude	Description
Very High	Total loss of, or very major alteration, to key elements/ features of the baseline conditions such that the post development character/ composition/ attributes will be fundamentally changed and may be lost from the site altogether; AND/OR Loss* of a very high proportion of the known population or range of the element / feature.
High	Major loss or major alteration to key elements/ features of the existing baseline conditions such that the post-development character, composition and/or attributes will be fundamentally changed; AND/OR Loss* of a high proportion of the known population or range of the element / feature.
Moderate	Loss or alteration to one or more key elements/features of the existing baseline conditions, such that post-development character, composition and/or attributes will be partially changed; AND/OR Loss* of a moderate proportion of the known population or range of the element / feature.
Low	Minor shift away from baseline conditions. Change arising from the loss/alteration will be discernible, but underlying character, composition and/or attributes of the existing baseline condition will be similar to pre-development circumstances/patterns; AND/OR Having a minor effect on the known population or range of the element / feature.

Very Low/Negligible	Very slight change from existing baseline condition. Change barely distinguishable, approximating to the "no change" situation; AND/OR Having a negligible effect on the known population or range of the element / feature.

*In the context of mobile fauna, the term "loss" can include displacement from an area.

Table 3: Matrix of level of effect

Magnitude	Ecological and/or Conservation Value				
	Very High	High	Moderate	Low	Negligible
Very High	1 (VH)	1 (VH)	1 (H)	1 (M)	1 (L)
High	1 (VH)	1 (VH)	2 (M)	3 (L)	4 (VL)
Moderate	1 (H)	1 (H)	2 (M)	3 (L)	4 (VL)
Low	2 (M)	3 (L)	3 (L)	4 (VL)	4 (VL)
Negligible	3 (L)	4 (VL)	4 (VL)	4 (VL)	4 (VL)
Positive	5 (Net gain)	5 (Net gain)	5 (Net gain)	5 (Net gain)	5 (Net gain)

Table 4: Scoring scale

Score	Level of Effect	
1	High to Very High	Significant adverse ecological effect
2	Moderate	Moderate adverse ecological effect
3	Low	Minor adverse ecological effect
4	Very Low	Negligible adverse ecological effect
5	Positive	Positive ecological effect

3 Assessment of Reservoir Sites

The Ecology impact assessment describes the vegetation, avifauna, and herpetofauna values at each of the three potential reservoir sites. The description for each of the three sites below assumes the maximum potential construction footprint has been shown.

3.1 Vegetation

3.1.1 Naenae 2

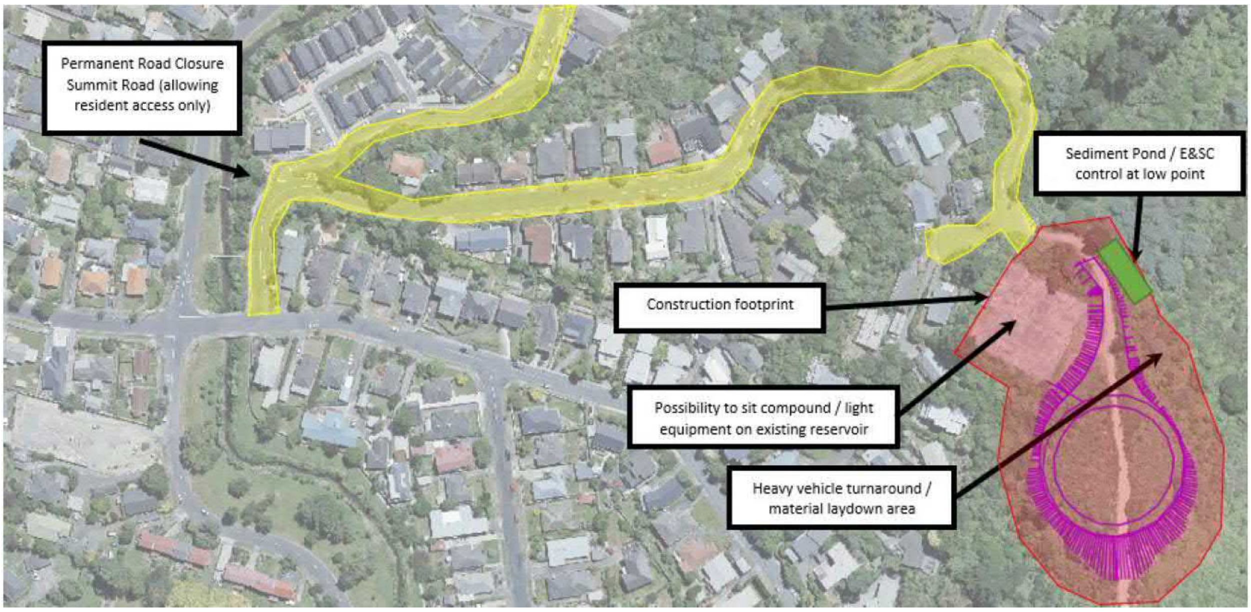

Figure 1: Aerial image showing the anticipated construction footprint at the proposed Naenae 2 reservoir site

The vegetation is characterized by natural regeneration. There are two successional stages of this present within the impact zone:

- Early successional: Predominately kanuka with a mixture of gorse and broom, with native seedling and sapling species present in the understory.
- Mid successional: Predominately mixed native species up to 3-4m tall.

The vegetation surrounding the existing reservoir and the proposed sediment pond is composed of mid successional native species with a mixture of exotic weed species and some mature pine trees. Native species such as five-finger, mahoe, and pigeon wood exist at heights of up to 3-4m tall. Other native species such as kawakawa, rangiora and red matipo are present in the understorey.

The area moving towards and surrounding the reservoir site can be characterised as early successional. Vegetation is a thick scrub composed of a mixture of kanuka, gorse, and broom. Beneath the scrub, both native seedlings, native saplings, and exotic weeds are present.

Table 5: Native flora species present at Naenae

Scientific Name	Common Name	Threat Status[2]
Kunzea robusta	Kanuka	Threatened - Nationally vulnerable
Alsophila dealbata	Silver fern	Not Threatened
Brachyglottis repanda	Rangiora	Not Threatened
Coprosma robusta	Karamū	Not Threatened
Hedycarya arborea	Pigeon wood	Not Threatened
Melicytus ramiflorus	Mahoe	Not Threatened
Myrsine australis	Red matipo	Not Threatened
Piper excelsum	Kawakawa	Not Threatened

2 Conservation status of New Zealand indigenous vascular plants, 2017 (de Lange, 2018).

Pittosporum eugenioides	Lemonwood	Not Threatened
Pseudopanax arboreus	Five Finger	Not Threatened
Cyathea medullaris	Mamaku	Not Threatened

Hutt City Council terrestrial maps[3], indicates that the site falls within a Significant Natural Resource (SNR) area. This area is classified as the following:

SNR 12: Eastern Hills Bush	Lowland forest on hill country. Contains a fire-induced regionally representative regenerating vegetation mosaic, including areas of pre-European Podocarps and Hard Beech. Nearly two-thirds of the forest is 90-110 years old. Plants - *Arthropodium cirrhatum*, *Fuchsia excorticata* and *Podocarpus totara*. Large species diversity due to different topography. Many bird species, including NZ pigeon.

3.1.2 Cambridge Terrace

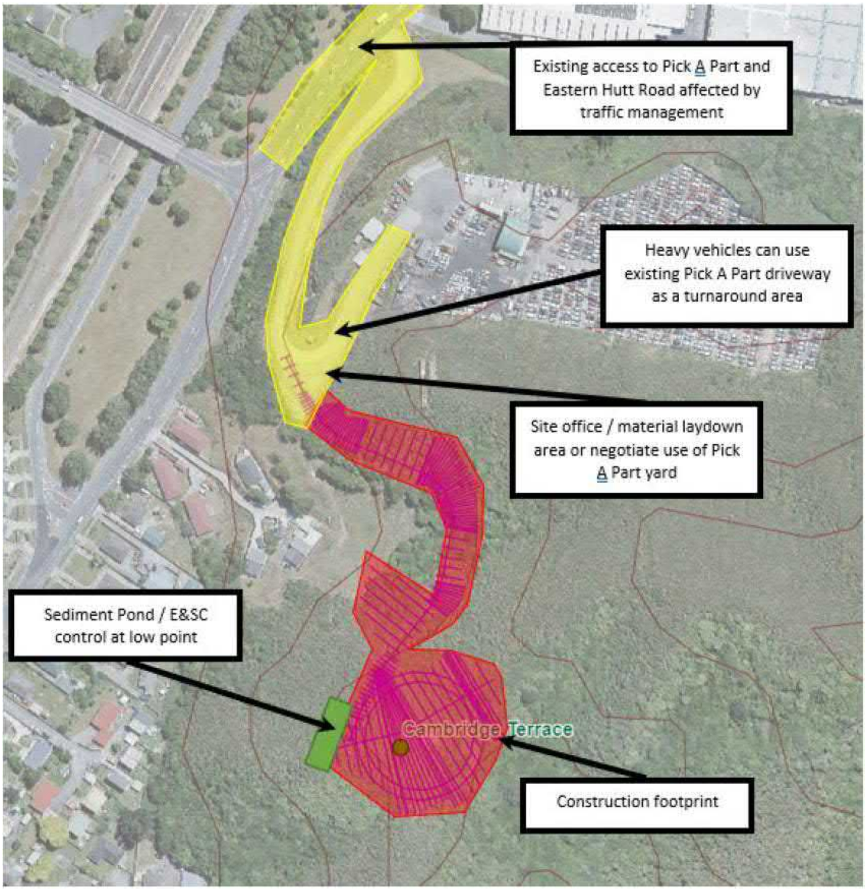

Figure 2: Aerial image showing the anticipated construction footprint at the proposed Cambridge Terrace reservoir site

The Cambridge Terrace site was not able to be directly accessed as it is located on private property. The site was able to be observed from nearby parks and streets using binoculars. The reservoir construction footprint is composed of a mix of gorse scrub and mamaku on the east facing slope. There are some larger kanuka trees along the ridge line.

3 Hutt City Council District Plan Map, Available at https://maps.huttcity.govt.nz/ (Accessed Feb 16th 2022)

The north-west facing slope, along the proposed access track, is composed of predominately gorse scrub. Along the edge of the dense gorse scrub, several native species such as mahoe, mamaku, and lancewood are present.

Hutt City Council terrestrial maps[3], indicates that the site falls within a Significant Natural Resource (SNR) area. This area is classified as the following:

SNR 12: Eastern Hills Bush	Lowland forest on hill country. Contains a fire-induced regionally representative regenerating vegetation mosaic, including areas of pre-European Podocarps and Hard Beech. Nearly two-thirds of the forest is 90-110 years old. Plants - ***Arthropodium cirrhatum***, ***Fuchsia excorticata*** and ***Podocarpus totara***. Large species diversity due to different topography. Many bird species, including NZ pigeon.

Table 6: Native flora species identified at Cambridge Terrace

Scientific Name	Common Name	Threat Status[2]
Kunzea robusta	Kanuka	Threatened - Nationally vulnerable
Brachyglottis repanda	Rangiora	Not Threatened
Melicytus ramiflorus	Mahoe	Not Threatened
Piper excelsum	Kawakawa	Not Threatened
Pittosporum eugenioides	Lemonwood	Not Threatened
Pittosporum tenuifolium	Pittosporum	Not Threatened
Pseudopanax arboreus	Five Finger	Not Threatened
Pseudopanax crassifolius	Lancewood	Not Threatened
Cyathea medullaris	Mamaku	Not Threatened

3 Hutt City Council District Plan Map, Available at thttps://maps.huttcity.govt.nz (Accessed Feb 16th 2022)
2 Conservation status of New Zealand indigenous vascular plants, 2017 (de Lange, 2018).

3.1.3 Gracefield 2

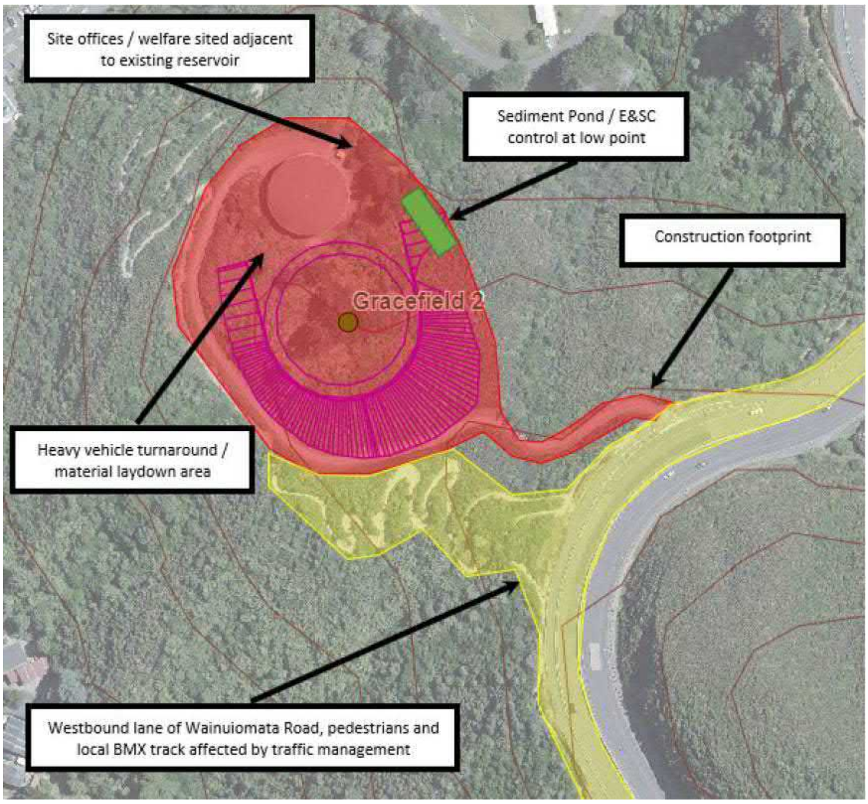

Figure 3: Aerial image showing the anticipated construction footprint at the proposed Gracefield 2 reservoir site

The vegetation at the proposed Gracefield reservoir site is comprised of two vegetation types which appear to be influenced by the topography of the land. The site has a gully running from the existing water reservoir, directly uphill to the existing access track. The west facing side of the gully is covered in thick gorse scrub. The east facing side is composed of a mixture of native and exotic species. Several tall pines are present, and the understory is dominated by exotic weeds. Native species are present along the slope and in the centre of the gully with height up to approximately 3m tall.

Table 7: Native flora species identified at Gracefield

Scientific Name	Common Name	Threat Status[2]
Kunzea robusta	Kanuka	Threatened - Nationally vulnerable
Alsophila dealbata	Silver fern	Not Threatened
Coprosma autumnalis	Kanono	Not Threatened
Coprosma robusta	Karamū	Not Threatened
Hedycarya arborea	Pigeon wood	Not Threatened
Melicytus ramiflorus	Mahoe	Not Threatened
Phormium tenax	Harakeke	Not Threatened
Piper excelsum	Kawakawa	Not Threatened
Pittosporum eugenioides	Lemonwood	Not Threatened
Pittosporum tenuifolium	Pittosporum	Not Threatened
Pseudopanax arboreus	Five Finger	Not Threatened

Cyathea medullaris	Mamaku	Not Threatened

Hutt City Council terrestrial maps[3], indicates that the site falls within a Significant Natural Resource (SNR) area. This area is classified as the following:

NR36: Mt Hawtrey Bush	Contains diverse lowland forest and scrub vegetation on hill country. Plants include, ***Botrychium lunaria***, ***Bulbophyllum pygmaeum***, ***Prymoanthus flavus***, ***Peraxilla tetrapetala***, ***Pittosporum divaricatum***, and ***Ranunculus macropus***. Large variety of bird species, including NZ Falcon and NZ Pigeon. Forest Gecko and Common Green Gecko.

3.2 Avifauna

Incidental bird observations were carried out at each site. Supplementary bird data was retrieved from eBird[4] (Table 8). A nearby survey from Avalon Park identified one threatened species, the Black billed gull (status: endemic nationally critical), and two at risk species; the New Zealand Falcon (status: endemic, at risk recovering), and the silver gull (status: native, at risk declining). While it is possible that these species will use the habitat at the sites, it is not likely that these sites would provide significant habitat. The lower Hutt area does not fall within the known breeding colony distribution of the Black Billed gull. Therefore, while the bird has been sighted within the areas, it is unlikely to significantly utilize the habitat.

Table 8: eBird species in proximity to the sites

Scientific Name	Common Name	NZ Status	Threat Classification[5]
Chroicocephalus bulleri	Black-billed Gull	Endemic	Threatened: Nationally Critical
Chroicocephalus novaehollandiae	Silver Gull	Native	At Risk - Declining
Falco novaeseelandiae	New Zealand Falcon	Endemic	At Risk - Recovering
Aythya novaeseelandiae	New Zealand Scaup	Endemic	Not threatened
Cygnus atratus	Black Swan	Native	Not threatened
Todiramphus sanctus	Sacred Kingfisher	Native	Not Threatened
Gerygone igata	Grey Warbler	Endemic	Not threatened
Hemiphaga novaeseelandiae	New Zealand Pigeon	Endemic	Not threatened
Larus dominicanus	Southern Black Backed Gull	Native	Not threatened
Petroica macrocephala	Tomtit/Snares Tomtit	Endemic	Not threatened
Porphyrio melanotus	Pukeko	Native	Not threatened
Prosthemadera novaeseelandiae	Tui	Endemic	Not threatened
Rhipidura fuliginosa	New Zealand Fantail	Endemic	Not threatened
Zosterops lateralis	Silvereye	Native	Not threatened
Acridotheres tristis	Common Myna	Introduced	Introduced and Naturalised
Anas platyrhynchos	Mallard	Introduced	Introduced and Naturalised

2 Conservation status of New Zealand indigenous vascular plants, 2017 (de Lange, 2018).
3 Hutt City Council District Plan Map, Available at thttps://maps.huttcity.govt.nz (Accessed Feb 16th, 2022)
4 eBird. 2022. eBird: An online database of bird distribution and abundance [web application]. eBird, Cornell Lab of Ornithology, Ithaca, New York. Available: http://www.ebird.org. (Accessed: February 17th, 2022).
5 Conservation status of New Zealand birds, 2016. (Robertson et al., 2017)

Carduelis carduelis	European Goldfinch	Introduced	Introduced and Naturalised
Chloris chloris	European Greenfinch	Introduced	Introduced and Naturalised
Columba livia	Rock Pigeon	Introduced	Introduced and Naturalised
Fringilla coelebs	Chaffinch	Introduced	Introduced and Naturalised
Gymnorhina tibicen	Australian Magpie	Introduced	Introduced and Naturalised
Larus dominicanus	South Black Backed Gull	Introduced	Introduced and Naturalised
Meleagris gallopavo	Wild Turkey	Introduced	Introduced and Naturalised
Passer domesticus	House Sparrow	Introduced	Introduced and Naturalised
Prunella modularis	Dunnock	Introduced	Introduced and Naturalised
Sturnus vulgaris	European Starling	Introduced	Introduced and Naturalised
Tadorna variegata	Paradise Shelduck	Introduced	Introduced and Naturalised
Turdus merula	Eurasian Blackbird	Introduced	Introduced and Naturalised
Turdus philomelos	Song Thrush	Introduced	Introduced and Naturalised

3.3 Herpetofauna

New Zealand herpetofauna (reptiles and amphibians) data is managed by the Department of Conservation (DOC). The DOC herpetofauna database was searched for observations in proximity to the sites. Additionally, information was sourced from the citizen science database iNaturalist[6]. A total of five at risk lizard species have been recorded within 10km of the sites (Table 9). Each of the species observed in these databases has been recorded in the area within the last two years.

A review of the literature[7] identified a further three at risk species, and one threatened species, whose distributions include the Lower Hutt area. Although these have not been observed in the area in recent years, it is possible that they could be present at the sites. All three sites contain suitable habitat for the herpetofauna species, including features such as exposed banks, rank grass, scrub, and trees. In the absence of a lizard survey at the sites it has been assumed for the purposes of this assessment that at least one or more of these species are present within all of three sites.

Table 9: Herpetofauna species potentially present at the sites

Scientific name	Common name	Threat classification[8,9]	Reference
Oligosoma aff. *infrapunctatum* "southern North Island"	Kupe skink	Threatened - Nationally Critical	Literature
Mokopirirakau "southern North Island"	ngahere gecko	At Risk - Declining	DOC database
Naultinus punctatus	barking gecko	At Risk - Declining	DOC database
Oligosoma aeneum	copper skink	At Risk - Declining	iNaturalist
Oligosoma kokowai	northern spotted skink	At Risk - Relict	iNaturalist

6 iNaturalist. Available from https://www.inaturalist.org. Accessed February 22nd, 20224. van Winkel, D., Baling, M., & Hitchmough, R. (2018) Reptiles and Amphibians of New Zealand. A Field Guide. Auckland university press
7 van Winkel, D., Baling, M., & Hitchmough, R. (2018) Reptiles and Amphibians of New Zealand. A Field Guide. Auckland University Press
8 Conservation status of New Zealand reptiles, 2015 (Hitchmough et al., 2016)
9 Conservation status of New Zealand amphibians, 2017 (Burns et al., 2018)

Oligosoma ornatum	ornate skink	At Risk - Declining	Literature
Oligosoma zelandicum	glossy brown skink	At Risk - Declining	iNaturalist
Woodworthia "Marlborough mini"	minimac gecko	At Risk - Declining	Literature
Woodworthia chrysosiretica	goldstripe gecko	At Risk - Declining	Literature
Oligosoma polychroma	northern grass skink	Not Threatened	DOC database
Woodworthia maculata	raukawa gecko	Not Threatened	DOC database
Lampropholis delicata	plague skink	Introduced and Naturalised	Literature
Litoria ewingii	brown (whistling) tree frog	Introduced and Naturalised	Literature
Ranoidea raniformis	Southern bell frog	Introduced and Naturalised	DOC database

4 Assessment of Stream Sites

The construction of the water reservoir at either Naenae or Gracefield would require the installation of a water pipe across Waiwhetu stream. Three sites along Waiwhetu Stream were assessed for the ecological impacts of the installation of a suspended water pipe across the stream on inanga spawning habitat, vegetation, herpetofauna, and avifauna. Two stream crossings were assessed for the Gracefield site option. The stream sites are associated with the following reservoir sites:

- Naenae Reservoir - Waiwhetu Stream at Tilbury St bridge
- Gracefield Reservoir - Waiwhetu Stream at Wainui St bridge OR Waiwhetu Stream at Bell Rd bridge

This assessment assumes that all construction impacts will be confined to the riparian zone, and no works will take place in the stream itself.

4.1 Inanga spawning habitat

Waiwhetu Stream at Wainui Rd and Bell Rd were identified to fall within potential whitebait spawning habitat ranges. However, both sites are unlikely to provide suitable habitat for inanga spawning. The average bank angles over the 1m which spans the high spring tide mark were too incised (angle >35°) to provide suitable habitat. Additionally, the riparian habitat does not offer thick grass root mats, the soil was insufficiently moist, and the grass is maintained by mowing. These features add to the habitat being unsuitable for inanga spawning.

4.2 Vegetation

4.2.1 Tilbury St

The Waiwhetu Stream upstream of the Tilbury St bridge is heavily vegetated with native species on the true left bank (Figure 4). The true right bank has areas of grassed bank, and areas of dense native vegetation. Species include cabbage trees, flax, kanuka, lemonwood, mahoe, mamaku, and kowhai.

Table 10: Native flora species present at the Tilbury St bridge site

Scientific Name	Common Name	Threat Status[2]

2 Conservation status of New Zealand indigenous vascular plants, 2017 (de Lange, 2018).

Kunzea robusta	Kanuka	Threatened-Nationally vulnerable
Coprosma robusta	Karamū	Not Threatened
Cordyline australis	Cabbage Trees	Not Threatened
Darcycarpus dacrydiodes	kahikatea	Not Threatened
Melicytus ramiflorus	Mahoe	Not Threatened
Phormium tenax	Harakeke	Not Threatened
Pittosporum eugenioides	Lemonwood	Not Threatened
Pittosporum tenuifolium	Black Matipo	Not Threatened
Sophora microphylla	Kowhai	Not Threatened
Sphaeropteris medullaris	Mamaku	Not Threatened
Veronica stricta var. stricta	koromiko	Not Threatened

Figure 4: Vegetation upstream of the Tilbury St bridge

4.2.2 Wainui Road

Upstream of the Wainui Road bridge the stream is heavily vegetated on the true left bank. The vegetation is primarily broadleaf (Figure 5). Downstream of bridge the true left bank isf open maintained grass (Figure 6). The true right bank has several mature planted native trees, both upstream and downstream of the bridge but is otherwise open grass area.

Table 11: Native flora species present at the Wainui Rd bridge

Scientific Name	Common Name	Threat Status[2]
Darcycarpus dacrydiodes	Kahikatea	Not Threatened
Griselinea littoralis	Broadleaf	Not Threatened
Myoporum laetum	Ngaio	Not Threatened
Pseudopanax arboreus	Five Finger	Not Threatened
Sophora microphylla	Kowhai	Not Threatened

2 Conservation status of New Zealand indigenous vascular plants, 2017 (de Lange, 2018).

Figure 5: Vegetation upstream of the Wainui Rd bridge

Figure 6: Vegetation downstream of the Wainui Rd bridge

4.2.3 Bell Road

The riparian zone on the upstream side of the Bell Road bridge has native plantings on both banks (Figures 7 & 8). Species include cabbage trees, ngaio, harakeke, lemon wood, and koromiko.

Table 12: Native flora species present at the Bell Rd bridge site

Scientific Name	Common Name	Threat Status[2]
Kunzea robusta	Kanuka	Threatened-Nationally vulnerable
Cordyline australis	Cabbage Trees	Not Threatened
Muehlenbeckia complexa	Pohuehue	Not Threatened
Myoporum laetum	Ngaio	Not Threatened
Myrsine australis	Red matipo	Not Threatened

2 Conservation status of New Zealand indigenous vascular plants, 2017 (de Lange, 2018).

Phormium tenax	Harakeke	Not Threatened
Pittosporum eugenioides	Lemonwood	Not Threatened
Veronica stricta var. stricta	koromiko	Not Threatened

Figure 7: Vegetation upstream of the Bell Rd bridge

Figure 8: Vegetation downstream of the Bell Rd bridge

4.3 Avifauna

Incidental bird observations were recorded at each site.

- Tilbury St – swallows, mallard ducks, magpies, and a south black backed gull.
- Wainui Rd – mallard ducks, paradise ducks, pukekos, sparrows, and a heron.
- Bell Rd – chaffinches, sparrows, starlings, and a south black backed gull.

The Bell Rd and Wainui Rd and sites are within close proximity to the Hutt River estuary (1.5 and 1.2km respectively). It is therefore possible that several shore birds may utilise the site. Bird records pulled from the eBird database[4] identified several at risk and threatened shore species which are listed in Table 13 below. It is however unlikely that these birds significantly utilize the site, such that an installation of the pipe would have any more than minor impacts if best practises are followed.

Table 13: At-risk and threatened bird species recorded at the Hutt River estuary by Waione St

Common Name	Scientific Name	NZ Status	Conservation Status[5]
Shore Plover	*Thinornis novaeseelandiae*	Endemic	Threatened - Nationally critical
White Heron	*Ardea alba*	Native	Threatened - Nationally critical
Banded Dotterel	*Charadrius bicinctus*	Endemic	Threatened - Nationally critical
Caspian Tern	*Hydroprogne caspia*	Native	Threatened - Nationally critical
Reef Heron	*Egretta sacra*	Native	Threatened - Nationally critical
Bar-tailed Godwit	*Limosa lapponica*	Native	At Risk - Declining
Silver Gull	*Chroicocephalus novaehollandiae*	Native	At Risk - Declining
South Island Pied Oystercatcher (SIPO)	*Haematopus finschi*	Endemic	At Risk - Declining
Pied Shag	*Phalacrocorax varius*	Native	At Risk - Recovering
Variable Oystercatcher	*Haematopus unicolor*	Endemic	At Risk - Recovering

4.4 Herpetofauna

New Zealand herpetofauna (reptiles and amphibians) data is managed by DOC. The DOC herpetofauna database was searched for observations in proximity to the sites. Additionally, information was sourced from the citizen science database iNaturalist[6]. A total of five at risk lizard species have been recorded within 10km of the sites (Table 14). Each of the species observed on these databases has been recorded in the area within the last two years. A review of the literature[7] identified a further three at risk species, and one threatened species whose distributions include the Lower Hutt area, though these have not been observed in the area in recent years. All three sites contain suitable habitat for the herpetofauna species, including features such as exposed banks, rank grass, scrub, and trees.

Table 14: Herpetofauna species potentially present at site

Scientific name	Common name	Threat classification[8,9]	Reference
Oligosoma aff. *infrapunctatum* "southern North Island"	kupe skink	Threatened - Nationally Critical	Literature

4 eBird. 2022. eBird: An online database of bird distribution and abundance [web application]. eBird, Cornell Lab of Ornithology, Ithaca, New York. Available: http://www.ebird.org. (Accessed: February 17th, 2022).
5 Conservation status of New Zealand birds, 2016. (Robertson et al., 2017)
6 iNaturalist. Available from https://www.inaturalist.org. Accessed February 22nd, 20224. van Winkel, D., Baling, M., & Hitchmough, R. (2018) Reptiles and Amphibians of New Zealand. A Field Guide. Auckland university press

7 van Winkel, D., Baling, M., & Hitchmough, R. (2018) Reptiles and Amphibians of New Zealand. A Field Guide. Auckland University Press
8 Conservation status of New Zealand reptiles, 2015 (Hitchmough et al., 2016)
9 Conservation status of New Zealand amphibians, 2017 (Burns et al., 2018)

Mokopirirakau "southern North Island"	ngahere gecko	At Risk - Declining	DOC database
Naultinus punctatus	barking gecko	At Risk - Declining	DOC database
Oligosoma aeneum	copper skink	At Risk - Declining	iNaturalist
Oligosoma kokowai	northern spotted skink	At Risk - Relict	iNaturalist
Oligosoma ornatum	ornate skink	At Risk - Declining	Literature
Oligosoma zelandicum	glossy brown skink	At Risk - Declining	iNaturalist
Woodworthia "Marlborough mini"	minimac gecko	At Risk - Declining	Literature
Woodworthia chrysosiretica	goldstripe gecko	At Risk - Declining	Literature
Oligosoma polychroma	northern grass skink	Not Threatened	DOC database
Woodworthia maculata	raukawa gecko	Not Threatened	DOC database

5 Options Assessment

The works covered in this options assessment include the installation of an above ground reservoir approximately 55m wide and 8m tall, and the installation of a suspended water pipe across Waiwhetu stream for two of the site options. A pipeline alignment has not been included in the assessment.

The scores provided for each reservoir option in this assessment assume that good practise remedy and mitigation will be undertaken during and following construction:

- Replanting of the site/s will occur following the works
- Avoidance of effects on the active nests of native birds will be required, either by ensuring habitat clearance occurs outside the breeding season, or by engaging with a qualified ornithologist to do pre-clearance checks for nests (and halting works if a nest is found)
- Lizard rescue and relocation will be carried out in any areas of potential lizard habitat. This will require a Wildlife Act Authority ("permit") from the Department of Conservation.
- Weeds will be managed during and following clearance to ensure they are effectively controlled within the site.
- An Erosion and Sediment Control Plan should be prepared and implemented following local council standards and guidelines for any stream works

5.1 Naenae 2 Reservoir

5.1.1 Reservoir site ecological values

The representativeness, rarity, diversity, and context of the vegetation, avifauna, and herpetofauna were considered according to EIANZ[1] guidelines to determine the ecological value of the sites (Table 1).

Vegetation: Low

1 Roper-Lindsay, J., Fuller S.A., Hooson, S., Sanders, M.D., Ussher, G.T. 2018. Ecological impact assessment. EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems. 2nd edition.

The early-successional vegetation has areas dominated by kanuka (*Kunzea robusta*). As a result of the Myrtle rust (*Austropuccinia psidii*) fungal disease invasion in New Zealand, all indigenous *Myrtaceae* species have been classed as nationally vulnerable. Despite belonging to the *Myrtaceae* family there is currently no evidence that myrtle rust infects kanuka. Therefore, for the purpose of this options assessment the nationally vulnerable status of kanuka has not been taken into consideration in assigning ecological value to the site. Overall, the early successional vegetation on the upper slopes of the site has been assessed as having Low ecological value due to the lack of rarity and diversity.

The mid-successional vegetation around the lower construction footprint and at the proposed sediment pond is moderately representative due to the dominance of indigenous species. The species present are naturally regenerating from seed sources from the connected landscape.

The ecological value of the sites has been determined to be Low. The area rates moderate in term of diversity due to the range of species present in the around the lower slopes and the proposed sediment pond. However, the sites rarity, and context are rated as Low, and is therefore of limited ecological value in the wider landscape.

Avifauna: Low

The site will provide habitat for common introduced and native bird species. One nationally critical, and two at risk bird species have been recorded in the wider area. However, the probability of these species utilizing this site on a regular basis is low. The ecological value of the site for birds has therefore been assessed as Low.

Herpetofauna: High

Several at risk lizards have been identified in the surrounding area within the last two years. Both the reservoir and stream crossing sites have suitable habitat to support these species. Therefore, it is possible that these species will be present at the sites. Due to the conservation status of these species the ecological value for herpetofauna has been assessed as High.

5.1.2 Waiwhetu stream at Tilbury St ecological values

Inanga Spawning Habitat: Negligible

Tilbury St is located too far inland, beyond the point of saltwater intrusion at high tide, to provide potential for inanga spawning habitat. Therefore, the ecological value has been determined to be Negligible.

Vegetation: Low

The riparian zone has a moderate diversity of native species present. However, impact on the wider connected habitat is expected to be minimal. Therefore, the ecological value has been determined to be Low.

Avifauna: Low

The site will provide habitat for common introduced and native bird species. One nationally critical, and two at risk bird species have been recorded in the wider area. However, the probability of these species utilizing this site on a regular basis is low. The ecological value of the site for birds has therefore been assessed as Low.

Herpetofauna: High

Due to the possibility of at-risk lizard species to be present at sites, the ecological value has been determined to be High. Riparian zones which contain vegetation and/or rank grass provide potential habitat for lizards. Therefore, the ecological value of the sites has been assessed as High.

5.1.1 Magnitude of effects

The reservoir site includes habitat that is connected to a large expanse of similar or higher quality habitat. Given the very small area of habitat that will be lost when considered in this wider context, the development of the Site will result in only a minor shift from baseline conditions. The underlying character, composition and attributes of the overall resource will be similar to the pre-development situation. Only minor effects on the populations or range of flora and fauna species are expected. The magnitude of effects has therefore been assessed as Low.

The assessment of the stream sites assumes that all construction impacts will be confined to a narrow corridor through the riparian zone, and no works will take place in the stream itself. The construction of the water pipe has potential to create negative impacts on the surrounding habitat, such as the removal of native vegetation, sediment input to the stream, and impact to threatened and at-risk lizards. However, if best practise and mitigation measures are carried out during and post construction the negative impacts can be controlled, and medium to long-term impacts to the habitat is expected to be negligible.

5.1.2 Assessment of effects

Ecological value has been determined to be High due to the potential of threatened and at-risk lizard species be on the site. The magnitude of effect has been determined to be Low due to the very small area of habitat affected compared to the total resource in the locality. Using the MCA scoring matrix Tables 3 & 4) the overall level of ecological effect of developing the Naenae site has been assessed as a minor adverse ecological effect (3L).

5.2 Cambridge Terrace Reservoir

5.2.1 Reservoir site ecological values

The representativeness, rarity, diversity, and context of the vegetation, avifauna, and herpetofauna were considered according to EIANZ guidelines[1] to determine the ecological value of the sites (Table 1).

Vegetation: Low

The site has low plant species diversity, with just two species dominating the area (gorse and mamaku). The highly modified nature of the vegetation and abundance of gorse means that the vegetation within the site has low representativeness. The indigenous vegetation along the edge of the gorse scrub appears to minimally be impacted by the project footprint. The area affected by the footprint is therefore of limited unlikely to be important at the level of the ecological district and has been assigned Low ecological value.

The early-successional vegetation has areas dominated by kanuka (*Kunzea robusta*). As a result of the Myrtle rust (*Austropuccinia psidii*) fungal disease invasion in New Zealand, all indigenous *Myrtaceae* species have been classed as nationally vulnerable. Despite belonging to the *Myrtaceae* family there is currently no evidence that myrtle rust infects kanuka. Therefore, for the purpose of this options assessment the nationally vulnerable status of kanuka has not been taken into consideration in assigning ecological value to the site.

Avifauna: Low

The site will provide habitat for common introduced and native bird species. One nationally critical, and two at risk bird species have been recorded in the wider area. However, the probability of these species utilizing this site on a regular basis is low. The ecological value of the site for birds has therefore been assessed as Low.

Herpetofauna: High

Several at risk lizards have been recorded in the surrounding area within the last two years. The Site has suitable habitat to support these species. It is possible that these species will inhabit the site. Due to the conservation status of these species the ecological value for herpetofauna has been assessed as High.

5.2.2 Magnitude of effect

The Site includes habitat that is connected to a large expanse of similar or higher quality habitat. Given the very small area of habitat that will be lost when considered in this wider

1 Roper-Lindsay, J., Fuller S.A., Hooson, S., Sanders, M.D., Ussher, G.T. 2018. Ecological impact assessment. EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems. 2nd edition.

context, the development of the Site will result in only a minor shift from baseline conditions. The underlying character, composition and attributes of the overall resource will be similar to the pre-development situation. Only minor effects on the populations or range of flora and fauna species are expected. The magnitude of effects has therefore been assessed as Low.

5.2.3 Assessment of impacts

Ecological value has been determined to be High due to the potential of threatened and at-risk lizard species be on the site. The magnitude of effect has been determined to be Low due to the very small area of habitat affected compared to the total resource in the locality. Using the MCA scoring matrix (Tables 3 & 4) the overall level of ecological effect of developing the Cambridge Terrace site has been assessed as a **minor adverse ecological effect (3L).**

5.3 Gracefield 2 Reservoir

5.3.1 Reservoir site ecological values

The representativeness, rarity, diversity, and context of the vegetation, avifauna, and herpetofauna were considered according to EIANZ guidelines[1] to determine the ecological value of the sites (Table 1).

Vegetation: Low

The there is a moderate diversity of common indigenous species present at the site, however the site is dominated by exotic species. Therefore, the vegetation has been determined to be of Low ecological value.

The early-successional vegetation has areas dominated by kanuka (*Kunzea robusta*). As a result of the Myrtle rust (*Austropuccinia psidii*) fungal disease invasion in New Zealand, all ingenious *Myrtaceae* species have been classed as nationally vulnerable. Despite belonging to the *Myrtaceae* family there is currently no evidence that myrtle rust infects kanuka. Therefore, for the purpose of this options assessment the nationally vulnerable status of kanuka has not been taken into consideration in assigning ecological value to the site.

Avifauna: Low

The site will provide habitat for common introduced and native bird species. One nationally critical, and two at risk bird species have been recorded in the wider area. However, the probability of these species utilizing this site on a regular basis is low. The ecological value of the site for birds has therefore been assessed as Low.

Both Bell Rd and Wainui Rd and sites are within close proximity to the Hutt River estuary (1.5 and 1.2km respectively). It is therefore possible that several shore birds may utilise the site. Bird records pulled from the eBird database[4] identified several at risk and threatened shore species. It is however unlikely that these birds significantly utilize the site, such that an installation of the pipe would have any more than minor impacts if best practises are followed.

Herpetofauna: High

Several at risk lizards have been identified in the surrounding area within the last two years. Both the reservoir and stream crossing sites have suitable habitat to support these species. Therefore, it is possible that these species will be present at the sites. Due to the conservation status of these species the ecological value for herpetofauna has been assessed as High.

5.3.2 Ecological values of Waiwhetu Stream at Wainui Rd (Stream crossing option 1)

Inanga Spawning Habitat: Negligible

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1 Roper-Lindsay, J., Fuller S.A., Hooson, S., Sanders, M.D., Ussher, G.T. 2018. Ecological impact assessment. EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems. 2nd edition.

4 eBird. 2022. eBird: An online database of bird distribution and abundance [web application]. eBird, Cornell Lab of Ornithology, Ithaca, New York. Available: http://www.ebird.org. (Accessed: February 17th, 2022).
5 Conservation status of New Zealand birds, 2016. (Robertson et al., 2017)

The site has been identified to fall within potential whitebait spawning habitat ranges, with saltwater intrusion at high tides. However, the riparian characteristics at the sites do not provide suitable habitat for inanga spawning. Therefore, the ecological value has been determined to be negligible.

Vegetation: Negligible

The riparian zone has several native species present on the upstream banks of the bridge. However, it has been indicated that the installation of the pipe is likely to occur on the downstream side of the bridge. The downstream area is composed of an open maintained reserve, with sparsely planted individual trees which are unlikely to be impacted by the installation of a water pipe. Therefore, the ecological value has been determined to be negligible.

Avifauna: Low

The site provides habitat for several common native and introduced species. Additionally, it is possible that several threatened and at-risk shore birds may be present in the wider area. It is however unlikely that these birds significantly utilize the site. Therefore, the ecological value of the site for birds has therefore been assessed as Low.

Herpetofauna: High

Due to the possibility of at-risk lizard species to be present at sites, the ecological value has been determined to be High. Riparian zones which contain vegetation and/or rank grass provide potential habitat for lizards. Therefore, the ecological value of the sites has been assessed as High.

5.3.3 Ecological values of Waiwhetu Stream at Bell Road (Stream crossing option 2)

Inanga Spawning Habitat: Negligible

The site has been identified to fall within potential whitebait spawning habitat ranges, with saltwater intrusion at high tides. However, the riparian characteristics at the sites do not provide suitable habitat for inanga spawning. Therefore, the ecological value has been determined to be negligible.

Vegetation: Low

The riparian zone has moderate diversity of planted native species present. However, impact on the wider connected habitat is expected to be minimal. Therefore, the ecological value has been determined to be Low.

Avifauna: Low

The site provides habitat for several common native and introduced species. Additionally, it is possible that several threatened and at-risk shore birds may be present in the wider area. It is however unlikely that these birds significantly utilize the site. Therefore, the ecological value of the site for birds has therefore been assessed as Low.

Herpetofauna: High

Due to the possibility of at-risk lizard species to be present at sites, the ecological value has been determined to be High. Riparian zones which contain vegetation and/or rank grass provide potential habitat for lizards. Therefore, the ecological value of the sites has been assessed as High.

5.3.4 Magnitude of effects Gracefield with stream crossing at Wainui Rd (Option 1)

The reservoir site includes vegetation that is connected to a large habitat of similar or higher quality vegetation. Given the very small area of habitat that will be lost when considered in this wider context, the development of the reservoir site will result in only a minor shift from baseline conditions. The underlying character, composition and attributes of the overall resource will be similar to the pre-development situation. Only minor effects on the populations or range of flora and fauna species are expected.

The assessment of the stream sites assumes that all construction impacts will be confined to a narrow corridor through the riparian zone, and no works will take place in the stream itself. Assuming the pipe is constructed on the downstream side of the Wainui Rd bridge, the impacts are expected results in negligible vegetation removal. During construction ecological impacts with best practises should be minimal, with negligible medium to long-term impacts.

The overall magnitude of effects has been assessed as Low

5.3.5 Assessment of impacts: Gracefield with stream crossing at Wainui Rd (Option 1)

Ecological value has been determined to be High due to the potential of threatened and at-risk lizard species be on the site. The magnitude of effect has been determined to be Low due to the very small area of vegetation affected compared to the total resource in the locality. Using the MCA scoring matrix (Tables 3 & 4) the overall level of ecological effect of developing the Cambridge Terrace site has been assessed as a minor adverse ecological effect (3L).

5.3.1 Magnitude of effects Gracefield with stream crossing at Bell Rd (Option 2)

The reservoir site includes vegetation that is connected to a large habitat of similar or higher quality vegetation. Given the very small area of habitat that will be lost when considered in this wider context, the development of the reservoir site will result in only a minor shift from baseline conditions. The underlying character, composition and attributes of the overall resource will be similar to the pre-development situation. Only minor effects on the populations or range of flora and fauna species are expected.

The assessment of the stream sites assumes that all construction impacts will be confined to a narrow corridor through the riparian zone, and no works will take place in the stream itself. It has been indicated that the installation of a water pipe would occur at the upstream side of Bell St as the river channel is narrower than on the downstream side. During construction ecological impacts with best practises should be minimal, with negligible medium to long-term impacts with replanting of the site following works.

The overall magnitude of effects has been assessed as Low

5.3.2 Assessment of impacts: Gracefield with stream crossing at Bell Rd (Option 2)

Ecological value has been determined to be High due to the potential of threatened and at-risk lizard species be on the site. The magnitude of effect has been determined to be Low due to the very small area of vegetation affected compared to the total resource in the locality. Using the MCA scoring matrix (Tables 3 & 4) the overall level of ecological effect of developing the Cambridge Terrace site has been assessed as a minor adverse ecological effect (3L).

5.4 Summary of Networks Options Assessment

Each of the sites has High ecological value as a result of potential at-risk herpetofauna species being onsite. Each of the sites have suitable habitat for these species and there is no difference in the probability of species being present between the sites.

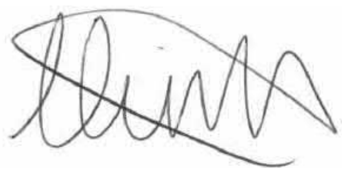
Despite the High ecological value as a result of potential at-risk herpetofauna being onsite, the medium to long term loss of the habitat at the reservoir sites should not notably affect the populations given the small extent of habitat affected compared to the total resource and assuming appropriate mitigations are carried out. A lizard salvage and relocation operation should provide mitigation for the impacts of development on herpetofauna. The potential impacts to the populations can be minimized if appropriate mitigations are carried out. A lizard salvage and relocation operation should provide some mitigation for the impacts of development on herpetofauna.

The construction of a water pipe could have impacts upon the stream environment during construction period. However, these impacts will be minimal, with negligible medium or long-term impacts for all if best practises and mitigation is followed. Where possible the removal of vegetation should be avoided. In the case where vegetation is required to be removed, this should be compensated through remedial planting.

Table 15: Summary table of MCA ratings for each site

	Ecological Value	Magnitude of Effect	MCA Impact Rating
Cambridge Terrace	High	Low	3L: Minor adverse ecological effects
Naenae with stream crossing at Tilbury St	High	Low	3L: Minor adverse ecological effects
Gracefield 2 with stream crossing at Wainui Rd	High	Low	3L: Minor adverse ecological effects
Gracefield 2 with stream crossing at Bell Rd	High	Low	3L: Minor adverse ecological effects

Prepared by:



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Appendix D

Landscape and Visual Assessment

Wellington Water
LOWER HUTT CENTRAL RESERVOIR

3 March 2022

Landscape Advice Note

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1 Background

This landscape advice note forms part of a multi-criteria analysis and describes the potential landscape effects[1] and visual effects for the proposed Lower Hutt Central Reservoir water reservoir at three possible alternative sites (**Figure 1**). Through previous review, the three potential sites for the Proposal now form a 'short-list' from an overall fourteen possible sites that were originally investigated. The three sites considered in this assessment of landscape and visual effects are:

- 'Naenae 2' (Option 1) (**Figure 2**)
- 'Gracefield 2' (Option 2) (**Figure 3**)
- 'Cambridge Terrace' (Option 3) (**Figure 4**)

This landscape input has been provided to outline the potential effects of the Proposal on landscape character (landscape effects) and amenity (visual effects) which may affect landscape values[2]. These effects may be positive or adverse. This is a high-level assessment for site scoping purposes and not a full landscape and visual assessment of one or all sites being considered.

***Figure 1** Locations of proposed options.*

[1] 'Landscape' effects concern physical changes to the setting which may or may not be seen but are otherwise understood to exist. A landscape effect is a consequence of a change in a landscape value/s. 'Visual' effects are a subset of landscape effects. Visual effects are consequences of change on landscape values as experienced in views and are one tool to help understand landscape effects. Other senses contribute to amenity values such as sound and smell, however the visual is typically pre-eminent for most people.
[2] Landscape 'Value' is the relative regard (quality, meaning, importance, merit, worth) with which a landscape is held. Values may be physical, associative and perceptual.

2 Sites description

All three sites are located along the eastern slopes above Hutt Valley at elevations around the 60 – 80 m contour. The sites occupy the relatively gentle tops of three lower spurs where the terrain has 'eased' to a degree in terms of slope gradient. Below the sites / spur tops the terrain drops sharply to the valley floor. The broader landform above and further east of the sites rises steeply to over 300 m elevation.

The Naenae 2 site in Fairfield straddles an existing firebreak / rough 4WD access track which extends uphill from the end of the sealed Summit Road. An existing 1,800 m^2 square concrete reservoir is located immediately to the north of the site at an elevation of approximately 66 m. Otherwise, the site is fully clothed in mixed indigenous and exotic vegetation. It is understood that locals use the firebreak as an informal walking track. The closest residences come to within 70 m of the site, accessed from Tilbury Street and Summit Road near the 60 m contour.

The Gracefield 2 site is located to the south of and uphill of an existing approximately 30 m diameter water reservoir at an elevation of approximately 66 m. This reservoir is accessed by an unsealed road that extends from Wainuiomata Road to the east. This site includes some tall trees amongst mixed indigenous and exotic shrubland. A local BMX club has formed a track near the existing access road. The closest residences to the site are along Riverside Drive approximately 500 m to the north beyond Waiwhetu Stream.

The Cambridge Terrace site is in Taita and is an unmodified site with a vegetation cover of mixed native and exotic shrubland. Residential development along Cambridge Terrace and Kowhai Street within the suburb of Avalon extends to within 150 m of the site up to the approximately 25 m contour. An automotive wrecking yard is located approximately 250 m to the north on flat land at the approximately 50 m contour. The closest part of Taita Cemetery is located approximately 150 m to the south of the site at an elevation of 20 – 30 m, accessed from Kowhai Street.

3 Options

The component of each option consistent with each site is a single circular concrete reservoir, around 55 m in diameter and approximately 8 m tall. The reservoir includes a steel safety railing around the top edge and a steel access stairway up the side of the reservoir.

Each option includes vegetation clearance and earthworks to provide a platform for the reservoir, but also for access from the nearest public road, along with a hardstand area for a construction laydown area and ongoing maintenance purposes. These aspects vary between the three sites depending on vegetation cover, the amount of excavation required to meet reservoir operational levels, vehicle manoeuvrability and the length and width of existing road access to modify or form anew.

Following construction, the exposed cut and fill batters and any other cleared area beyond the formed hardstand area, accessway and the reservoir will be revegetated using local indigenous plant species.

4 Who will be affected?

Potentially affected parties are broadly considered in this Advice Note to include:

- Permanent residents living in the Hutt Valley including on the valley floor and above, on the western slopes beyond State Highway 2 (SH2).
- Those occupying the commercial and industrial areas in the Hutt Valley during work time.

- People in various public places including open space areas, public roads, SH2, the railway and railway stations and the numerous parks and reserves and water bodies within the Hutt Valley.

5 Assessment Methodology

The methodology for assessment is based on the NZILA Landscape Assessment Guidelines[3] and utilises information obtained from desk top study only, which largely relies on zones of theoretical visibility (ZTV) mapping. A site visit was not undertaken due to Covid-19 travel limitations.

A 3D model 'fly-through' and separate ZTV maps have therefore been utilised to help assess each of the three site options, the contextual landscape and evaluate the key issues and potential visual effects of each option at each site, including positive effects, if any.

The 11 February 2022 *'Lower Hutt Central Reservoir Stage 1 – Constructability Review (Revision 1)'* prepared by Kidd Civil Consulting has been used to help inform some of the overall build requirements, where relevant to landscape and visual effects outcomes.

Google Earth Pro has also been used to help determine approximate relative elevations and distances as well as to provide a general understanding of the landscape pattern including urban and natural landscape features and patterns in the broader site context, and at each site itself.

Figure 2 *Proposed Naenae 2 reservoir (Option 1). Note existing reservoir below Proposal.*

[3] New Zealand Institute of Landscape Architects Te Tangi a te Manu – Aotearoa New Zealand Landscape Assessment Guidelines, Final Draft, April 2021.

5.1 Zone of Theoretical Visibility mapping

The ZTV maps (**Appendix 1**) map the theoretical visibility of each reservoir at the three site options from all points in the Hutt Valley landscape within an approximately 10 km radius. This was undertaken using ArcGIS software, utilising a terrain model based on LiDAR survey data.

When examining ZTV maps, it is important to understand that:

- ZTV maps do not show how an element in the landscape will appear or the magnitude of visual effects as they only show an indicative area and the extent of the potential viewshed. For example, recessive colours are not considered, which typically reduces the visibility of buildings in the landscape substantially.
- ZTV maps do not take into consideration the potential screening effect of vegetation cover or structures within the area and are solely based on 'bare' topography. It is inevitable that in most cases there will be buildings and trees near most viewpoints that will interrupt or fully screen views of all sites and the Proposal – particularly from the Lower Hutt valley floor.
- The accuracy is limited to the contour information/intervals.
- ZTV's are an assessment tool which produces a baseline of the potential maximum visibility of the element, however it does not consider the effects of distance of viewer, intervening elements that may visually distract or detract from views, and atmospheric conditions such as sun/glare or humidity etc. The ZTV assumes an equal baseline condition for all views.

Figure 3 *Proposed Gracefield 2 reservoir (Option 2). Note existing reservoir below Proposal.*

5.2 The seven-point scale of effects

A seven-point scale of effects[4] has been used when assessing the potential adverse and positive landscape and visual effects arising from the options. This effects scale ranges between: 'Very Low' to 'Low' to 'Moderate to Low' to 'Moderate' to 'Moderate to High' to 'High' to 'Very High' for adverse effects. It is generally understood that 'less than minor' adverse effects are equivalent to the 'Very Low', or lowest adverse effects rating (**Appendix 2**).

6 Assessment of the Landscape and Visual Effects

6.1 Landscape effects

Landscape effects concern physical changes to the setting which may or may not be seen but are otherwise understood to exist. Landscape effects are also synonymous with effects on character and levels of amenity derived from landscape character or in other words - whether a change to the setting is appropriate or not. Landscape character is comprised from a combination of landform, land cover and land use (or cultural patterns). As such, physical changes to the landscape arising from each site option include:

- Vegetation clearance – including tall trees, but mostly, indigenous and exotic shrubland, to make way for the reservoir, access road, hardstand areas and buried pipework.
- Earthworks to form a flat building site at the required operational level, provide connections to existing public roads for heavy vehicle access for construction and ongoing maintenance works, laydown areas, trenching for pipework, stormwater management features and cut and fill batters.
- The introduction of a 15 ML, 55 m diameter x 8 m tall circular concrete reservoir with steel balustrade and stair access.
- Sealed hardstand areas and access roading.
- Exposed 1:1 / 45^0 cut faces and gentler 2:1 fill batters.
- Site remediation works including restoration planting.

The landscape changes listed above, will occur at all three potential sites to greater or lesser degrees. The levels of vegetation and earthworks disturbance differ between the three sites.

At the Naenae 2 site, earthworks volumes are estimated to be 70,000 m^3 and 20 m deep. This site is located next to an existing square concrete reservoir. For this reason, the proposed reservoir will not be a 'new element' in the scene. In addition, existing roading will be able to be utilised/upgraded to provide access. Vegetation cover removal will be minimal.

The Gracefield 2 site has the greatest levels of earthworks at 75,000 m^3 and 32 m deep. This is largely due to the need to set the reservoir down to required operational levels within the site's steep setting. The result will be a cut batter approximately 32 m high behind the reservoir. The Proposal at this site will requires some removal of large trees, along with that of mixed indigenous and exotic shrubland.

At the Cambridge Terrace site, a new access road will need to be formed off the hairpin bend near the 'Pick a Part' automotive dismantlers. The new access road up to the site will require substantial vegetation removal and earthworks, including the creation of substantial cut slopes and fill batters. At one point a small gully will need to be culverted and filled in to provide a trafficable grade. However, overall earthworks are the least of the three options at 41,000 m^3 and 19 m deep. This is because the construction footprint for the reservoir itself will occupy a

[4] New Zealand Institute of Landscape Architects Te Tangi a te Manu – Aotearoa New Zealand Landscape Assessment Guidelines, Final Draft, April 2021. The definitions come from NZILA national workshop discussions prior to the publication of the guidelines and are based on the Boffa Miskell effects descriptions.

relatively flat area on a ridge crest, at a suitable existing elevation requiring relatively little excavation.

6.1.1 Landscape effects summary

In terms of landscape effects arising from the options, these will be greatest at the Cambridge Terrace site due to the extent of the newly formed access roading extending the landscape disturbance effects to the north towards 'Pick a Part'. Potentially adverse landscape effects are considered in this option to be '**Moderate-High**'[5]. Potentially adverse landscape effects at Naenae 2 are '**Moderate-Low**'[6] and potentially adverse landscape effects will be slightly higher than this at the Gracefield 2 site and are assessed as '**Moderate**'[7] (**Table 1**).

Figure 4 *Proposed Cambridge Terrace (Option 3). Note Pick a Part automotive dismantlers to left of Proposal.*

6.2 Visual effects

Levels of visual amenity are generally associated with how 'natural' a place is. The more natural or unmodified the place is, the higher the level of visual amenity will be, typically. The sites and their immediate context are modified through vegetation change, including the introduction of exotic species, and in some cases also include built development such as operational water reservoirs and access tracks. Urban development, including residential housing presses up close to the Cambridge Terrace and Naenae 2 reservoir sites. The Naenae 2 and Gracefield 2 sites are beside existing water reservoirs. As such, each proposed reservoir site is located near the edge of

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[5] **Moderate-High**: A moderate to high level of effect on the character or key attributes of the receiving environment and/or the visual context within which it is seen; and/or have a moderate-high level of effect on the perceived amenity derived from it.

[6] **Moderate-Low**: A moderate to low level of effect on the character or key attributes of the receiving environment and/or the visual context within which it is seen; and/or have a moderate to low level of effect on the perceived amenity derived from it.

[7] **Moderate**: A moderate level of effect on the character or key attributes of the receiving environment and/or the visual context within which it is seen; and/or have a moderate level of effect on the perceived amenity derived from it. *(Oxford English Dictionary Definition: Moderate: adjective-average in amount, intensity or degree).*

/ above varying degrees of urban development. Therefore, the landscape surrounding, and including the three sites is assessed as having a medium degree of 'naturalness'.

Given the extent of change that has occurred within or very close to each site, it is considered that all three sites have a reasonable level of capacity to absorb further change, including reservoirs and their surrounding infrastructure. The various options' levels of compatibility with their respective settings will be further improved with appropriate mitigation techniques such as tank colour and earthworks remediation and planting being incorporated.

The ZTV mapping is based on the reservoir structure only. That is, an 8 m tall 'cylinder', 55 m in diameter, set at a stipulated elevation in the topographical landscape has been programmed into the ZTV modelling software. It is understood that the ZTV mapping has not taken earthworks into account. This is fair as over time, any exposed earthworks will be remediated and revegetated, assisting these areas to blend back in to the surrounding scrubby, dense contextual vegetation cover where the modified topography around the site will go unnoticed.

Without the benefit of a site visit, a reliance is placed on the ZTV analysis maps to provide a useful comparison between the three sites. This clearly shows that the proposed reservoir at the Gracefield 2 site will be visible to the least number of people. This is largely due to an intervening knoll to the north rising above Mawson Street which truncates the view 'wedge' at a line north of Waterloo Station. Conversely, the mapping also shows that this reservoir option will be more visible to those on the slopes to the west beyond/above SH2 than the Cambridge Terrace reservoir site. However, people living to the west of SH2 will be nearly 4 kms away where the options will be unlikely to be visible, but if so, would not be particularly noticeable with any visual effects being negligible. In this regard a 'receiving environment' where any visual effects may be potentially adverse is confined to closer areas to each site within the valley floor.

Nonetheless, the ZTV mapping demonstrates clearly that the Gracefield 2 site is the better option with regards to the size of the potential viewing audience. Visibility of the Gracefield 2 reservoir would be limited to views from Alicetown in the south, Boulcott in the north and Waiwhetu in the east. Hutt Central CBD, Woburn, Western Hutt and Melling Stations are also within the Gracefield 2 view 'wedge' but any adverse visual effects from these locations would be negligible due to the generous view distances.

It is also noted that there are dwellings extending to within approximately 150 m and 70 m from the Cambridge Terrace and Naenae 2 reservoir options respectively where there would likely be some views of each option. The closest dwellings to the Gracefield 2 reservoir site are 500 m away, separated by substantial intervening industrial development at Seaview, though the Gracefield 2 option will doubtless be visible above these large buildings from some viewpoints.

Each reservoir proposal will be visible from other non-residential buildings within the broader receiving environment. However, it is considered that any adverse effects will be acceptable, as these potentially affected parties are typically within the receiving environment from 9 am to 5 pm engaged in working activities and do not permanently occupy the buildings. Any visitors to these buildings such as customers or visitors will be there for a short period of time and as such cannot be considered affected to an unacceptable level by the options.

For those travelling through the area or recreating within it, where the options will be visible, it is considered that any adverse effects of the options on amenity will be negligible. This is because any views will be transient, reducing any potentially adverse effects.

6.2.1 Visual effects summary

Potentially adverse visual effects generated will be similar at all of the options. The Cambridge Terrace option includes earthworks volumes smaller relative to the other options. However, the earthworks are concentrated in unmodified terrain to form the site access. The Naenae 2 and Gracefield 2 options require high cut faces to form the reservoir platforms. In essence the visual effects at all sites will therefore be similar. However, the visual effects at all three sites will exist from the short to medium term (0 – approximately 7 years) while the disturbed areas gradually revegetate following site remediation works. Potential adverse visual effects are conservatively assessed as **Moderate-High**'[8] reducing over approximately seven years to '**Low**'[9] at all sites, to all potentially affected parties within the Hutt Valley opposite the sites (**Table 1**).

Site Location	Potentially adverse Landscape Effects	Potentially adverse Visual Effects (from 0 - 7 years)	Potentially adverse Visual Effects (from 7 years onwards)
Naenae 2	'Moderate-Low'	'Moderate-High'	'Low'
Gracefield 2	'Moderate'	'Moderate-High'	'Low'
Cambridge Terrace	'Moderate-High'	'Moderate-High'	'Low'

Table 1 *Summary of levels of landscape character and visual amenity effects.*

The visual effects ratings in Table 1 above are coarse and based on the likely visual changes to the three sites regardless of viewpoint location. This can only be determined through focussed observations carried out during fieldwork, where for example, people living closer to a proposal such as this will typically experience greater adverse effects on their levels of amenity than by those further away.

It is therefore relevant to consider the size of the viewing audience for each site through the ZTV analysis. The viewing audience for the Cambridge 2 and Naenae 2 options are similar, and as mapped, appear extensive. The viewing audience for the Gracefield 2 option is substantially smaller than the other two options. Therefore, it is considered that any potentially adverse visual effects will be substantially less for the Gracefield 2 option based solely on the numbers of people who will see this option.

Further detailed assessment of landscape/visual effects is likely to be required following the outcomes of the multi-criteria analysis phase.

7 Cumulative effects

Generally, cumulative effects come into play where a proposal - added to the landscape, triggers a 'tipping point' where the landscape's capacity to absorb further change has been surpassed and where the landscape's character and values derived from that character have been permanently compromised. Of the three options, the Cambridge Terrace option is the most likely to generate cumulative effects. This is because the Naenae 2 and Gracefield 2 sites are very close to existing water reservoirs where the option will be seen alongside these, essentially consolidating existing activity. There is an existing reservoir at Taitā around 1.5 kms to the north of the Cambridge Terrace site. The Cambridge Terrace option would therefore constitute a 'fourth standalone' reservoir along the eastern hills above the Hutt Valley. Four reservoirs, rather than three could potentially generate cumulative effects. However, the Cambridge Terrace site is approximately 2 kms from the existing Naenae reservoir, almost 6 kms from the existing Gracefield reservoir and 1.5 kms from the existing Taitā reservoir. This

[8] **Moderate-High**: A moderate to high level of effect on the character or key attributes of the receiving environment and/or the visual context within which it is seen; and/or have a moderate-high level of effect on the perceived amenity derived from it.

[9] **Low**: A low level of effect on the character or key attributes of the receiving environment and/or the visual context within which it is seen; and/or have a low level of effect on the perceived amenity derived from it. *(Oxford English Dictionary Definition: Low: adjective-below average in amount, extent, or intensity).*

physical separation is assessed as sufficient to avoid cumulative effects occurring. Or in other words, a new reservoir at any of the three sites will not lead to an effect where the hilly, natural backdrop to the Hutt Valley has become dominated by reservoir structures.

8 Conclusion

Regarding landscape character effects, all three options will have a level of adverse effects that will fall between '**Moderate**' and '**Moderate-High**' – all effects which are 'more than minor'. This is largely due to the levels of vegetation clearance and earthworks volumes proposed at all sites. The actual reservoir structure is a lesser physical change to each setting - particularly with regards to the Naenae 2 and Gracefield 2 options, which are near existing water reservoirs. For this reason, any landscape change must be tempered by what has gone before.

With regards to visual effects and largely relying on the ZTV analysis mapping, this appears much more clear-cut. The Gracefield 2 option has the least visual effects as it has the smallest view audience due to the following reasons:

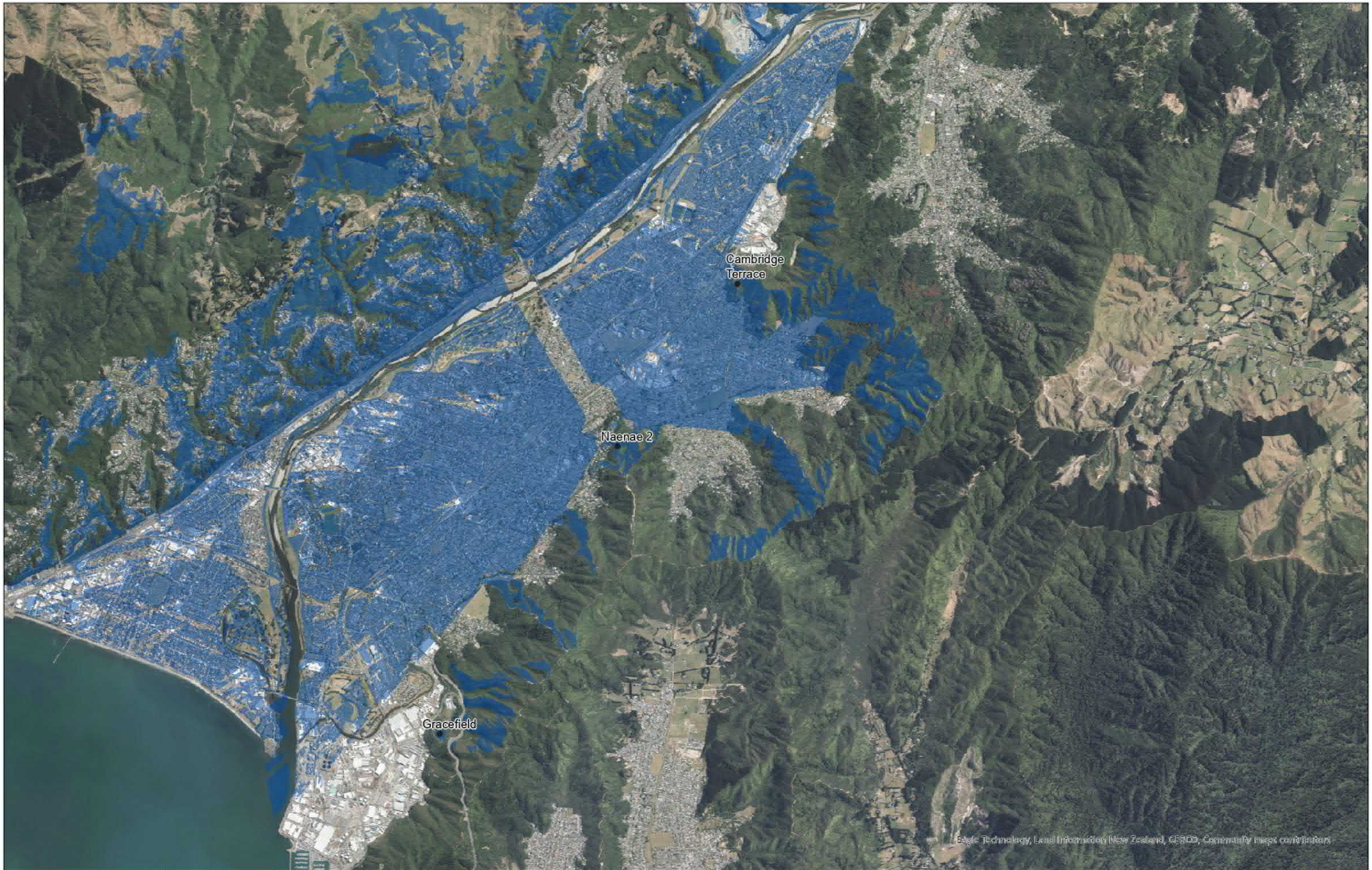
- An intervening knoll above Mawson Street blocks views to the north.
- The reservoir will be excavated down into its site where the retained topography to the south/west will block views towards Petone.
- The site is approximately 500 m away from the nearest permanently occupied dwelling.
- Substantial industrial development is located below the site at Gracefield which has greater adverse visual effects than this option. This provides this option with a degree of compatibility with its broad setting where it will 'stand out' less.

Even though the Gracefield 2 option has potentially adverse landscape character effects in the middle of the three options, on balance the Gracefield 2 option is assessed as the most favourable option in terms of any potentially adverse landscape effects, largely for visual effects reasons.

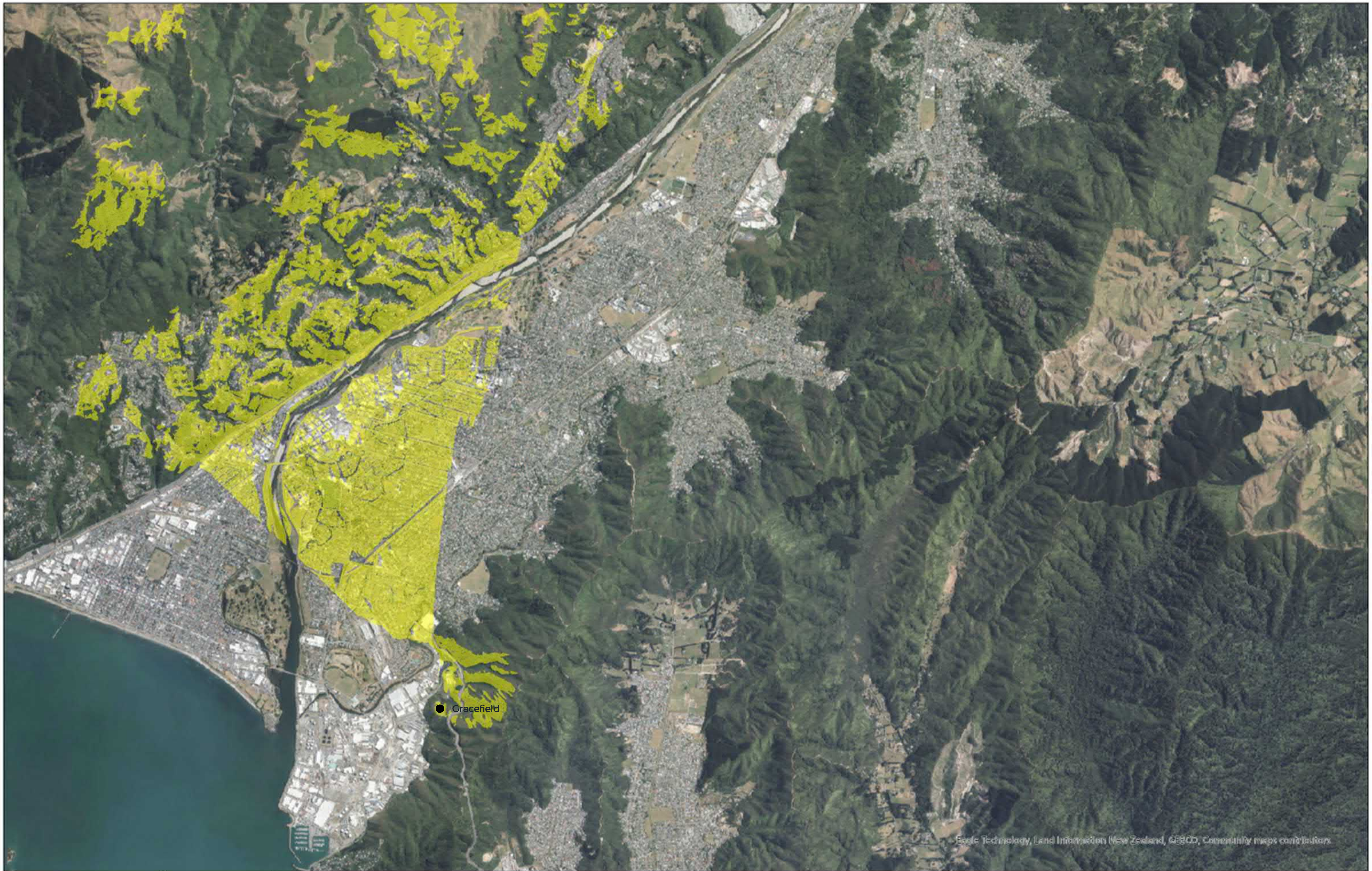
Any adverse landscape effects arising from the visibility of the reservoirs at all sites will be minimised using recessive reservoir colours. Landscape effects will gradually reduce over time following the establishment of planting as part of a robust earthworks remediation / revegetation plan.

Appendix 1

Naenae 2 / Option 1	A3 sheet 1 (blue overlay)
Gracefield 2 / Option 2	A3 sheet 2 (yellow overlay)
Cambridge Terrace / Option 3	A3 sheet 3 (red overlay)



Geospatial Opus House, Princes Street, Hamilton 3204 | Tel +64 21 220 7841 Property of WSP NZ Ltd. All rights reserved.	Client:	Naenae 2 / Option 1 Zone of Theoretical Visibility Map	Legend:	Scale: 1:36,112 @A3 N Project number: 0-XXXXX.00 Date: 00/00/2018 Author: andrew.standley@wsp.com



wsp

Geospatial

Client:

Gracefield 2 / Option 2
Zone of Theoretical Visibility Map

Legend:

Scale:

1:36,112 @A3

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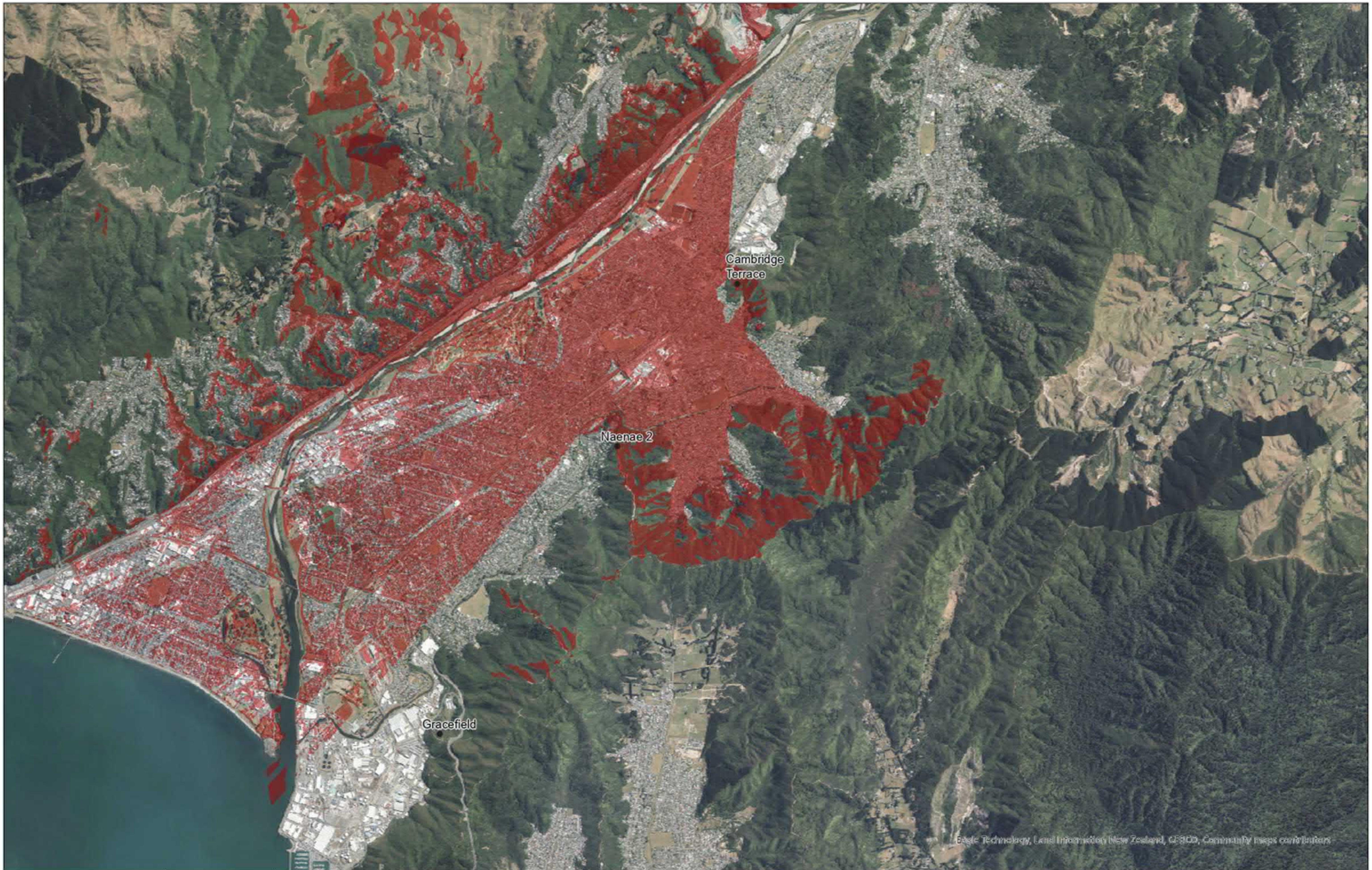
Project number:

Date:

Author:



Geospatial
Opus House, Princes Street, Hamilton 3204 | Tel +64 21 220 7841

Client:

Cambridge Terrace / Option 3
Zone of Theoretical Visibility Map

Legend:

Scale:
1:36,112 @A3

Project number: 0-XXXXX.00
Date: 00/00/2018
Author: andrew.standley@wsp.com

Appendix 2

Scale of Effects (7 Point)

From New Zealand Institute of Landscape Architects Te Tangi a te Manu – Aotearoa New Zealand Landscape Assessment Guidelines, April 2021. The definitions come from NZILA national workshop discussions prior to the publication of the guidelines and are based on the Boffa Miskell effects descriptions.

The below seven-point scale is used to describe effects:

- Very High: Total loss to the key attributes of the receiving environment and/or visual context amounting to a complete change of landscape character

- High: Major change to the characteristics or key attributes of the receiving environment and/or visual context within which it is seen; and/or a major effect on the perceived amenity derived from it.

- Moderate-High: A moderate to high level of effect on the character or key attributes of the receiving environment and/or the visual context within which it is seen; and/or have a moderate-high level of effect on the perceived amenity derived from it.

- Moderate: A moderate level of effect on the character or key attributes of the receiving environment and/or the visual context within which it is seen; and/or have a moderate level of effect on the perceived amenity derived from it. *(Oxford English Dictionary Definition: Moderate: adjective-average in amount, intensity or degree).*

- Moderate-Low: A moderate to low level of effect on the character or key attributes of the receiving environment and/or the visual context within which it is seen; and/or have a moderate to low level of effect on the perceived amenity derived from it.

- Low: A low level of effect on the character or key attributes of the receiving environment and/or the visual context within which it is seen; and/or have a low level of effect on the perceived amenity derived from it. *(Oxford English Dictionary Definition: Low: adjective-below average in amount, extent, or intensity).*

- Very Low: Very low or no modification to key elements/features/characteristics of the baseline or available views, i.e., approximating a 'no-change' situation.

Appendix E

Archaeological Assessment

Archaeology Risk Indication

Project Name - Proposed Hutt Central Reservoir Locations

Project Contact - Dougal Quayle

Project Number - 3-WW021.02/00100

Project Description and Location

This archaeological risk check has been prepared for the Proposed Hutt Central Reservoir Locations Project, Hutt Valley (the project).

This document aims to identify the risk of encountering archaeological deposits within the project area and to provide recommendations on the management of archaeological risk in line with the statutory requirements of the *Heritage New Zealand Pouhere Taonga Act2014*.

Figure 1: Broad Site Overview. Reservoir locations are outlined in red.

Disclaimer and Limitations

- This ArchCheck is only a preliminary guide to identify potential risk and is not a complete archaeological assessment.
- All archaeological sites are protected under the *HNZPTA*, whether they are recorded in ArchSite or not. It is illegal to modify or destroy an archaeological site without an Archaeological Authority from Heritage New Zealand Pouhere Taonga (HNZPT).
- This report does not present the views of local iwi regarding the significance of the area to them. Such assessments can only be made by tāngata whenua, as Māori concerns may encompass a wider range of values than those associated with archaeological sites.

- The New Zealand Archaeology Association's (NZAA) digital site record database ArchSite was the primary resource used for identifying recorded sites in the area. Archaeological site location data in ArchSite should be regarded as a guide only as it is often based on reconnaissance rather than on accurate survey information. In addition to this, the area extents for many recorded sites are poorly defined.

Project Overview

The following list of sites are those that pose the greatest Archaeological risk to the project. Each site has been individually investigated by way of desktop review of the Archology Associations database, Archsite. Select historic survey plans were also reviewed when further risk analysis was required. These sites are ranked in order from greatest, to least risk, with a brief description of the history of each site.

Gracefield reservoir

Documented Archaeological Sites

R27/725 – Pa site, Ngutu-ihe ~ within 50m

R27/231 - Tanged adze findspot. ~ within 10m

Description

The Gracefeild location poses the greatest risk of all proposed sites due to its proximity to ArchSite R27/725. This site is noted for containing the remains of Ngutu-ihe pa. It is describes as being located "above the junction of Hutt Park Road and Gracefield Road but, more exactly, on the end of a projecting spur of Puke-atua ridge and below the existing Wainui-o-mata Road." - Elsdon Best (1918, p.165-166.) Pa are highly visible sites and are often the only archaeological site recorded in an archaeological landscape that includes extensive occupation. As this recorded pa site is within the vicinity of the proposed reservoir, the likelihood of associated archaeological sites within the project area is considered high.

Archsite R27/231 supports this risk analysis as a "Adze was found, still lying on the surface and embedded less than its own thickness – found by M. Ongley, 28March 1962, on his section 400m up the hill" – G.L. Adkin' s "Ethnological Notebook Vol.55. The location of this find would put it directly under the proposed reservoir location.

Te Whiti reservoir

Documented Archaeological Sites

R27/540 – Flour Mill & Shipyard located 'at the base of the hills' ~ within 50m of access track

Description

The Te Whiti location would pose a lower archaeological risk if it weren't for the unknown nature of Archsite R27/540. This site was primarily a shipyard but as noted by Andy Dodd in 2015 "A photo held by the Turnbull Library suggests that a flour mill was probably located further back (east) closer to the foothills (ATL 1/1-025978-G)." While this would not affect the reservoir proper, the location of the access track poses a risk of uncovering the historic flour mill.

Harbour View reservoir

Documented Archaeological Sites

R27/625 – The Lochaber house & Wigwam Cottage ~ 50m below project site

Description

Archaeological site record R27/625 describes "three separate buildings within Section 1 SO 37208. Of these only one, the historic "Lochaber House" homestead which was built ca 1899-1900 remains on site. A second, 1870s building, known as "The Wigwam", had descended into a state of severe dereliction and was demolished between November and December 2018 under HNZPT Authority 2019/068" – Victoria Grouden, Archsite R27/625, 2018. While these structures will not be affected by the proposed reservoir location as it is 100m up the slope from Wigwam house and is grade separated by 40m, it does indicate wider historic use of the area. That said, due to the lack of recorded sites within the proposed project area, it is considered that the archaeological risk is low.

Taita reservoir

Documented Archaeological Sites

R27/459 – Anglican Church ~100m

Description

There is no risk posed by Archsite R27/459, which is an Anglican church built to serve the 32 European families in the district in 1854. Christ Church is one of the five first Anglican churches to have been built in the Wellington District. As the church site is easily defined, more than 300m away and grade separated by 52m the archaeological risk to this project is considered low.

Naenae 2 reservoir

Documented Archaeological Sites

R27/739 – Various mill ~150m not related to project

Description

Recorded archaeological site R27/739 is the site of the 1894 Flock mill. This mill operated from 1894 to 1939, with different iterations of processing mills onsite. This site of this mill is clearly defined from historic accounts, aerial photographs from the early 1940's and several surveys of the area. As this site has previously had a detailed site investigation (Nicholas Beynon, 15/12/2020) confidence can be sought that site location is over 500m from the proposed reservoir site. It will therefore be unaffected by the proposed project area and the archaeological risk is considered low.

Conclusions and recommendations

Below are the proposed reservoir sites and associated archaeological risks to each site. In addition to the below, it is recommended that further archaeological review of the proposed site be undertaken once further design has occurred.

Site Name	Risk of Archaeological Sites within Project Area (Low, Medium or High)	Risk assessment of archaeology to the proposed location (Low, Medium or High)	Comment
Cambridge	Low	Low	

Gracefield A	High (archaeological site likely within proposed project area).	Medium	It is likely that an Archaeological Authority would be required for this location. This would be a 'business as usual approach' but it is recommended further research is undertaken to confirm this.
Gracefield C	Low	Low	
Harbour	Low	Low	
Naenae 2	Low	Low	
Page Grove	Low	Low	
Taita	Low	Low	
Te Whiti	Medium	Medium	It may be that an Archaeological Authority would be required for this location. This would likely be a 'business as usual approach' but it is recommended further research is undertaken to confirm this.
Waddington	Low	Low	
Willcox Grove	Low	Low	
Swainson B	Low	Low	
Rata	Low	Low	
Page Grove	Low	Low	

Prepared by:

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11/10/2021

Reviewed by:

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Senior Archaeologist
18/10/2021

Appendix F

Community Impact Assessment

Temporary Impacts Scoring Criteria

Score		Description	Risks
7	**Strong positive**	This option presents no difficulties in terms of achieving the project on the basis of the criterion being evaluated. There is no disruption to recreation, traffic and access with noise and vibration.	Negligible
6	**Moderate positive**	This option presents few difficulties in terms of achieving the project on the basis of the criterion being evaluated. There is minor disruption to recreation, traffic and access, with noise and vibration having less than minor and localised effects.	Very low
5	**Slight positive**	This option includes some difficulties in terms of achieving the project on the basis of the criterion being evaluated. There may be some disruption to recreation, traffic and access, with noise and vibration having only minor and localised effects.	Low
4	**Neutral**	This option includes some difficulties in terms of achieving the project on the basis of the criterion being evaluated. There may be some disruption to recreation, traffic and access, with noise and vibration having some negative localised effects.	Moderate –tolerable
3	**Slight negative**	This option includes considerable difficulties in terms of achieving the project on the basis of the criterion being evaluated. There may be considerable disruption to recreation, traffic and access, with noise and vibration having considerable adverse effects.	High
2	**Moderate negative**	This option includes significant difficulties in terms of achieving the project on the basis of the criterion being evaluated. There may be significant disruption to recreation, traffic and access, with noise and vibration having significant adverse effects.	Very high
1	**Strong negative**	This option includes significant difficulties in terms of achieving the project on the basis of the criterion being evaluated. There may be intolerable disruption to recreation, traffic and access, with noise and vibration having significant adverse effects.	Extreme – unacceptable

Noise, Dust & Vibration Impacts Scoring

Wellington Water

SITE	NOISE/VIBRATION	SCORE
Cambridge Tce	Residential development in the vicinity of the proposed reservoir, potentially significantly impacted by noise, dust & vibration. Longer pipe route means impacts more adjacent landowners over extended duration. Less earthworks compared to other sites meaning fewer construction vehicles movements.	2
Naenae 2	Residential property immediately adjacent to reservoir site and on access road – may require acoustic barrier. Vulnerable residents at Laura Fergusson Facility nearby. High number of construction vehicle movements - vibration issues may be a nuisance with trucks moving past houses. Shorter pipe route will impact fewer adjacent landowners over a shorter duration.	2
Gracefield 2	No residential properties in the vicinity of the proposed reservoir. Vibration issues unlikely to impact local stakeholders. High number of construction vehicle movements. Longer pipe route impacts more adjacent landowners over extended duration.	3

Traffic and Access Impacts Scoring

SITE	TRAFFIC	SCORE
Cambridge Tce	Longer pipeline length results in greater disruption – wider community impact by increased and prolonged vehicle movements. Disruption to public facing business. No footpath at entrance so unlikely to impact pedestrians.	4
Naenae 2	Summit Street and Tilbury Street require full road closures and permanent parking restriction to accommodate heavy vehicle movements. Will require approximately 14,000 vehicle movements through residential areas. Bus route through Waiwhetu Road will need to be diverted. However, shortest pipeline length resulting in less disruption and pipeline length does not pass businesses.	3
Gracefield 2	Significant disruption of commuters along Wainuiomata Road due to size of temporary traffic management required. Full closure of westbound lane will be required for establishment of large plant. Wider community impacted by increased and prolonged vehicle movements as Wainuiomata Road is heavily used. Access for trucks is from westbound only due to concrete median barrier meaning construction vehicles from Lower Hutt have to travel to Wainuiomata and then back across the hill again. Conflict between truck movements and cyclists using Wainuiomata Road. Longer pipeline length results in greater disruption.	2

Recreation Impacts Scoring

SITE	RECREATION	SCORE
Cambridge Tce	No facilities affected	4
Naenae 2	Popular track traverses site, can possibly be re-routed. Potential to improve access when completed.	4
Gracefield 2	No access to mountain biking track during construction. Conflict between truck movements and cyclists using Wainuiomata Road	3

Appendix G

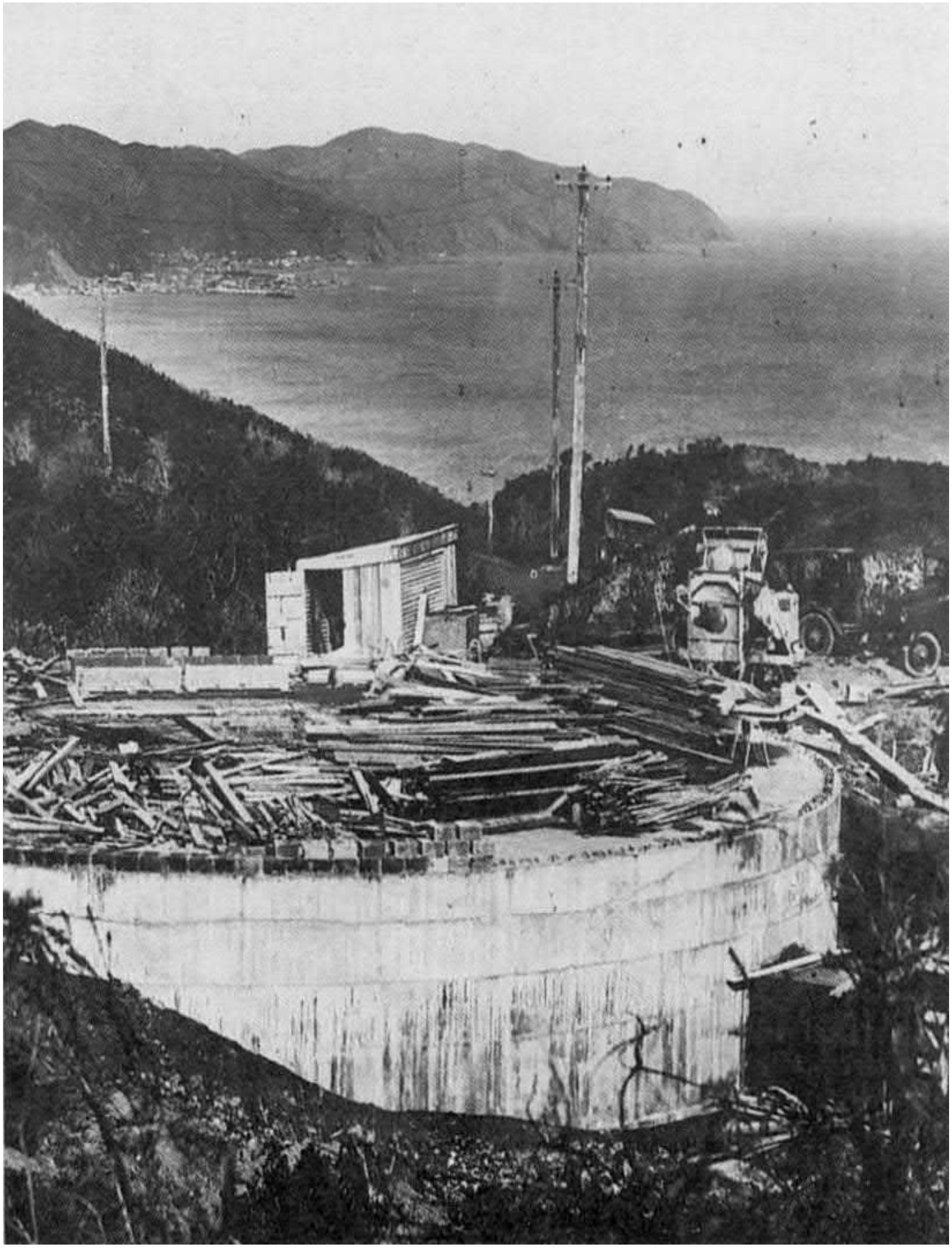
Geotechnical Assessment

Wellington Water

HUTT CENTRAL RESERVOIR SITE SELECTION

ENGINEERING GEOLOGICAL DESKTOP ASSESSMENT OF THREE PROPOSED RESERVOIR SITES

9 May 2022



Question today
Imagine tomorrow
Create for the future

HUTT CENTRAL RESERVOIR SITE SELECTION

ENGINEERING GEOLOGICAL DESKTOP ASSESSMENT OF THREE PROPOSED RESERVOIR SITES

Wellington Water

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REV	DATE	DETAILS

	NAME	DATE	SIGNATURE
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Reviewed by:	Matt Howard	23 February	MHoward
Approved by:			

3-WW021.02 / GER2022/05 9 May 2022

1 INTRODUCTION

Wellington Water has commissioned Connect Water to provide professional services associated with upgrading the potable water storage to serve the Lower Hutt and Taita area in the wider Wellington region.

A range of potentially accessible reservoir sites were previously identified by Connect Water, some of which were not considered further due to site complexity and associated construction challenges. Three of the potential sites and their associated pipeline routes have been selected for a more detailed analysis prior to identification of a preferred site option by Wellington Water. These are referred to as Naenae 2, Gracefield 2, and Cambridge Terrace (see Figure 1 for site locations). The proposed design for each reservoir site is provided in Appendix A.

WSP Limited (WSP) has been engaged by Connect Water to undertake a geotechnical appraisal of the three potential reservoir sites and to advise on design and development considerations. The scope of this report is as follows:

- Complete site reconnaissance and a desktop study to confirm and describe the geology in the vicinity of each site and associated pipeline route.
- Identify considerations for geotechnical design and construction specific to each site.

Presented in this report is data from publicly available sources including Land Information NZ (LINZ), Geological and Nuclear Sciences NZ, Greater Wellington Regional Council Webmap viewer, NZ Society for Earthquake Engineering, and Retrolens NZ. No subsurface investigations were undertaken.

This report presents the results of the desktop study and site reconnaissance, and a preliminary appraisal of expected geotechnical conditions at the three shortlisted sites. Our findings are summarised in Table 1.

2 DESCRIPTION OF RESERVOIRS, PIPES AND CUT PLATFORM

We understand the reservoir will comprise an above ground, circular concrete structure with an external diameter of 55.2 m, an overall height of 8.35 m and a storage capacity of 15 ML. The associated 750mm diameter, concrete lined steel pipeline will run mostly underground (approximately 2 m below ground surface). The structure is considered an Importance Level 4 structure according to AS/NZS 1170.0.

The excavation for each of the potential reservoir sites will be a flat pad upon which the reservoir will be located (see Appendix A for a plan of each site with the proposed reservoir). Natural ground surrounding the pad will be cut to nominally 1H:1V (45°). Under this configuration the vertical height of cut slopes could be up to 16 m on the upslope side.

The distance between the proposed cut toe and the outside edge of the reservoir is 5 m and is used as a buffer for slope stability.

We understand that Wellington Water requires access to the reservoir to be serviceable at all times, including following a large earthquake or storm event.

3 REGIONAL GEOLOGY AND SEISMICITY

3.1 GEOLOGICAL SETTING

The proposed reservoir sites are on the foot of the eastern hills overlooking the Lower Hutt Basin. The proposed pipeline routes run along the eastern edge of the Lower Hutt Basin.

Wellington Belt geology (part of the Torlesse Complex) underlies the entire Wellington region west of the Rimutaka range (see Figure 2). In places they are overlain by younger alluvial terrace and floodplain sediments of mainly Quaternary age (2.6 million years old) that comprise poorly to well sorted gravel, with the addition of gravel, sand, and beach deposits to the south near Petone. The Wellington Belt mostly comprises Greywacke (sandstone and siltstone) and are pervasively faulted, jointed, and veined. The weathering of the Wellington Belt rocks is highly variable, with the more extremely weathered rocks present inland, particularly where the land surface is flat or gently sloping (Begg & Johnston, 1996). Existing geological mapping indicates all three reservoir sites are underlain by Greywacke.

The Lower Hutt Basin has developed along the active Wellington Fault, and it is deepest on its northwest side, where the Quaternary sequence butts against the Wellington Fault (Begg & Johnston, 2000). Towards the north and east the sequence thins. The maximum drilled thickness of sediments filling the Lower Hutt Basin is 299 m at Petone. Existing geological mapping indicates the proposed pipeline routes are underlain by alluvial terrace, alluvial floodplain, and beach deposits (see Figure 2).

3.2 SEISMICITY OF THE INVESTIGATION SITES

The GNS Active Faults Database (https://data.gns.cri.nz/af) indicates that the Wellington Fault is the only active fault in the immediate area. The Cambridge Terrace, Naenae 2 and Gracefield 2 sites are approximately 1.5 km, 2 km, and 3.5 km respectively from the Wellington Fault.

The 1:50,000 geological mapping by Begg & Johnston (1996) identified other faults close to Naenae 2 and Cambridge Terrace reservoir sites however, these faults are classed as inactive (see Figure 2).

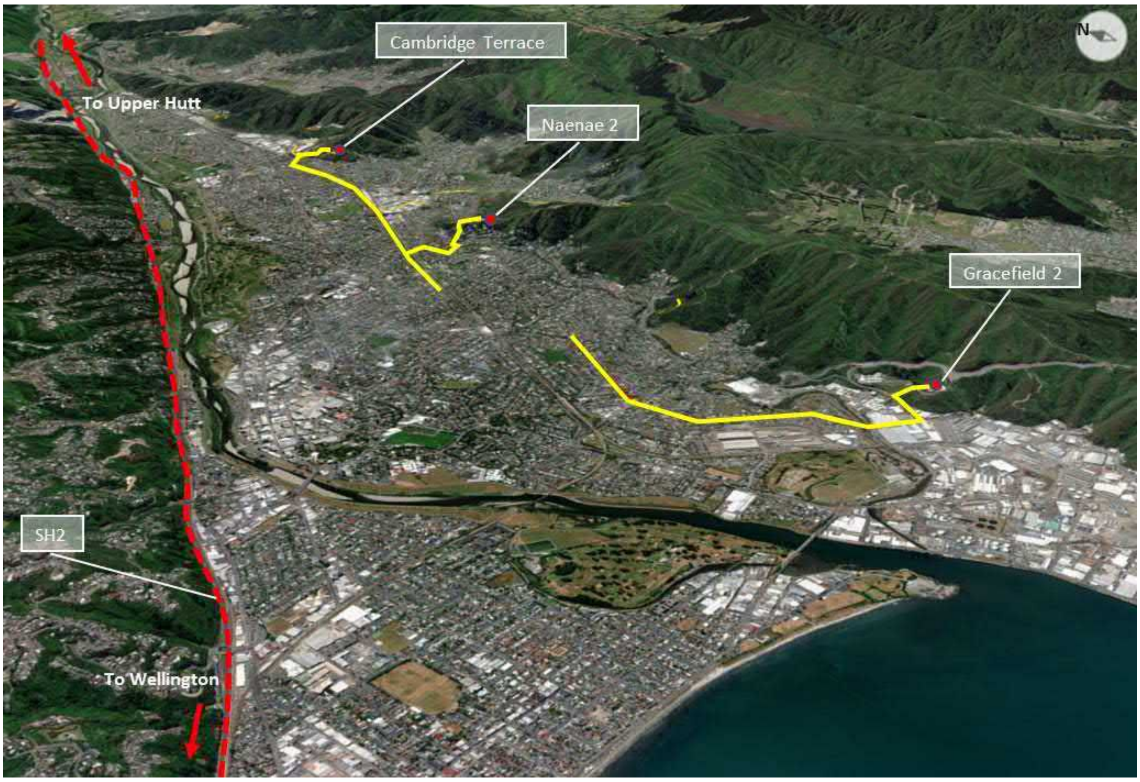

Figure 1 - Site location figure showing the three proposed reservoir sites and associated pipeline routes (yellow lines).

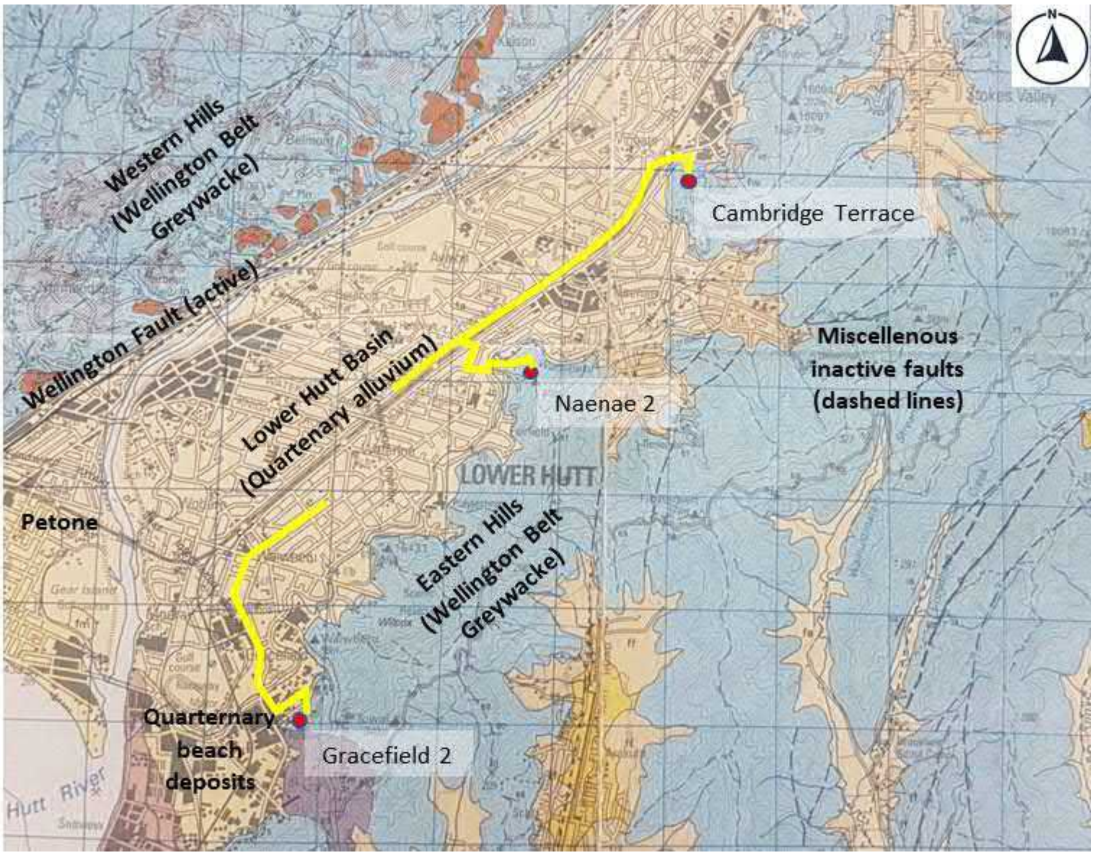

Figure 2 – Extract of 1:50,000 geological map of Wellington (Begg & Mazengarb, 1996). Red dots mark the proposed reservoir sites. Yellow line is approximate pipeline route. Gridline intervals are 1 km.

4 INVESTIGATIONS

A desktop appraisal has been undertaken to review existing information about the proposed sites. Information sources that have been reviewed include:

- Publicly available aerial imagery (1939 to 2021) from Retrolens NZ and LINZ.
- Publicly available surface geotechnical information (LiDAR) from LINZ.
- Subsurface information in the area (including WSP's in-house reports database and the New Zealand Geotechnical Database), and published literature/maps on the engineering and geological properties of the area.

No records were located of subsurface investigations close to the proposed reservoir sites.

A site reconnaissance walkover was undertaken at each of the three proposed reservoir sites by a WSP engineering geologist on 20th January 2022 to support the desktop appraisal of geological and geotechnical site suitability. Field photos are presented for each site in Appendix B.

5 ENGINEERING GEOLOGY OF PROPOSED RESERVOIR SITES

5.1 NAENAE 2

5.1.1 SITE DESCRIPTION

The site location and proposed development are illustrated in Figure 3 and Appendix A. Naenae 2 is positioned on a small, localised hill that sits upon a densely vegetated north-south trending ridgeline. Directly downslope to the north is the existing reservoir that is located on a platform cut into bedrock.

Access to the site is from the upper end of Summit Road with the upper part being on a steeply inclined unsealed track that narrows into a firebreak. The track currently provides vehicular access to the existing reservoir.

5.1.2 SITE GEOLOGY

The following observations were made from our field inspection (see Appendix B for site photographs):

- Rock cuts observed at the access track entrance are subvertical, approximately 3 m high exposing highly weathered, weak to moderately strong Greywacke.
- The rock mass is highly fractured and dilated.
- Small defect-controlled failures have occurred with gaps in the slope suggesting rock volumes up to 2 m^3 in maximum dimension has fallen from the slope due to wedge failure. No major shear structures were observed, with joints and bedding comprising the observable defect types.
- Soil cover is less than 1 m thick.
- We expect the condition of the rock mass will improve (i.e. become less weathered) with depth.

5.1.3 GROUNDWATER AND SURFACE WATER

No groundwater or seepages were observed. Surficial (natural) and dry drainage channels were observed downslope to the west (see Figure 3). These are expected to flow only following rainfall.

5.1.4 HISTORICAL AERIAL IMAGERY AND LIDAR INTERPRETATION

Historic aerial imagery between 1939 and 2021 was viewed and no mass movement was identified. The site has been covered in vegetation since 1954. Distinct concave gully features were observed in historical imagery and LiDAR directly downslope of the site, but no evidence was observed that these have been unstable in the last approximately 70 years (Appendix C).

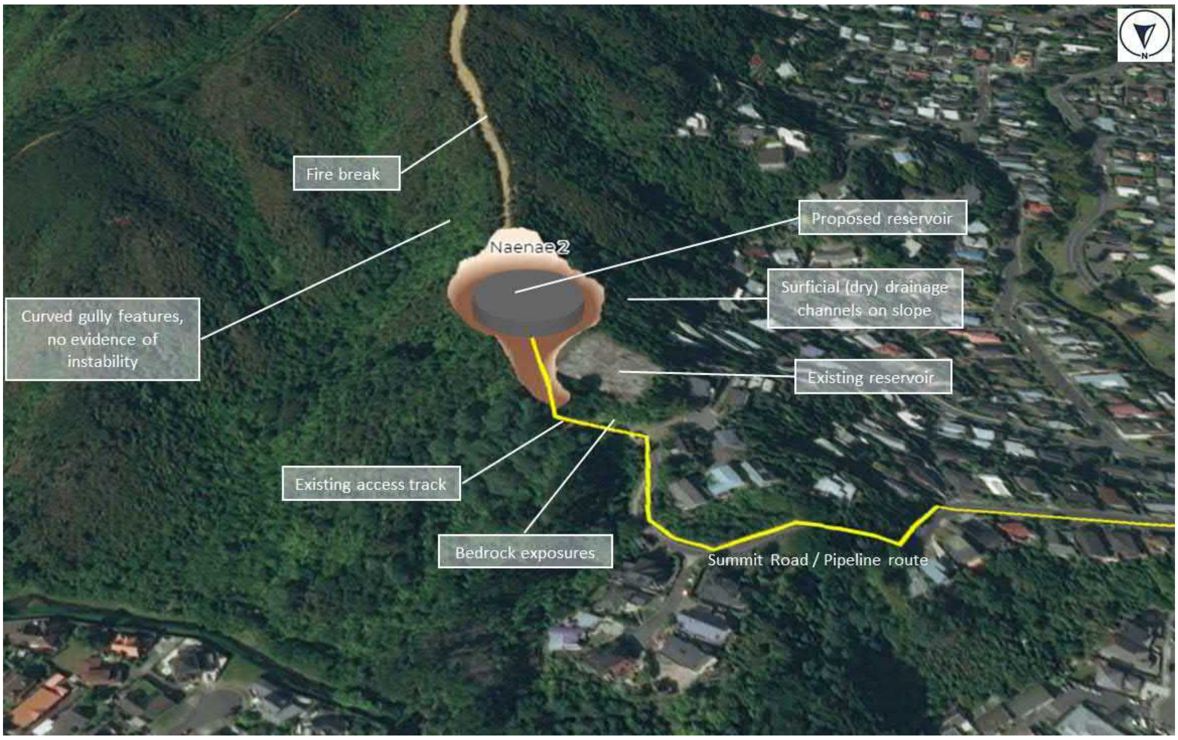

Figure 3 – Naenae 2 site location and proposed development.

5.2 CAMBRIDGE TERRACE

5.2.1 SITE DESCRIPTION

The proposed site is positioned on a densely vegetated, approximately level, broad ridge (see Figure 4 and Appendix A). No reservoir currently exists on the site.

The proposed site is accessed through private land and could not be inspected. The site is undeveloped and does not have an existing accessway. Planned access is on a gently sloping road from Pick-a-Part Lane to the north. It will comprise of cut slopes and fill embankments.

5.2.2 SITE GEOLOGY

The following observations were made from our field inspection (see Appendix B for site photographs):

– The closest observed rock exposure to the site is approximately 300 m away to the southwest near Taita Cemetery. Slopes are artificially cut at approximately 75°, about 2 m high and expose completely weathered (rock decomposed to soil, rock fabric visible), very weak to weak Greywacke rock.

- No defect orientations were measured due to the extent of weathering. However, the Greywacke rock remains blocky and closely jointed.
- Soil cover is less than 1 m thick.

5.2.3 GROUNDWATER AND SURFACE WATER

A stream flows down a gully to the southeast of the site. At the foot of the slopes on the eastern edge of the cemetery waterlogged ground and wet areas were observed, possibly indicating shallow groundwater at the toe of the slope.

5.2.4 HISTORICAL AERIAL IMAGERY AND LIDAR INTERPRETATION

Historic aerial imagery between 1939 and 2021 was viewed and shows that slope instability occurred approximately 250 m northeast of the site. The location of the instability has since been excavated for industrial premises. No other slope instability was identified on historical imagery or LiDAR (Appendix C).

Figure 4 – Cambridge Terrace site location and proposed development.

5.3 GRACEFIELD 2

5.3.1 SITE DESCRIPTION

The proposed Gracefield 2 site is positioned on the side of a vegetated northwest to southeast-trending ridgeline and is located near the top of a gully (see Figure 5 for location, see Appendix A for proposed development). An existing concrete reservoir is located downslope and to the north. It is located on a platform cut into bedrock.

Access to the site is from Wainuiomata Road (northbound lane) and along a gently declining and winding existing gravel track that provides access to the existing reservoir. The access track has small cut slopes along most of its length.

5.3.2 SITE GEOLOGY

The following observations were made from our field inspection (see Appendix B for photographs):

- Cut slopes observed around the existing reservoir slope at approximately 65° and are up to 8 m high. The material exposed in these cuts comprised highly weathered, weak to moderately strong, closely fractured, dilated Greywacke rock. A localised exposure of moderately weathered rock was observed at the foot of the 8 m high cut behind the existing reservoir.
- Cut slopes along the existing accessway are subvertical and up to 2 m high. The material exposed in these cuts comprises highly weathered, closely fractured, dilated, Greywacke rock.
- Wedge failures of rock up to 4 m^3 were observed in the cut slope behind the existing reservoir that was due to widely spaced, intersecting defect sets.
- No major shears were observed, with joints and bedding comprising the dominant defect types.
- Soil cover is less than 1 m thick.

5.3.3 GROUNDWATER AND SURFACE WATER

No groundwater or seepages were observed. Surficial (natural) and dry drainage channels were observed downslope to the northeast. These are expected to flow only following rainfall.

5.3.4 HISTORICAL AERIAL IMAGERY AND LIDAR INTERPRETATION

Historic aerial imagery between 1939 and 2021 was viewed (Appendix C). In the 1940s, slope instability up to 100 m high and 150 m wide occurred at the toe of steep slopes approximately 250 m to the west of the site. It is possible the instability was associated with excavation or quarrying activities. This location has since been re-profiled and is now partially vegetated and used by industrial premises.

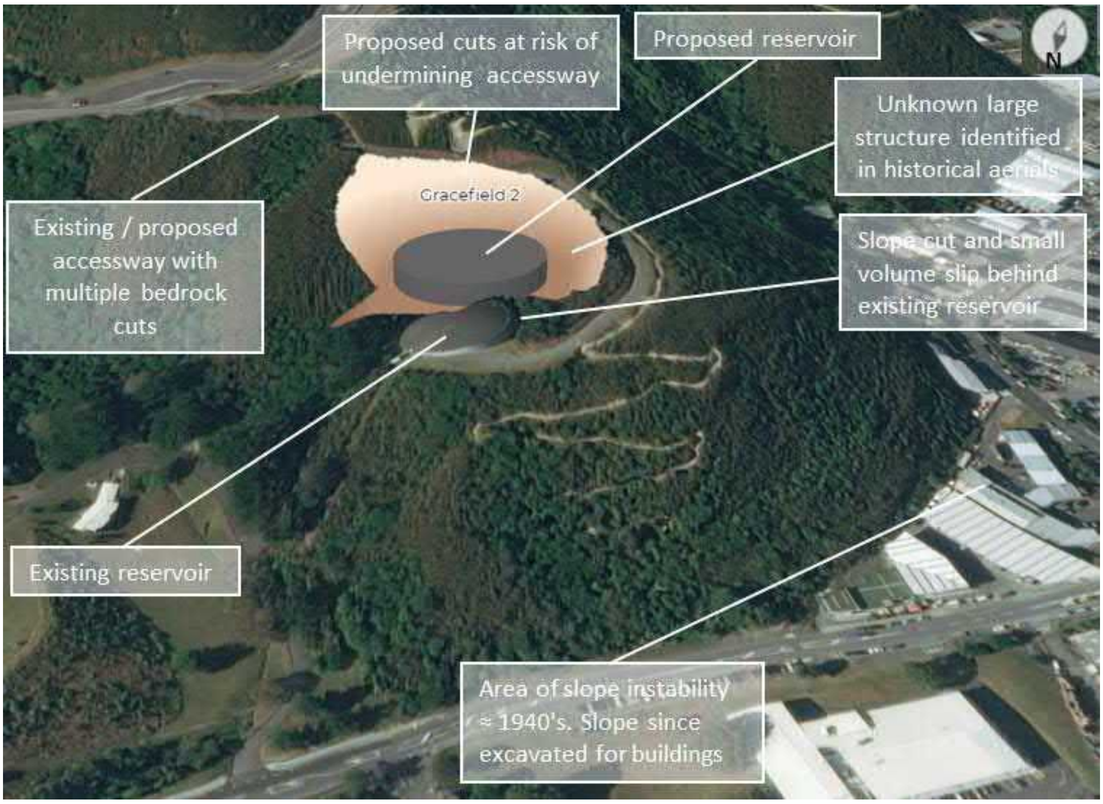

Figure 5 – Gracefield 2 site location and proposed development.

6 PIPELINE ROUTE

6.1 ROUTE DESCRIPTION

Each of the proposed reservoirs requires a new pipeline to be constructed that connects the reservoir to the existing network. For all three proposed sites, the pipeline exits the reservoir and initially traverses Greywacke hill slopes with nominally 1 m of soil cover (as described in Section 5), before mostly traversing alluvial sediments of the relatively flat Lower Hutt Basin. The following above-ground pipeline stream crossings are proposed:

- Cambridge Terrace - Waiwhetu Stream
- Gracefield 2 – Waiwhetu Stream

No crossings are proposed for the Naenae 2 site pipeline. The proposed pipeline routes for all three sites are located on land that has been modified by residential and industrial development.

6.2 ROUTE GEOLOGY

No subsurface materials were observed on the proposed pipeline alignments. Geological literature on the Lower Hutt Basin shows:

- There is a general increase in total sediment thickness and thickness of near-surface soft sediment down valley towards the southwest (Figure 2).
- Much of the sediment in the Lower Hutt Basin is composed of fine to coarse alluvial gravel interfingered with weaker layers of sand and silt. The total thickness of sediment increases

from approximately 10 m to 20 m near Cambridge Terrace to approximately 300 m at Petone.

Van Dissen *et al.* (1992) categorised sediments of the Lower Hutt Basin into different zones (see Figure 6). Based on this, pipeline routes are interpreted to be situated within:

- For Cambridge Terrace and Naenae 2 pipeline – alluvial gravel and fan alluvium (Zone 2), comprising compact fine to coarse gravel interfingered with beds and lenses of finer grained sediment (sand, silt, clay, and peat) usually less than 5 m thick. The coarse sediment typically has moderate to high SPT values (N = 20 - >50).
- Gracefield 2 pipeline – soft sediment (Zone 3 and 4), comprising fine-grained sediment (fine sand, silt, clay, and peat) within the top 20 m or so of alluvial gravel, underlain by alluvial gravel and finer grained sediment. The near surface fine grained sediment typically has low SPT values (N = <20), whereas the coarser consolidated sediments generally have moderate to high SPT values (N = 20 - >50).

6.3 GROUNDWATER AND SURFACE WATER

Water bore information from Greater Wellington Regional Council (Figure 7) indicates the likely groundwater level range for each pipeline route is:

- Gracefield 2: 1.5 m to 2.5 m below ground level.
- Naenae 2: 2.5 m to 7.5 m below ground level.
- Cambridge Terrace: 7.5 to 9 m below ground level.

6.4 HISTORICAL AERIAL IMAGERY AND LIDAR INTERPRETATION

Historic aerial imagery between 1939 and 2021 was viewed and shows that historical stream paths intersect the proposed pipeline alignments (Appendix C). While urban development has removed any surficial evidence of their location, their existence emphasises the likelihood of finding localised deposits of soft sediment along the pipeline routes.

Figure 6 – Sediment zones of Lower Hutt basin (adapted from Van Dissen et al. (1992)). Three proposed reservoirs and associated pipeline routes overlain.

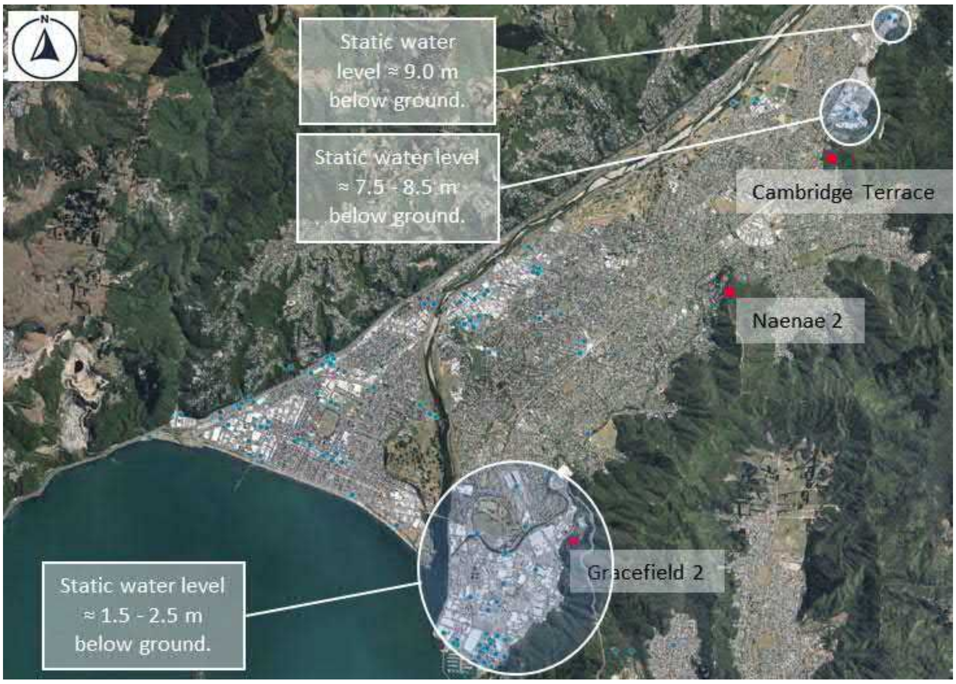

Figure 7 – Water well levels, Lower Hutt Basin. Data sourced from Greater Wellington WebMap Viewer – consents/environmental monitoring (https://mapping.gw.govt.nz/gwrc/).

7 DESIGN AND CONSTRUCTION CONSIDERATIONS

7.1 PROPOSED RESERVOIR SITES

The following are some considerations for the three proposed reservoirs:

- Slope geometry – the proposed design cut slope geometry of 1H:1V is expected to be a generally stable configuration. A steeper, stable configuration may be possible to achieve in favourable ground.
- Slope failure (rock) – is expected to be in the form of localised wedge failures where widely spaced defects intersect. Based on observations at the sites, these may be up to 4 m^3, but could be larger. It is expected that potentially unstable wedges could be supported by a combination of rock bolts, mesh, and shotcrete.
- Slope failure (soil) – the soil overlying rock is expected to be approximately 1 m thick and may be eroded by surface water flows. Soil may need to be cut flatter than 1H:1V.
- Fill embankments – material cut from the slopes around the reservoir will probably be suitable for use as fill. Design fill embankments (i.e. Cambridge Terrace site) will need to be benched-in for stability, incorporate geogrid reinforcement and underdrainage.

A geotechnical investigation should be undertaken to inform the detailed design of the selected reservoir option. This may include a borehole drilling and test pitting programme. Design assumptions can be confirmed at the construction stage by detailed mapping of geology and structural defect interpretation of exposed soil and rock.

7.2 PROPOSED PIPELINE ROUTES

The following are some considerations for the three pipeline routes:

- Liquefaction – the main hazard associated with the resilience of all three proposed pipeline routes is the presence of saturated, unconsolidated alluvial sediments under or around the pipeline. During times of ground shaking during earthquakes, these sediments can liquefy causing loss of ground support resulting in rupture and/or floatation of the pipeline.
- Localised lateral spreading – this may occur near 'free-faces', i.e. at Waiwhetu Stream (Naenae 2 and Gracefield 2 sites), leading to pipe damage.
- Shallow groundwater - the shallow groundwater within the alluvial sediments may require dewatering where a pipeline is proposed within saturated ground, leading to increased costs.
- Excavation – of trenches for pipelines is expected to be within easily excavatable alluvial materials on the alluvial valley floor. Temporary support may be required to prevent excavation collapse. On the steeper slopes near to the reservoir, shallow soils (approximately 1 m thick) are expected, and rock breaking may be required to form a suitable trench.

A geotechnical investigation should be undertaken to inform the detailed design of the selected pipeline alignment. This may include Cone Penetrometer tests (CPT) and a test pitting programme. Design assumptions can be confirmed during construction by observing the excavated trenches prior to the laying of the pipes.

7.3 SITE SUBSOIL CLASS FOR PROPOSED RESERVOIRS AND PIPELINES

All three reservoir sites are located on ridgelines that have thin surficial deposits of residual soil and loess (wind-blown silt), overlying variably weathered rock with compressive strengths expected to be between 1 and 50 MPa. We interpret all three sites to be categorised as Subsoil Class B.

The pipeline routes are expected to be located within Subsoil Class D where they are in alluvial deposits (i.e. for most of the proposed length of pipeline).

8 CONCLUSIONS AND RECOMMENDATIONS

We conclude the following:

- All three reservoir sites and pipeline routes appear to be appropriate for the proposed reservoir conceptual design and any identified geotechnical issues can be mitigated as part of the detailed design.
- There may be instability of cut slopes in rock, including wedge failures and isolated loose blocks where defects intersect. In the proposed design configuration these are likely to be less than 4 m^3 and can be mitigated by localised slope support (e.g. with rock bolting, mesh, and shotcrete). Soil failure along the upper 1 m of the cut slope is possible, which may require adoption of a flatter profile.
- Historical slope instability has not been identified at any of the three reservoir sites, however, slope failures have previously occurred nearby in similar steep terrain. It is possible that during heavy rainfall or an earthquake, nearby slope instability may impact a reservoir excavation, for example from a landslip entering the excavation.
- Geotechnical issues associated with the pipeline route will relate to elevated groundwater, and the distribution and thickness of soft sediments.

We recommend the following:

- That a subsurface geotechnical investigation be undertaken to inform the detailed design of the selected option(s). The specification of the investigations should occur when the final option(s) has been selected and may include:
    - Geotechnically logged boreholes at each reservoir site to 8 m below the proposed foundation level.

Cone Penetrometer tests (CPT) and a geotechnically logged test pitting programme, with hand auger and scala penetrometer testing, at selected locations along the pipeline alignment.

9 SUMMARY

Table 1 – Summary of geotechnical information for three shortlisted reservoir sites and associated pipeline routes.

Reservoir Site	Likely ground conditions	Potential hazards	Access resilience	Geotechnical site investigation access
Naenae 2	— Limited rock exposures onsite. — No groundwater observed.	— Evidence of cut slope wedge instability, volumes likely < $4m^3$. — Lateral spread risk where pipeline crosses Waiwhetu Stream.	— No fills embankments. — Access steeply sloping.	— Access directly to site currently exists, suitable in drier months.
Cambridge	— Very limited rock exposures onsite. — Deeper (highly weathered) weathering profile compared to other sites. — Potentially shallow groundwater.	— Increased thickness of soil cover (deeper weathering profile). — Historical land instability on nearby slopes.	— High cuts and fills along accessway. — Under slips and over slips in severe storm or earthquake. — Level accessway.	— No access tracks — Possible helicopter mobilisation.
Gracefield 2	— Rock exposures across site. — Moderately weathered rock observed. — No groundwater observed.	— Evidence of cut slope wedge instability, volumes likely < $4m^3$. — Historical slope instability nearby. — Lateral spread risk where pipeline crosses Waiwhetu Stream. — Pipeline route traverses increased thicknesses of soft sediment compared to other two sites (i.e. Figure 6).	— No fills embankments. — Access gently sloping. — Access close to top of cut slope, risks undermining.	— Partial access exists. — Further tracks need to be created or cleared.
Pipeline	— Alluvial deposits (consolidated gravels, lenses of soft sediments < 5m thick). — Shallow groundwater across all routes.	— Dewatering during construction. — Liquefaction/settlement on soft saturated sediments. — Lateral spread risk at 'free faces' i.e. Waiwhetu Stream.	— Flat access	— Accessible for most of the pipeline route. — Flat access suitable for all seasons.

10 REFERENCES

- Begg, J. G., & Mazengarb, C. (1996). Geology of the Wellington area, scale 1:50 000. Institute of Geological & Nuclear Sciences geological map 22. Lower Hutt, New Zealand: Institute of Geological & Nuclear Sciences.
- Begg, J. G., & Johnston, M. R. (2000). Geology of the Wellington area, scale 1:250 000. Institute of Geological & Nuclear Sciences geological map 10. Lower Hutt, New Zealand: Institute of Geological & Nuclear Sciences.
- Van Dissen, J. R., Taber, J. J., Stephenson, W. R., Sritheran, S., Read, S. A. L., McVerry, G. H., Dellow, G. D., & Barker, P. R. (1992). Earthquake ground shaking hazard assessment for the Lower Hutt and Porirua areas, New Zealand. Bulletin of the New Zealand National Society for Earthquake Engineering, Pp 286 – 302, Vol. 25, No. 4, December 1992.

APPENDIX A – PROPOSED DEVELOPMENT (ALL SITES)

NAENAE 2

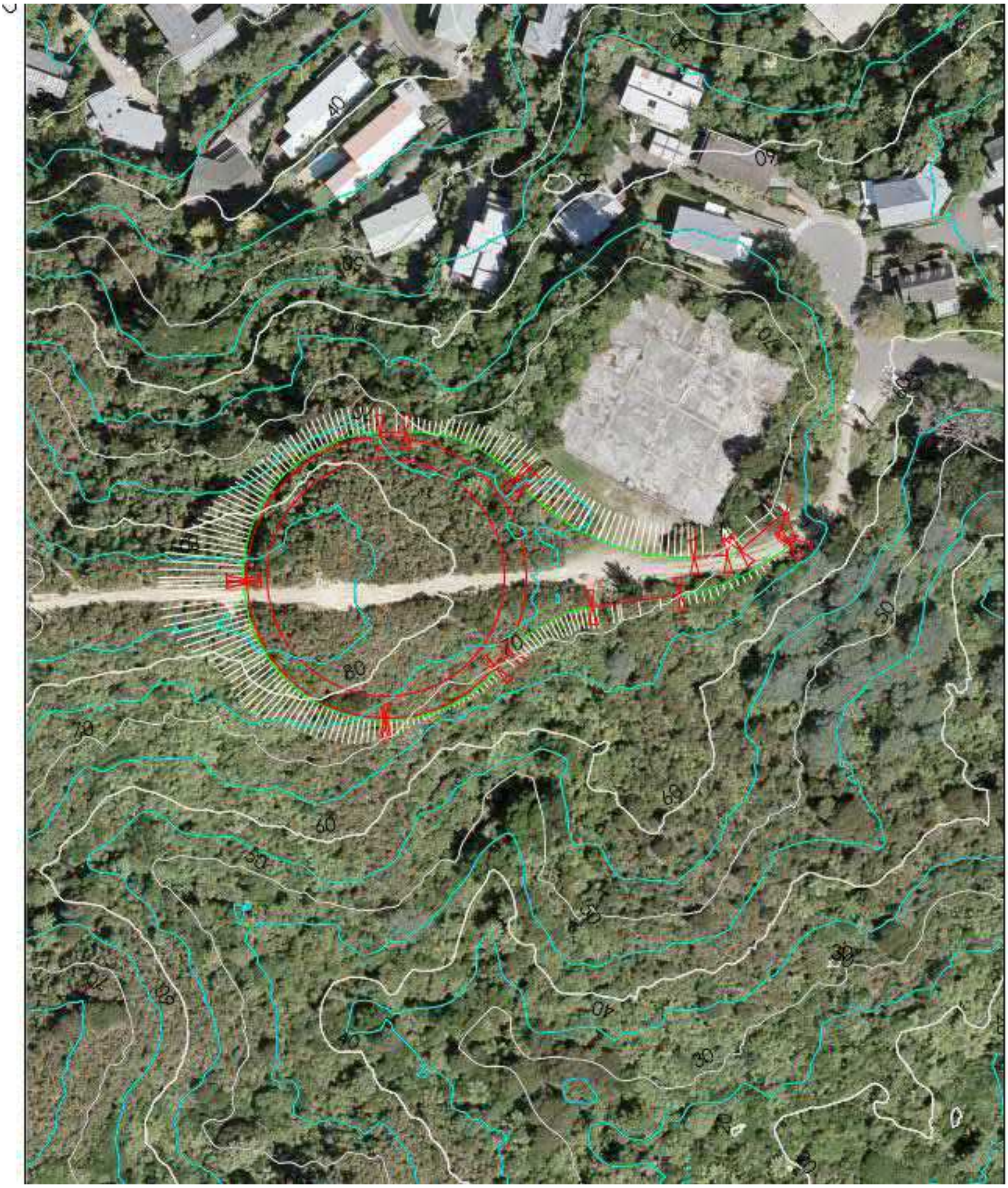

Figure A1 – Naenae2 proposed development

CAMBRIDGE TERRACE

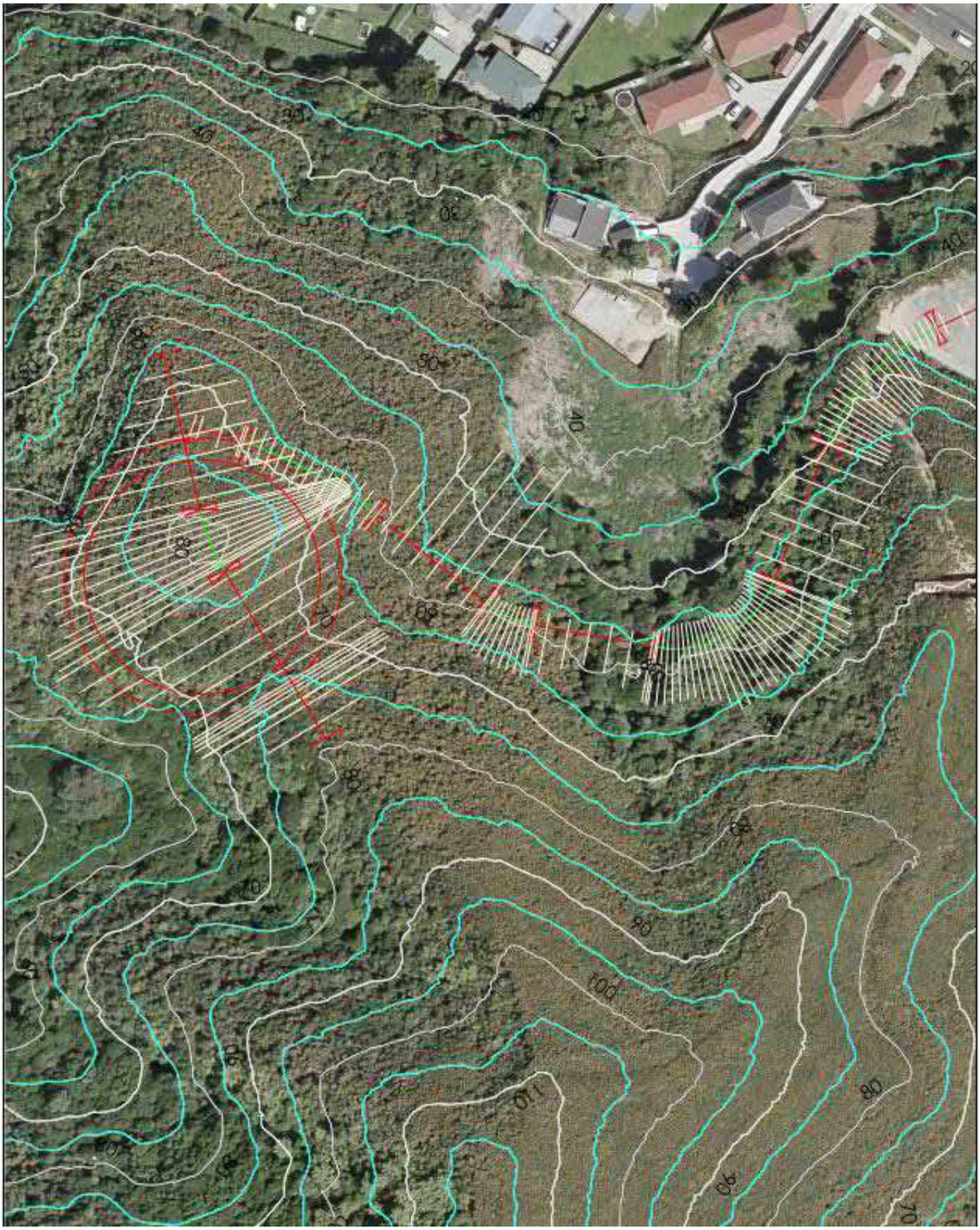

Figure A2 – Cambridge Terrace proposed development

GRACEFIELD 2

Figure A3 – Cambridge Terrace proposed development

APPENDIX B – SITE PHOTOS (ALL SITES)

NAENAE 2

Figure B1 – Naenae 2 site photos: approximately 2m high slope cut adjacent to access track 100m from proposed reservoir site. Exposing highly weathered, highly fractured greywacke rock.

CAMBRIDGE TERRACE

Figure B2 – Cambridge Terrace site photos: approximately 2m high cut slopes around the perimeter of the Taita cemetery 300m from the proposed reservoir site. Exposing completely weathered, greywacke rock.

GRACEFIELD 2

Figure B3 – Gracefield 2 site photos: approximately 2m high cut slope along the access track (top and middle photo) and 8m high cut slope around the perimeter of the existing reservoir (lower photo). Exposing highly weathered, greywacke rock.

APPENDIX C – HISTORICAL AERIAL IMAGERY (ALL SITES)

NAENAE 2

Figure C1- Historic aerial imagery of Naenae 2 site from 1954.

Figure C2 - Historic aerial imagery of Naenae 2 site from 1966.

Figure C3 - Historic aerial imagery of Naenae 2 site from 1995.

CAMBRIDGE TERRACE

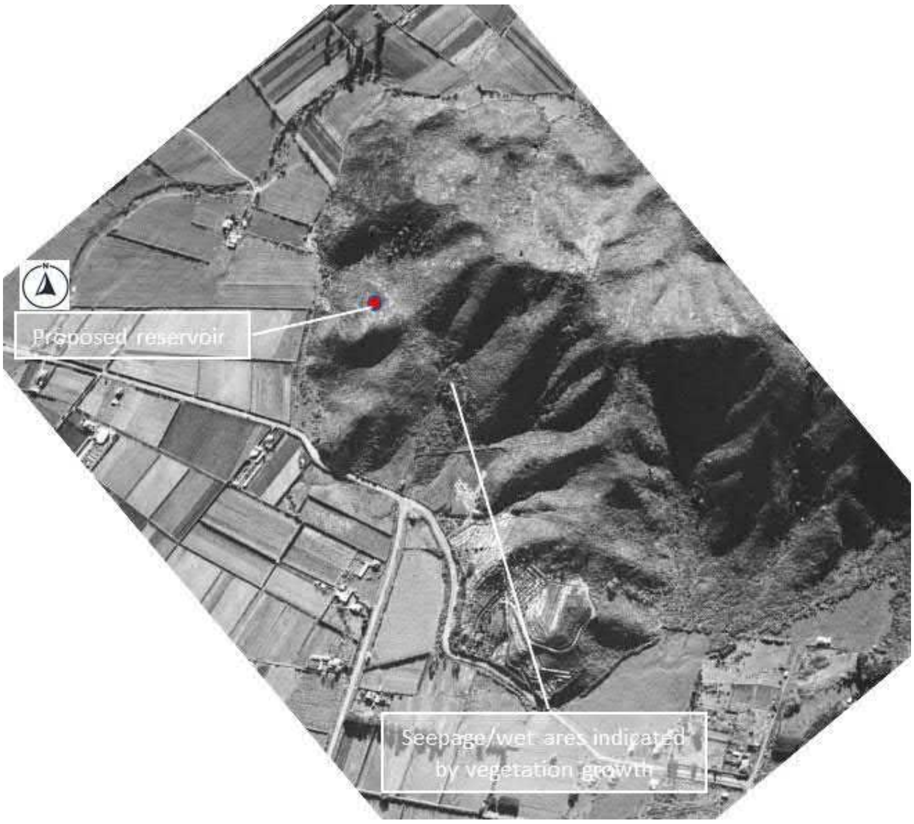

Figure C4 – Historic aerial imagery of Cambridge Terrace site from 1939.

Figure C5 – Historic aerial imagery of Cambridge Terrace site from 1969.

Figure C6 – Historic aerial imagery of Cambridge Terrace site from 1995.

GRACEFIELD 2

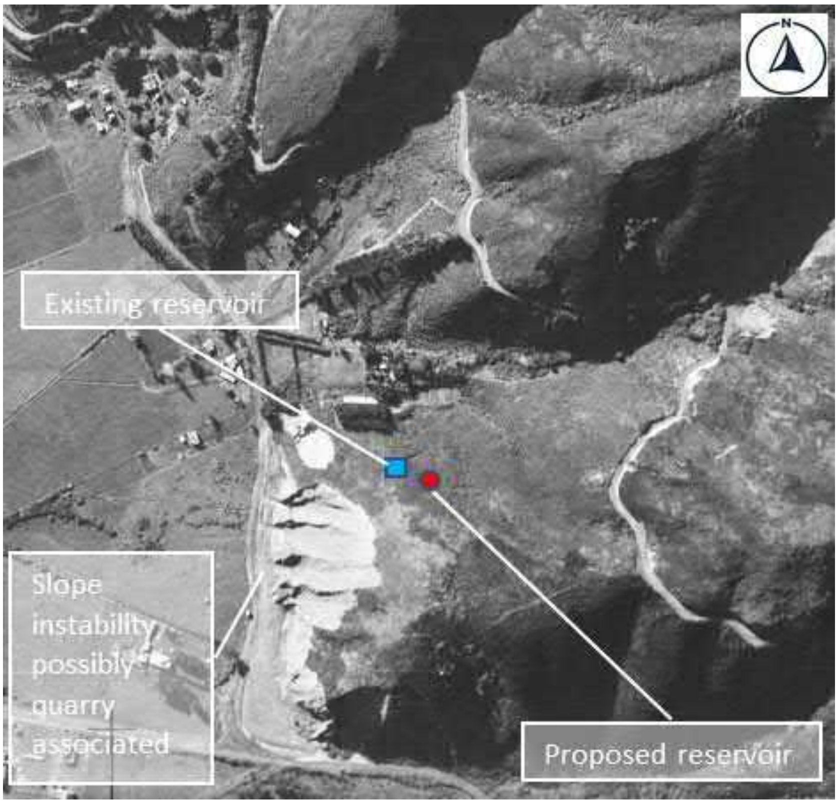

Figure C7 – Historic aerial imagery of Gracefield 2 site from 1939.

Figure C8 – Historic aerial imagery of Gracefield 2 site from 1986.

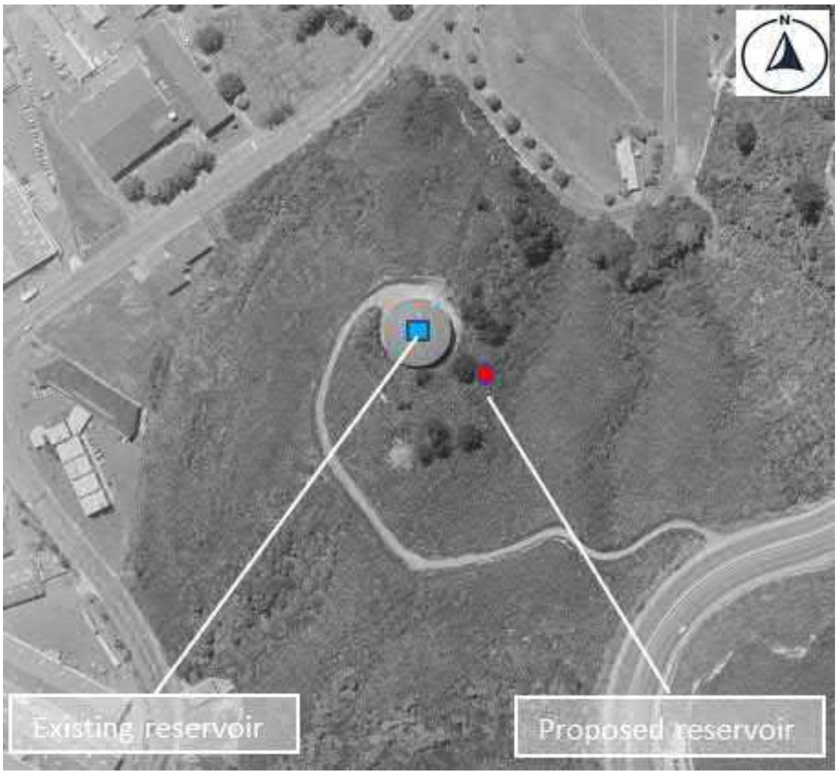

Figure C9 - Historic aerial imagery of Gracefield 2 site from 1995.

PIPELINE ROUTE

Figure C10 – Aerial image from 1939 showing evidence of historical stream paths which have likely deposited soft sediments. Cambridge Terrace and Naenae 2 sites shown for reference.

Appendix H

Not used

Appendix I

Constructability Assessment

February
2022

KIDD CIVIL CONSULTING

Lower Hutt Central Reservoir

STAGE 1 – CONSTRUCTABILITY REVIEW
Revision 1

Document Control

Contact Information

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Revision History

Date	Version Number	Change Details
11/02/2022	1	Issued

Document Approval

Date	Version Number	Title	Name	Signature
11/2/2022	1	ECI Report	David Kidd	DKidd

Executive Summary

Kidd Civil Consulting was engaged by WSP New Zealand Ltd (WSP) to provide a constructability review for the Lower Hutt Central Reservoir site selection project, identifying a preferred site from the three shortlisted below.

- Naenae 2
- Gracefield 2
- Cambridge Terrace

The assessment focused on:

- High-level construction methodology for reservoir and inlet/outlet pipelines.
- Temporary construction impacts on stakeholders.
- Buildability of current geometry and recommendations to improve constructability for each site.
- Identification of significant construction risks.

After carrying out a site visit and desktop study, the sites were ranked in order of constructability as below using the options assessment matrix in Appendix A:

1. Naenae 2
2. Cambridge Terrace
3. Gracefield 2

The Naenae 2 site was considered the best location. It has existing site access, which is safer for construction staff on local access roads and can facilitate the proposed precast construction method.

The pipework required for this site is significantly shorter than the other locations, which should provide cost benefits to the client and less disruption to the residents due to the short construction time frame required.

The detractors for this site were similar to the other two sites investigated, with it requiring large volumes of earthworks in rock to create a building platform for the reservoir and long-haul times to dispose of spoil at consented sites.

Like the Cambridge Tce and the Gracefield site, it requires pipes to be constructed in the road alignment and under KiwiRail property. Due to the traffic management needed to build both the reservoir and pipelines, it will adversely affect residents.

The following construction considerations were identified with the Naenae 2 site:

- Cut to fill opportunities on-site and the consenting of a nearby clean fill site should be considered early in the project life cycle to reduce cost and reduce stakeholder impact.
- Significant heavy vehicle movements are required (approximately 14,000) through residential areas.
- The current 20m offset may not allow sufficient space between the existing reservoir and the new proposed reservoir for future refurbishment of the existing reservoir.
- There appears to be a lack of laydown/storage area on-site based on the current earthworks model.
- Risk of overland flows and construction runoff leaving site footprint will need further investigation.
- Further ECI should be carried out once the concept design develops to ensure that the design and the construction sequencing are achievable due to the limited crane size that can access the site.
- The residents will be significantly impacted due to the traffic management requirements during the project.
- PE pipe should be considered when the pipe is to be laid in a road alignment with many changes of direction and possible service clashes to de-risk this construction element.
- Trenchless methods would be preferred to install the pipe under KiwiRail infrastructure.

All three sites proposed will present significant construction challenges. However, based on the findings of this report, the Naenae 2 Site is considered the best site from a constructability aspect.

Contents

1 Introduction

Kidd Civil Consulting has been engaged by WSP New Zealand Ltd (WSP) to provide a constructability review for the Lower Hutt Central Reservoir site selection project.

The purpose of this report is to present constructability considerations related to the proposed reservoir and associated pipelines, to inform multi-criteria analysis and identify a preferred site from the three shortlisted sites provided by WSP.

The three shortlisted sites are listed below and shown in Figure 1:

- Naenae 2
- Gracefield 2
- Cambridge Terrace

The sites were assessed from a desktop study and from a site visit carried out on the 20th of January 2022. The Cambridge Terrace site was not able to be visited as it required access to privately owned land.

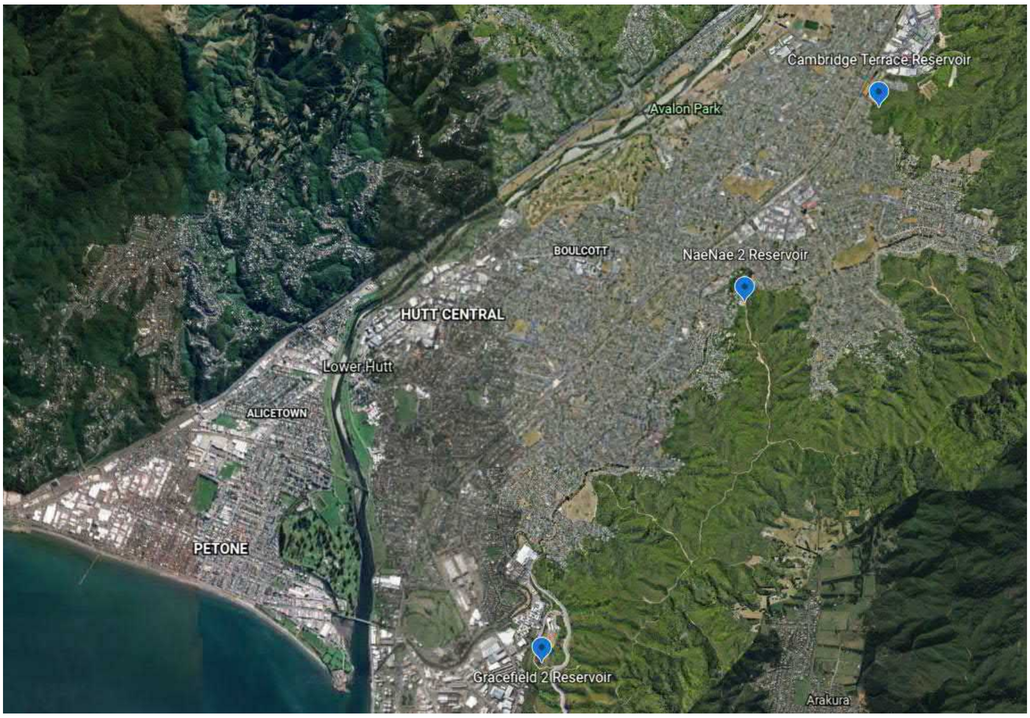

Figure 1 - Site Location Map of Shortlisted Sites

This report presents the results of the assessment and focuses on the following:

- High-level construction methodology for each site, identifying essential construction techniques, major plant items, traffic management, and spoil disposal.
- High-level assessment of temporary construction impacts on stakeholders and the public, including:
  - Noise
  - Vibration
  - Site clearance and footprint
  - Estimated truck movements
- Assessment of construction method, level of disruption, challenges from stream and rail crossings and any optimisation of the proposed pipeline routes for each site.
- Buildability of the current geometry of the specimen design and advice on any constructability issues and changes that could enhance constructability on the proposed site footprint.
- Significant construction risks for each site.

A site assessment matrix was utilised to identify a preferred site for the construction of the proposed reservoir.

2 Constructability Review Assumptions

2.1 Design Assumptions

This report has been completed based on the design information provided by WSP, summarised in Table 1:

Reservoir Shape and Size	
Volume	15 megalitres (ML)
Shape	Circular
Diameter (External)	55.2m
Wall Thickness	250mm
Wall Panel Type	Post – tensioned
Base Slab Thickness	250mm
Roof Thickness	600mm
Height (internal)	7.5m
Maximum structural member weight (largest panel)	12 tonnes
Footprint and Earthworks Extent	
Buffer for slope stability below cut batter	5m
Total construction pad diameter	65.2m
Assumed cut slope	1H:1V
Assumed fill slope	2H:1V
Reservoir Type	Above Ground
Inlet / Outlet Pipelines	
Pipeline diameter	750mm
Pipeline type	Concrete lined steel (CLS)
Pipeline cover	1000mm

Table 1 - Design information provided by WSP

2.2 Geotechnical Assessment

The desktop geotechnical assessment provided by WSP identified a consistent geological profile across the shortlisted sites and noted the following:

Reservoir

- Sites appear to be underlain by Wellington Greywacke (interbedded siltstone and sandstone) with an expected typical profile:
- 0 – 5m depth - completely weathered rock
- 5 – 15m depth - moderately weathered rock.
- Rock is likely to be able to be ripped with moderate to large excavators
- It would be unlikely to encounter groundwater during excavation of reservoir platform
- Without stabilisation, slopes can be cut between 45 degrees and 55 degrees. Steeper slopes may require nailing with mesh or shotcrete facing.

Pipeline

- The geology of the proposed pipeline routes comprises alluvial deposits made up of sandy gravels with silt and peat interbeds.
- It is typical for groundwater in the alluvial deposits of the Hutt Valley (i.e. primarily residential parts) to be within 2 to 3 meters of the ground surface.

2.3 Contamination

The three shortlisted reservoir locations are not on or adjacent to Selected Land Use Register (SLUR) sites. Therefore, this report has assumed that earthworks material will be disposed of as clean fill.

There are some instances where a proposed pipeline route is adjacent to a SLUR site. These areas will require further investigation, and material may need to be disposed of at an appropriately managed facility.

2.4 Disposal Sites

Each of the shortlisted sites will require significant earthworks to create an access road and construction pad for the reservoir. Modelling provided by WSP for each site shows that 41,000 – 75,000m^3 of excess material will need to be transported off-site.

There are limited clean fill disposal sites currently available in the Wellington region. Potential sites were considered are shown in Table 2:

Site	Comment
Dry Creek Clean fill	Now permanently closed.
Wainuiomata Clean fill	Scheduled for closure June 2022.
Silverstream Landfill	Do not accept clean fill.
C & D Landfill	Located in Owhiro Bay, Wellington. Have the capacity to accept material; however, this is subject to the type of material excavated, and travel distance to the landfill is problematic.

Table 2 - Clean fill sites considered as disposal sites

C&D landfill was the only viable site identified. The location may not be feasible due to the significant cartage distance between Lower Hutt and Owhiro Bay. It may be more cost-effective to identify and consent a clean fill facility specifically for the project.

To assess truck routes for disposal and temporary impacts of the heavy vehicle movements, this report has been completed assuming that trucks will be required to travel from the preferred site onto State Highway 2 and head south to C&D landfill.

3 Naenae 2 Reservoir

3.1 Site Overview

The site is in Fairfield, adjacent to the existing Naenae Reservoir. The site sits at the end of Summit Road with residential homes to the northwest and a small waterway to the north of the site. The proposed reservoir is sited over an existing firebreak, with residents using the firebreak as a walking trail. A 3D representation of the site is provided in Figure 2.

Figure 2 - 3D Representation of Naenae 2 (Image courtesy of WSP NZ Ltd)

3.2 High-Level Construction Methodology

Site clearance will involve the removal of the existing medium-density scrub, which can be mulched on site. An all-weather access track will then be formed to allow road trucks and trailers to be loaded and turned around on site. Due to the excavation depth, temporary stabilisation of the large cut faces should be considered and staged with the excavation sequence.

WSP has modelled indicative earthworks volumes for the site; approximately 70,000m3 of excavation is required up to a depth of 20m. The model does not allow for sufficient construction area and will need amendment to assist with runoff and sediment management, both during construction and operation of the reservoir. It is likely that a larger volume of excavation than currently modelled will be required.

During the site visit, highly weathered Greywacke was observed at ground level. It is expected that as the depth of excavation increases, the rock will become less weathered and more difficult to excavate, slowing productivity. Shallow excavations will be possible with a ripper; however, a breaker and large excavator (45T or larger) could be required for the deepest cut sections.

Earthworks will require extensive erosion and sediment controls as the site will have a large, disturbed footprint, significant vehicle movements and a stream downslope from the site that will need protection.

The size of the construction platform and existing access track mean that this site is suitable for a precast construction method. Given the indicative maximum member sizing of 12 tonnes, a 100T – 120T self-erecting telescopic crane should be suitable for use on-site.

Larger cranes could be utilised and assembled on the construction platform however, once the reservoir is constructed, with the sloping nature of the site, it will be particularly challenging to have sufficient area available for the deconstruction of a large crane. A telescopic crawler crane would allow for loading/unloading to occur at the site entrance without needing an area to lay down the crane boom.

To allow for the limited lifting radius of the telescopic crane, the structure will need to be constructed segmentally, with the crane operating inside the structure and building its way out. This report has identified at a high level that precast construction will be suitable however the designer should ensure that a contractor is engaged throughout the design process to ensure that construction sequencing is considered as the design progresses.

It will be crucial to ensure that a truck turnaround bay is included in the earthworks design model outside of the footprint of the reservoir for the construction of the final segments of the structure.

3.2.1 Routes for Disposal

Due to the considerable number of heavy vehicle movements (several thousand), local authorities should be consulted to identify a preferred heavy vehicle route through Lower Hutt to access State Highway 2. A likely route is shown in Figure 3.

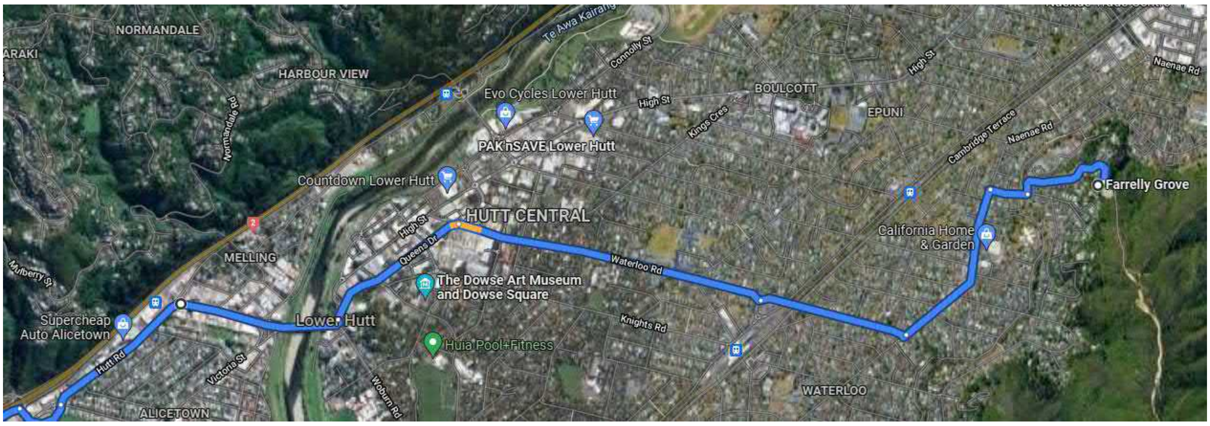

Figure 3 – Potential Heavy Vehicle Route to SH2 from Naenae reservoir site

3.3 Major Plant Requirements

Table 3 provides an indicative list of key construction plant required for each stage. The final design, consent conditions and contractors preferred methodology will dictate the actual plant required.

Plant	Mobilisation	Earthworks	Reservoir Construction	Pipeline Construction	Demob
Hi-Ab Trucks	☑	☐	☑	☑	☑
Hydro Excavator	☐	☑	☐	☑	☐
20T Excavators	☑	☑	☑	☑	☑
45T Excavators	☐	☑	☐	☐	☐
Vibrator Roller	☐	☑	☑	☑	☐
Mobile Crane	☑	☐	☑	☑	☑
Road Truck – Truck Only	☑	☑	☐	☑	☐
Road Truck /Trailers	☐	☑	☐	☑	☐
Pipe Rammer (Railway Crossing)	☐	☐	☐	☑	☐
Concrete Trucks	☐	☐	☑	☐	☐
Concrete Pump	☐	☐	☑	☐	☐
100T – 120T Telescopic Crane	☐	☐	☑	☐	☑

Table 3 - Major plant requirements for Naenae 2 Reservoir

3.4 Access to Reservoir Site

The site is located at the end of Summit Road. There are no other feasible access points to the site, meaning there is only one access route into the site (shown in Figure 4).

Access from Woodvale Grove was considered but would require the construction of an access track to link up with the track upslope from the reservoir. This route would require significant earthworks while providing no additional benefit compared with access from the existing Summit Road.

The site will be accessed from Waiwhetu Rd, via Tilbury St, crossing the Waiwhetu Stream and then turning onto Summit Rd.

The intersection of Tilbury St and Summit Road has a limited turning circle and will require traffic management or adjustments to facilitate large vehicle movements.

Summit Rd is a narrow local access road that will require permanent parking restrictions to accommodate heavy vehicle movements. At the top of Summit Road, a small cul de sac (Farrelly Grove) may be suitable for unloading and assembly of large plant (over-dimension excavators/cranes).

There is an existing gravelled access track that is approximately 4m wide. This track will require some modification and realignment to allow heavy truck and trailer units to access the site.

Due to the grade and narrow width of Summit Road, there is no viable location for vehicle turnaround therefore, the site footprint will need to have sufficient area to allow heavy vehicles to turn around on site. This area will need to be provided outside of the footprint of the proposed reservoir to future proof the site for the refurbishment of the existing reservoir.

Figure 4 - Access route to Naenae reservoir site

3.5 Site Footprint and Layout

The sloping nature of the site means that there is limited room for site laydown area. The current earthworks model (assuming a 5m buffer around the reservoir) will not provide sufficient construction area for material laydown and vehicle turnaround.

The site footprint will need to extend beyond the current modelled excavation as per Figure 5. A sufficient area will need to be set aside for a sediment control pond and discharge structure. Control of overland flow paths will need to be carefully considered as part of the site design.

There is an opportunity to utilise the existing reservoir roof (subject to structural assessment) for offices/welfare areas to reduce the footprint required.

Figure 5 - Site footprint of Naenae reservoir site

3.6 Traffic and Pedestrian Management

A full road closure (allowing resident access only), combined with permanent on-street parking restrictions, will be required on Summit Road. Traffic management requirements are shown in Figure 6. There is insufficient width on Summit Road for heavy vehicles to pass each other and the access to the site is a single lane only.

Therefore, a stop-go system will likely be required to coordinate construction and residential traffic. The stop-go system will need to manage access to Laura Fergusson Grove. The existing public walkway through the reservoir site will need to be closed. There is no alternative access route for this walkway.

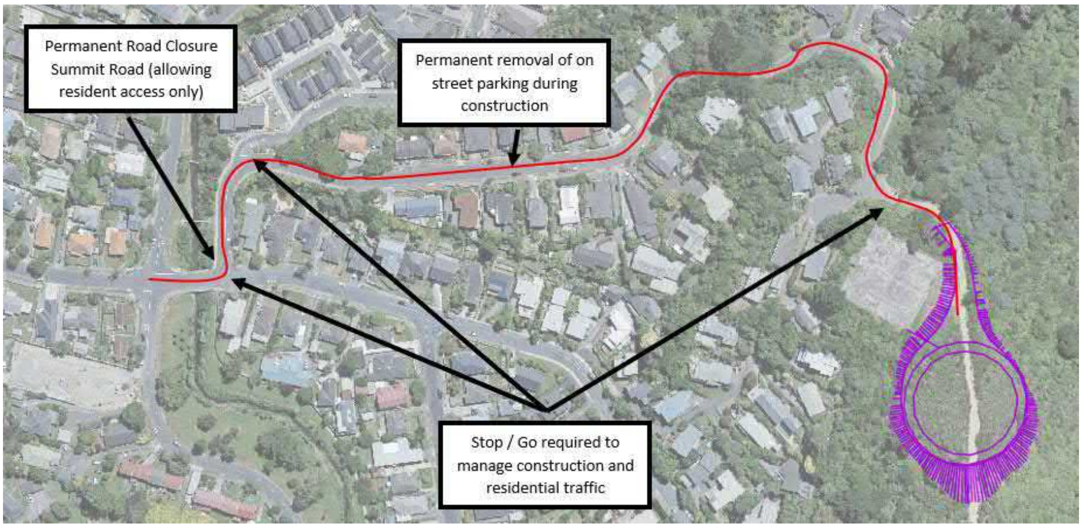

Figure 6 - Traffic Management for Naenae Reservoir

3.7 Temporary Construction Impacts

3.7.1 Stakeholders and Public

Impacts to residents of Summit Road will be significant due to the prolonged duration of traffic restrictions, removal of on-street parking and truck movements required to complete the construction of the reservoir. Vulnerable residents live at the Laura Fergusson Trust facility on Laura Fergusson Grove (runs off Summit Road).

The wider community will be moderately impacted by the increased and prolonged vehicle movements as heavy vehicles move through residential roads to access arterial routes. The closure of the walking track through the site may require consultation.

3.7.2 Noise and Vibration

The most significant activities that will generate noise and vibration will be the excavation of rock (potentially by rock breaker) and the use of vibratory rollers. Acoustic barriers may be required given the site's proximity to residential sections and a site-specific noise assessment required given the site's elevated position. Vibration issues are unlikely to exceed minor nuisance (trucks moving past houses).

The floor and roof concrete pours may require early morning or night-time truck movements to allow sufficient time to pour, finish and cure the concrete.

3.7.3 Estimated Truck Movements

Table 4 gives an estimation of truck movements required for construction. Movements are based on the following assumptions:

- Truck and Trailer unit (Earthworks) – 13m^3 per load
- Precast delivery – one element per load
- Concrete truck – 6m3 per load

Construction Phase	Loads required	Total Movements
Establishment	25	50
Earthworks	6,000	12,000
Precast (walls and roof)	120	240
Concrete (in situ pour)	350	700
Material delivery	500	1000
Total Movements	*6,995*	*13,990*

Table 4 - Estimated Truck Movements Naenae Reservoir

3.8 Reservoir Geometry and Buildability

The site is suitable for the circular geometry of the reservoir. There is no constructability benefit in changing the geometry, as this would increase member sizes and potentially require a larger crane.

The following changes could be considered to enhance constructability:

1. Assessment of any areas on site that would be suitable for placement of fill to reduce the number of truck movements required to construct the reservoir. This would be difficult to build but may be preferable to minimise impact to stakeholders and create a more extensive site footprint to aid construction.
2. Increase the offset of the proposed reservoir to the existing reservoir. This is currently set to 20m which will not leave sufficient room for the construction area required to refurbish the existing reservoir once the new reservoir is constructed.
3. Shifting the reservoir further to the south could increase the available area for construction plant and material laydown and help the future works planned for the existing reservoir that will need earthworks to access the buried structure. This would increase the earthworks volume.
4. If hydraulically po01ssible, raise the invert level of the reservoir. A pressure reducing valve could be added onto the outlet pipeline. This has the potential to reduce the required excavation volume and cut slope.
5. Cost/benefit analysis of a steeper cut face and stabilisation of the slope. This would reduce site footprint and excavation volume but would add stabilisation costs.

3.9 Inlet and Outlet Pipeline

3.9.1 High-Level Construction Methodology

WSP has provided the indicative alignment required for the site's proposed inlet and outlet pipework. This alignment is shown in Figure 7.

- Inlet Pipe (approx. 100m length) – there is an existing 750mm inlet pipe to the Naenae reservoir, and it is proposed to extend the inlet pipe from this line for approximately 100m.
- Outlet Pipe (approx. 1100m length) – runs along Summit Rd, via Tilbury St, crosses the Waiwhetu Stream, via Waiwhetu Road and Naenae Road before crossing Cambridge Terrace and the railway.

With an assumed pipe cover of 1000mm and a typical trench detail, the assumed trench profile will be approximately 2000mm deep x 1800 wide. As the pipeline is proposed to be concrete-lined steel, the construction method will be a traditional trenched installation.

Dewatering may be required (groundwater typically 2-3m deep) but is not anticipated to be a significant issue.

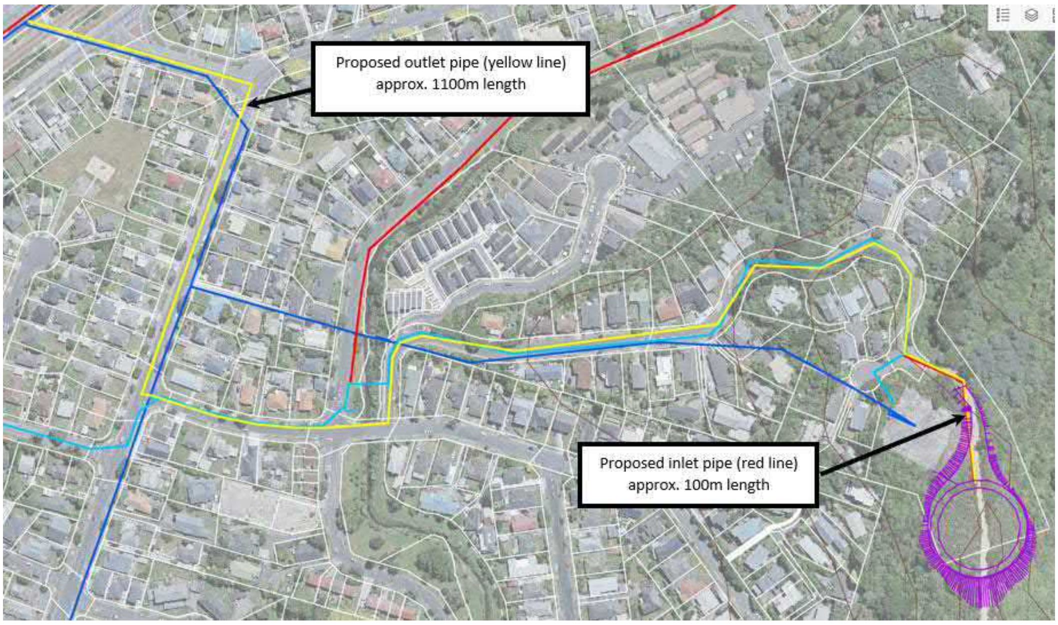

Figure 7 - Naenae reservoir pipeline alignment

3.9.2 Stream / Railway Crossings

The outlet pipeline will need to cross the Waiwhetu stream. The stream crossing is short, with sufficient room to establish a large crane on Riverside Drive. Like the existing crossing, shown in Figure 8, supports would be installed on either side of the stream, and a section of the pipe lifted in place using a mobile crane. No significant constructability issues are expected.

Figure 8 - Waiwhetu Stream Crossing (image courtesy of Google Maps)

The pipeline crosses the rail line between Cambridge Terrace and Oxford Terrace. The rail crossing can be completed two ways:

- Trenchless Pipe Ramming (preferred) – This method does not require the closure of the rail line. Pits are excavated on either side of the railway, with a steel carrier pipe installed (extending 5m past rail centreline or full rail corridor width) and pipeline installed within the carrier pipe. The method's suitability depends on the location of existing services, geological profile, and proximity of connection point to the existing network from the railway.
- Traditional trenched installation would require a block of line and closure of the rail corridor to install the pipeline and reinstate the area.

3.9.3 Traffic Management

Summit St and Tilbury St will require full road closures to provide sufficient room for the construction plant to work alongside the trench safely. Depending on the alignment available with existing services Waiwhetu Rd may be possible to construct with a single lane closure (if alignment is near the edge of the seal) but will most likely require a full road closure. Work along Naenae Road and Cambridge Terrace may be necessary at night to minimise disruption to peak traffic flows. Parking restrictions will be required during the work.

3.9.4 Disruption to Stakeholders and Public

Residents will be significantly affected by the road closures required to install the pipeline, especially on Summit Road where the pipeline cannot be installed concurrently with reservoir construction. The bus route along Waiwhetu Road will need to be diverted. The alignment does not pass any businesses.

The pipe ramming will create significant noise and vibration, requiring monitoring during work. Residents and stakeholders will be adversely affected and will need to be carefully managed.

KiwiRail will likely require speed restrictions on the railway line during pipe ramming, disrupting any train movements.

3.10 Major Construction Risks

This desktop study has identified the following significant risks, which the designer should consider:

- Lack of nearby disposal location for clean fill disposal of excess material from the site. The requirement to find a consented location for disposal of material or to reshape the hillside adjacent to the reservoir site could delay the design and consenting process and reduce productivity on site.
- Lack of laydown/storage area on-site will require detailed planning and sequencing. This will require construction to be staged and will reduce productivity on site.
- The current 20m offset may not allow sufficient space between structures for future refurbishment of the existing reservoir.
- Risk of overland flows and construction runoff leaving site footprint and affecting the stream in the gully below site.
- The single-lane accessway will reduce productivity and increase site congestion.
- The railway crossing is a high-risk activity that will require a specialist subcontractor, detailed planning, and an application for a permit to install a pipeline from KiwiRail.
- The stream crossing is a high-risk activity that will require careful consideration for bank stability and sediment controls when working around the stream.
- The pipeline alignment along Summit Road will require many bends and connections, increasing the cost and number of joints in pipes. HDPE may be considered to reduce the tolerance necessary to achieve this and provide some flexibility around unknown obstructions that may be encountered.

4 Gracefield 2 Reservoir

4.1 Site Overview

The site is in Gracefield, adjacent to the existing reservoir, above Gracefield Road. The current access is from the westbound lane of Wainuiomata Road. The site is sloped and sits over a steep gully. A 3D representation of the site is provided in Figure 9.

Figure 9 - 3D Representation of Gracefield 2 Site (Image courtesy of WSP NZ Ltd)

4.2 High-Level Construction Methodology

Site establishment will require modification to the existing entrance to allow truck-only units to access the site without reversing along the current access track. The designer could consider additional site access to allow left in / left out style access to the site.

Site clearance will involve the removal of the existing medium-density scrub. There are areas adjacent to the existing reservoir in the gully that will require large tree removal. The current access track will need to be regraded and reshaped to allow for a construction laydown area to be formed between the existing and proposed reservoirs.

WSP has modelled indicative earthworks volumes for the site, and there is approximately 75,000m^3 of excavation required up to a depth of 32m. The model does not allow for sufficient construction area and access around the existing reservoir. It is likely that a larger volume of excavation than currently modelled will be required.

The designer should consider permanent stabilisation of the cut slope to reduce the area of the excavation batter. This would reduce the design conflict with the existing access track and significantly reduce the volume of material required to establish the building platform.

A shallow topsoil layer was observed during the site visit for the top 0.5m approx. of exposed face. This was underlain by highly weathered Greywacke. With a cut depth of up to 32m there is a significant risk the deeper rock will be less weathered and that a breaker and large excavator will be required for deeper excavations, significantly impacting productivity. With access restrictions, the Contractor may elect to use an off-road dump truck to transport material from the excavation to the access track entrance and utilise the slip lane on Wainuiomata Road to load road truck and trailer units from a surge stockpile.

The earthworks will require substantial sediment controls, particularly for the gully that sits above the GNS driveway.

The nature of the site and proximity of the structures means once the new reservoir is constructed, there will be no room available to deconstruct a large crane. The Contractor may elect to use a 100T – 120T self-erecting telescopic crane so long as its tracks can be retracted to travel along the access road. A full closure of the westbound lane of Wainuiomata Road will be required for the establishment of large plant.

The current site access would not allow the safe delivery of precast panels, and a cast-in-situ method may need to be considered if new access arrangements cannot be made.

The designer could consider additional access to the site, shown in Figure 11, which would allow trucks and trailers to access the site. This would allow for a precast installation methodology to be utilised.

To allow for the limited lifting radius of the telescopic crane, the structure will need to be constructed segmentally. The designer should ensure that a contractor is engaged throughout the design process to ensure that the required construction sequencing and interaction of structural elements are considered as the design progresses.

4.2.1 Routes for Disposal

Due to the considerable number of heavy vehicle movements (several thousand), local authorities should be consulted to identify a preferred heavy vehicle route through Lower Hutt to access State Highway 2. A likely route is shown in Figure 10.

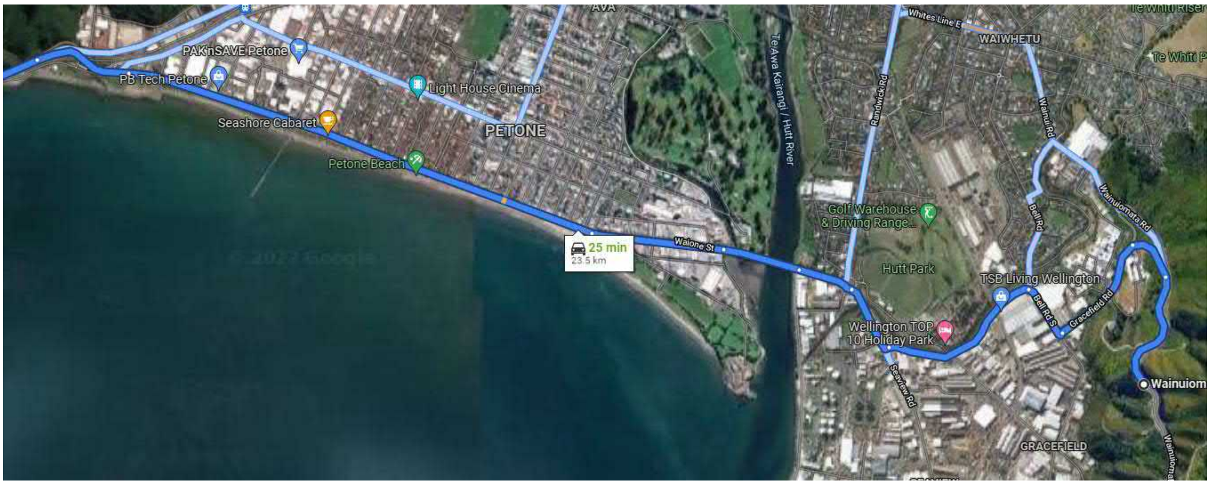

Figure 10 – Indicative Heavy Traffic Route from Gracefield site to State Highway 2

4.3 Major Plant Requirements

Table 5 provides an indicative list of key construction plant required for each project stage. The final design, consent conditions and contractors preferred methodology will dictate the actual plant required.

Plant	Mobilisation	Earthworks	Reservoir Construction	Pipeline Construction	Demob
Hi-Ab Trucks	☑	☐	☑	☑	☑
Hydro Excavator	☐	☐	☐	☑	☐
20T Excavators	☑	☑	☑	☑	☑
45T Excavators	☐	☑	☐	☐	☐
Vibrator Roller	☐	☑	☑	☑	☐
Mobile Crane	☑	☐	☑	☑	☑
Road Truck – Truck Only	☑	☑	☐	☑	☐
Road Truck /Trailers	☑	☑	☐	☑	☐
Off-Road Dump Truck	☐	☑	☐	☐	☐
Pipe Rammer (Railway Crossing)	☑	☐	☐	☑	☐
Concrete Trucks	☐	☐	☑	☐	☐
Concrete Pump	☐	☐	☑	☐	☐
100 – 120T Telescopic Crane	☐	☐	☑	☐	☑

Table 5 - Major plant requirements for the Gracefield 2 reservoir

4.4 Access to Reservoir Site

It is only possible to access the site from Wainuiomata Road above the existing reservoir. Access from below the site via Gracefield Road or the GNS accessway is not practical due to the steep slope of the hill (35 – 55 degrees).

A concrete median barrier separates traffic on Wainuiomata Road. This means access to the site can only be achieved from the westbound lane. There is an existing gravelled access to the existing reservoir site. The current entranceway requires modification for large vehicles to access the site.

Even with modification to the entranceway, the current access would not allow trucks and trailers to turn into the site. They would be required to reverse along the existing accessway, approximately 300m long. Any vehicles accessing the site from Lower Hutt would have to travel to Wainuiomata before turning westbound at the roundabout and heading back to the site. The grade of Wainuiomata hill means this will significantly affect the time required for each load delivered to the site and is carbon inefficient.

Alternative access further along the road could be created to allow heavy truck and trailer units to access the site, as shown in Figure 11.

The existing access will need to be reshaped to allow for an offloading and turning area on site. There is insufficient room to form a construction platform adjacent to the existing reservoir.

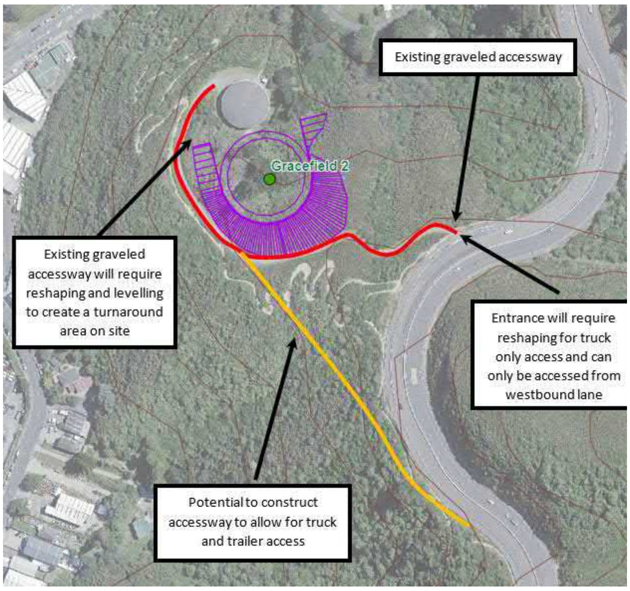

Figure 11 - Sketch of potential additional access to the site

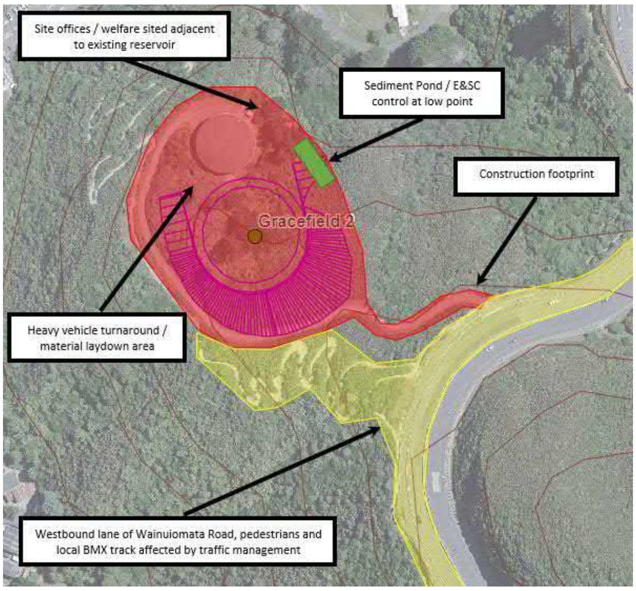

Figure 12 - Construction site footprint for Gracefield 2

4.5 Site Footprint and Layout

The site is severely constrained, with minimal area available for construction turnaround and laydown. The existing reservoir is situated on the only flat area of the site. The hill between the existing and current reservoir will need to be benched to allow a flat construction laydown and turnaround area.

The cut slope will need to be increased as the current design conflicts with the existing access road. The cut slope may require stabilisation to achieve this. The site footprint will need to extend beyond the current modelled excavation, and additional earthworks will be required for the proposed laydown area.

Sufficient area will need to be set aside for sediment control structures and to manage overland flow paths during construction. The site footprint is shown in

Figure 12.

4.6 Traffic and Pedestrian Management

Significant traffic management will be required as site access is off Wainuiomata Road. Construction traffic will only be able to enter from the westbound direction due to the concrete median barrier.

Provision of a left in / left out style of site access will require a reduction from two lanes to one for westbound traffic on Wainuiomata Rd. Due to the lack of site distance available, this lane reduction and associated speed reduction may be required from the uphill section of the road as traffic leaves Wainuiomata. The left lane would become a deceleration lane to allow heavy vehicles to slow for the site. An acceleration lane continuing past the site would be required to allow vehicles exiting the site to safely merge with traffic, as shown in Figure 13

A stop / go will be required at site access points to manage vehicle and shared path conflicts. At times, a full westbound closure may be required during off-peak hours to establish a large plant.

The temporary traffic management required would likely need a crew on-site, full time. Due to the traffic levels on Wainuiomata Rd access to the site could be restricted during peak flow periods depending on the road controlling authorities' requirements.

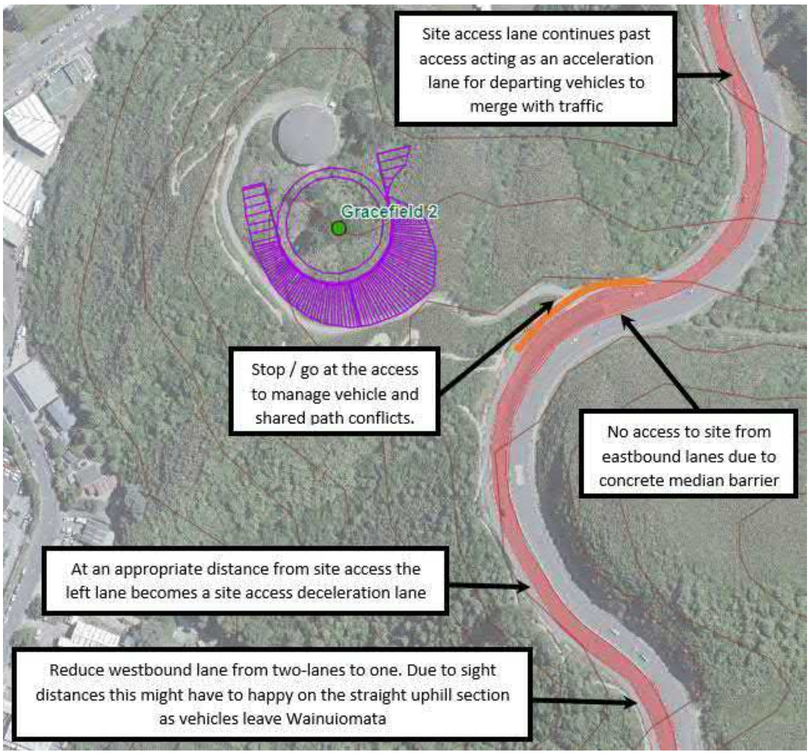

Figure 13 - Traffic Management requirements for Gracefield site

4.7 Temporary Construction Impacts

4.7.1 Stakeholders and Public

The site sits above an industrial area and is accessed off Wainuiomata Road. There are no identified residential properties in the vicinity of the site. Impacts to local businesses would be minor and related to noise or vibration.

There will be a significant disruption for commuters along Wainuiomata Road due to the size of the temporary traffic management required for the duration of the project. Users of the shared path will experience a minor inconvenience due to the stop/go required at site entrances.

The local BMX club has constructed a track adjacent to the access road (visible in overhead images). This track will be inaccessible during construction. The club may require some consultation on the disruption and what reinstatement will occur.

The wider community will be slightly impacted by the increased and prolonged vehicle movements as Wainuiomata is already heavily used as a heavy traffic route.

4.7.2 Noise and Vibration

The most significant activities that will generate noise and vibration will be excavating rock and using the vibratory roller. Even with no properties immediately adjacent, given the site's elevated position, construction noise may impact local businesses during the project. Vibration issues are unlikely to impact local stakeholders.

The floor and roof concrete pours may require early morning or night-time truck movements to allow sufficient time to pour, finish and cure the concrete.

4.7.3 Estimated Truck Movements

Table 6 gives an estimation of truck movements required for construction. Movements are based on the following assumptions:

- Truck and Trailer unit (Earthworks – assuming loading at the entrance from surge stockpile) – 13m^3 per load.
- Concrete truck (assumed poured in situ method) – 6m3 per load.

Construction Phase	**Loads required**	**Total Movements**
Establishment	25	50
Earthworks	5,800	11,600
Concrete (in situ pour)	550	1,100
Material delivery (smaller load)	800	1,600
Total Movements	*7,175*	*14,350*

Table 6 - Heavy Vehicle movements required for Gracefield 2 site

4.8 Reservoir Geometry and Buildability

There is no constructability benefit in altering the geometry of the reservoir, as any change in shape would require an increase in the member sizing of the structure. The constraints relate primarily to access and the depth of cut needed.

The following changes could be considered to improve constructability.

- Construction of an additional access track to allow for large vehicle movements and improve site access.
- Assessment of any areas on site that would be suitable for placement of fill to reduce the number of truck movements required to remove excess material.
- Permanent stabilisation of the cut slop to reduce cut slope area and excavation volume.
- If hydraulically possible, raise the invert of the reservoir. A pressure reducing valve could be added to the outlet pipeline. This has potential to reduce the required excavation volume.

4.9 Inlet and Outlet Pipeline

4.9.1 High Level Construction Methodology

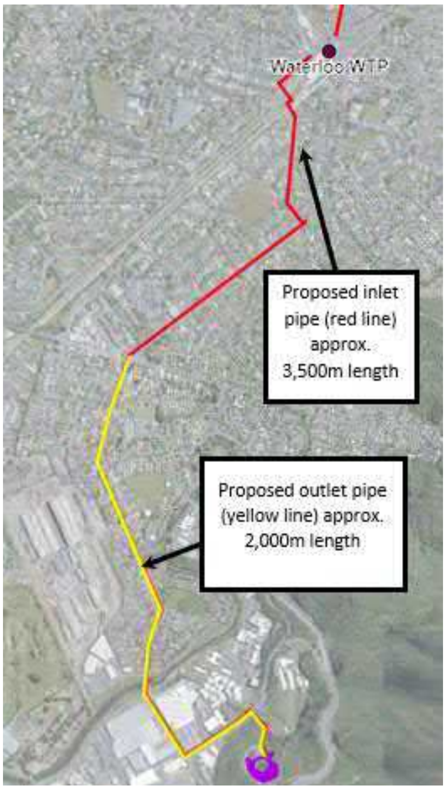

Figure 14 - Indicative alignment for Gracefield pipeline

WSP has provided the indicative alignment required for the site's proposed inlet and outlet pipes. This alignment is shown in

Figure 14.

- Inlet Pipe (approx. 3,500m length) – travels from the Waterloo WTP, crossing the railway to the south of the Waterloo station, via Vincent St, Waiwhetu St and Bell Rd before crossing the Waiwhetu Stream and connecting to the reservoir via Gracefield Rd.
- Outlet Pipe (approx. 2,000m length) – runs along Gracefield Rd, via Bell Rd, across the Waiwhetu stream and connects to the existing network at Bell Rd / Whites Lines East intersection.

With an assumed pipe cover of 1000mm and a typical trench detail, the assumed trench profile will be approximately 2000mm deep x 1800 wide. As the pipeline is proposed to be concrete-lined steel, the construction method will be a traditional trenched installation.

The section of inlet and outlet pipeline heading downslope from the proposed reservoir will be installed at an approximate 1V:3H grade and may require stabilised backfill. Consideration could be given to an overland ductile iron pipe or a PE pipe sleeved in a steel casing to reduce construction costs.

Dewatering may be required (groundwater typically 2-3m deep) but is not anticipated to be a significant issue.

4.9.2 Stream / Railway Crossings

Both the inlet and outlet pipelines will need to cross the Waiwhetu stream. WSP has advised that attaching either pipeline to the existing bridge at Bell Road is not feasible. The stream crossing is 17m, shown in Figure 15, and may require intermediate support in the stream. There are existing overhead lines on Quadrant Drive (if alignment is west of the bridge), and some trees may require removal on Riverside Drive (if alignment is to the east of the bridge). There is sufficient room to construct a crane platform and establish a mobile crane. No significant constructability issues are anticipated, but in water construction methods and access for the intermediate support will need to be considered for consenting.

Figure 15 - Waiwhetu Stream crossing point at Bell Road

The outlet pipeline crosses the rail line south of the Waterloo train station. The rail crossing can be completed two ways, as described previously in the report.

- Trenchless Pipe Ramming (preferred).
- Traditional trenched installation.

4.9.3 Traffic Management

As the proposed inlet and outlet pipe share the same alignment for approximately 2,000m there is a trade-off between productivity and the type of traffic management required.

Both pipelines could be installed simultaneously if a full road closure was allowable, however, given the traffic levels along the industrial portion of Bell Rd and Gracefield Rd, this may not be acceptable to the road controlling authority.

Depending on alignment Gracefield Rd, Bell Rd South and Waiwhetu Rd could be constructed with a single lane closure. Bell Rd (residential section) and Collingwood St would require a full road closure. Parking restrictions will be necessary during the work. Work at intersections may be required at night to minimise disruption to peak traffic flows.

4.9.4 Disruption to Stakeholders and Public

Road closures and lane reductions required to install the pipeline will significantly affect local residents and businesses. The construction will affect the bus route along Bell Rd and Waiwhetu St.

The current alignment for the rail crossing would require the closure of the car park to the south of Waterloo station, which will impact public transport users. The alignment also passes many local businesses who will require ongoing access to their property during works.

The pipe ramming will create significant noise and vibration, which will require monitoring during the work. Residents and stakeholders will be adversely affected and must be carefully managed.

4.9.5 Route Optimisation

The current alignments are the shortest and most efficient. No further optimisation is recommended to the outlet pipe. For the inlet pipe, there is an opportunity to reduce the impact to stakeholders at the Waterloo station by shifting the rail crossing point further south, adjacent to the Guthrie St intersection, with the pipeline then travelling to Waiwhetu Rd via Guthrey St.

Figure 16 Possible inlet pipe optimised route

A change in pipe material to PE and a trenchless installation method could be considered to reduce disruption to stakeholders. Micro tunnelling would not be suitable due to the multiple changes in direction however, directional drilling could be appropriate. Should the ground conditions permit, it is possible to complete large bore pipe installations with drill shots of several hundred metres.

This method would require a detailed geotechnical and service investigation to determine if it is feasible. The pipe would need to be installed deeper than traditional methods to avoid service clashes, so it may not be suitable for this project.

4.10 Major Construction Risks

This desktop study has identified the following significant risks, which the designer should consider:

- Lack of nearby disposal location for clean fill disposal of excess material from the site.
- Truck and trailers cannot access the site using existing access, reducing productivity and increasing the number of heavy vehicle movements.
- Traffic management restrictions imposed by access from Wainuiomata Road will reduce productivity, require heavy vehicles to travel to Wainuiomata to access the site, increase cost and negatively impact many commuters.
- Installation of the pipeline on the steep hill section immediately below the reservoir exposes staff on-site to significant risk while working at height.
- Lack of laydown/storage area on-site will require detailed planning and sequencing. This will require construction to be staged and will reduce productivity on site.
- Risk of construction runoff leaving site footprint and affecting the stream in the gully below site.
- The railway crossing is a high-risk activity that will require a specialist subcontractor, detailed planning, and an application for a permit to install pipeline from KiwiRail.
- The stream crossing is a high-risk activity that will require careful consideration for bank stability and sediment controls when working around and in the stream.

5 Cambridge Terrace Reservoir

5.1 Site Overview

The site is in Taita, adjacent to the Pick a Part business and above residential properties on Cambridge Terrace. The site is privately owned with access required from the (separately) privately owned Pick a Part business. Due to the private land ownership, a site visit was not possible. A 3D representation of the site is provided in Figure 17 below.

For this report, it has been assumed that an agreement can be reached to use the Pick a Part access for construction traffic and as a laydown area.

Figure 17 - 3D representation of Cambridge Terrace site

5.2 High-Level Construction Methodology

The site will be established by first constructing the reservoir's access road. The most efficient construction method for the access road would be the use of an off-road dump truck to transport material to the hairpin on the existing driveway. It could be loaded into road truck and trailer units from a surge stockpile. The access road requires the placement of approximately 2,000m^3 of fill directly above a residential property. This work will need to be carefully staged and managed to ensure there are no adverse effects on the environment or the resident below.

As a site visit was not possible, it is assumed that site clearance will be similar to the other sites with medium density scrub requiring removal or mulching on-site.

WSP has modelled the site's indicative earthworks volumes for both the reservoir and access track. There is approximately 41,000m^3 of excavation up to a cut depth of 19m and 2,000m^3 of fill required. The model may need to be modified slightly with an increased area around the reservoir footprint. This will allow trucks and trailers to be able to turn on-site during the latter stages of the project. The earthworks initially are as per the access track method until a turnaround can be benched into the excavation for road trucks and trailers to access the reservoir site.

It is assumed that, highly weathered greywacke is present near ground level like the other sites. It is expected that as the depth of excavation increases, this rock will become less weathered and more difficult to excavate, slowing productivity. Shallow excavation will be possible with a ripper, a breaker, and a large excavator could be required for deeper cut sections.

Earthworks will require extensive erosion and sediment controls to protect properties below from construction runoff and overland flows from the disturbed footprint.

Provided an area is included in the earthworks model for trucks and trailers to turn around outside the reservoir, this site is suitable for precast construction. As construction progresses and available laydown space decreases, material may need to be stored at Pick a Part and transported along the access road as required.

Once the reservoir is constructed, with the sloping nature of the site limiting available area, there will not be sufficient area available for deconstruction of a large crane on site. The use of a telescopic crane would allow for loading / unloading to occur at the Pick a Part driveway. Given the indicative maximum member sizing of 12 tonne provided by WSP, a 100T – 120T self-erecting telescopic crane should be suitable for use on-site.

5.2.1 Routes for Disposal

Due to the considerable number of heavy vehicle movements (several thousand), local authorities should be consulted to identify a preferred heavy vehicle route through Lower Hutt to access State Highway 2. A likely route is shown in Figure 18.

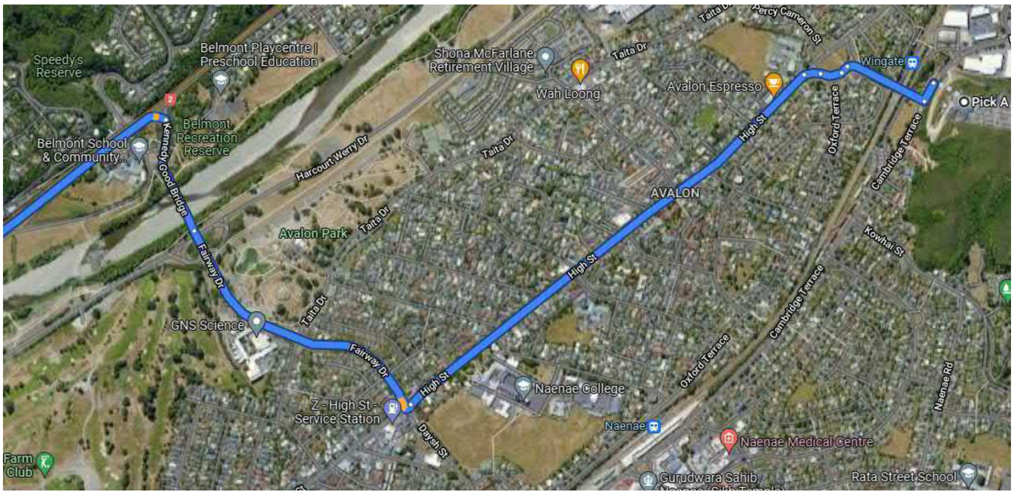

Figure 18 - Potential heavy vehicle route from Cambridge Terrace

5.3 Major Plant Requirements

Table 7 provides an indicative list of key construction plant required for each project stage. The final design, consent conditions and contractors preferred methodology will dictate the actual plant required.

Plant	Mobilisation	Earthworks	Reservoir Construction	Pipeline Construction	Demob
Hi-Ab Trucks	☑	☐	☑	☑	☑
Hydro Excavator	☐	☐	☐	☑	☐
20T Excavators	☑	☑	☑	☑	☑
45T Excavators	☐	☑	☐	☐	☐
Vibrator Roller	☐	☑	☑	☑	☐
Mobile Crane	☑	☐	☑	☑	☑
Off Road Truck – Truck Only	☐	☑	☐	☑	☐
Road Truck /Trailers	☑	☑	☐	☑	☐
Pipe Rammer (Railway Crossing)	☐	☐	☐	☑	☐
Concrete Trucks	☐	☐	☑	☐	☐
Concrete Pump	☐	☐	☑	☐	☐
100T Telescopic Crane	☐	☐	☑	☐	☑

Table 7 - Major Plant requirements required for Cambridge Terrace

5.4 Access to Reservoir Site

The site is located above residential properties on Cambridge Terrace. There are two potential options for access:

- Utilising existing Pick A Part concrete driveway on Eastern Hutt Road and then constructing a gravelled accessway approximately 250m long to the proposed reservoir site. This is the preferred access, shown in Figure 19.
- Creating a new access from Kowhai St. This option was discounted because the existing slope was too steep to construct an access road suitable for heavy vehicles.

Due to the length of the access road, to minimise earthworks volumes, it has only been designed as single-lane access. The designer should consider passing bays along the access track and make provisions in the earthworks design to increase the construction platform so that there is enough room outside of the footprint of the proposed reservoir for trucks and trailers to turn around on site.

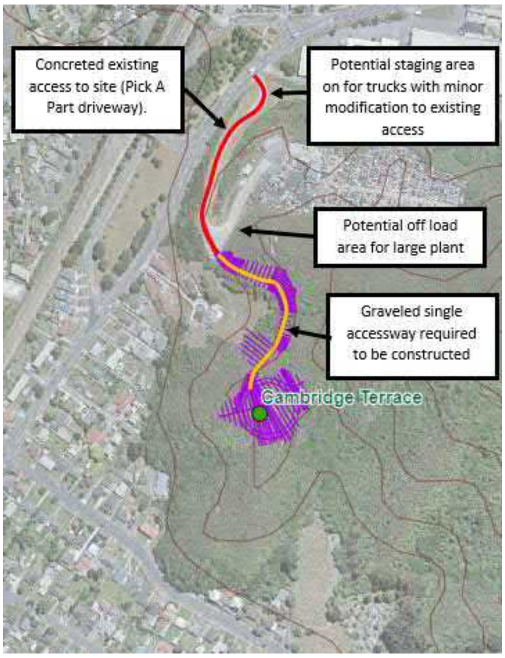

Figure 19 - Access to Cambridge Terrace site

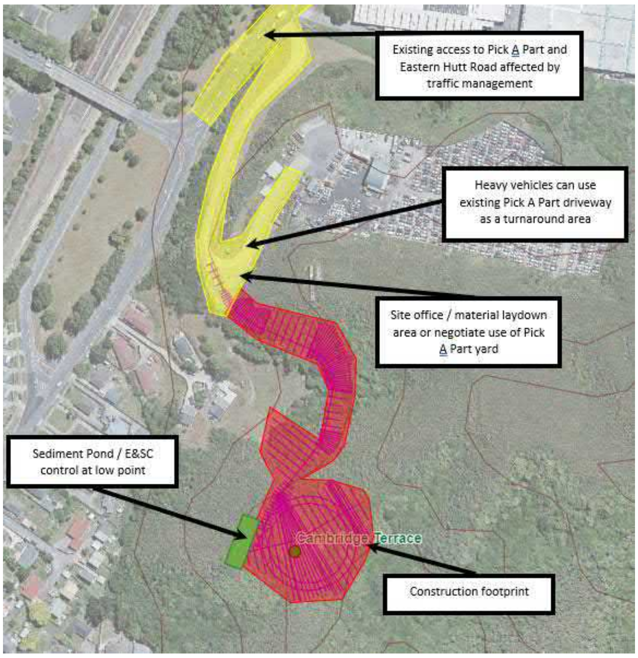

Figure 20 - Site footprint of Cambridge Terrace reservoir

5.5 Site Footprint and Layout

The sloping nature of the reservoir site means that there is no room for a construction laydown area at the reservoir site without significant earthworks. The existing accessway has some areas that would be suitable for use as a laydown and office/welfare area, shown in Figure 20. It may also be possible to negotiate further laydown within the Pick a Part yard.

Construction traffic will need to be controlled along the single accessway between the laydown and reservoir site to avoid vehicle conflicts. Passing bays could be included in the access track design.

5.6 Traffic and Pedestrian Management

Construction traffic can utilise the existing Pick A Part entranceway, shown in Figure 21, to drive in / drive out of the site. A stop / go system will be required for any construction traffic accessing the site via the Wingate Overbridge or turning across the southbound lane due to insufficient width in the road to create a turning bay into the site. The alternative would be a left in / left out system however, this would increase travel distance for construction traffic. There is no footpath outside the entranceway, so pedestrians will not be impacted.

Line marking or lane delineation would assist in controlling the shared access between Pick a Part and the construction site. For certain stages of the project (i.e., earthworks), it may be necessary to have a stop / go system controlling vehicle movements within the property boundary.

Figure 21 - Existing entranceway to Pick a Part site

5.7 Temporary Construction Impacts

5.7.1 Stakeholders and Public

Impacts to Pick a Part would be significant with the construction site using the accessway to the business. The residents at the base of the hill along Cambridge Terrace and Kowhai Street would be significantly impacted by increased noise, vibration, and construction traffic.

The wider community would be moderately impacted by the increased and prolonged vehicle movements as heavy vehicles move through residential roads to access arterial routes.

5.7.2 Noise and Vibration

Noise and vibration will be most significant during earthworks (potential use of rock breaker and vibratory roller). Due to the site's elevated position, the noise will carry, and acoustic barriers may be required for residents below the site. A detailed noise assessment will be required. Vibration effects are not expected to exceed minor nuisance (heavy traffic moving adjacent to houses).

The floor and roof concrete pours may require early morning or night-time truck movements to allow sufficient time to pour, finish and cure the concrete.

5.7.3 Estimated Truck Movements

The table below gives an estimation of truck movements required for construction. Movements are based on the following assumptions:

- Truck and Trailer unit (Earthworks) – 13m^3 per load
- Precast delivery – one element per load
- Concrete truck – 6m3 per load

Construction Phase	Loads required	Total Movements
Establishment	25	50
Earthworks	3,350	6,700
Precast (walls and roof)	120	240
Concrete (in situ pour)	350	700
Material delivery	500	1000
Total Movements	*4,345*	*8,690*

5.8 Reservoir Geometry and Buildability

A circular reservoir provides the most structurally efficient design. The site could suit a rectangular geometry, but costs (increased member sizing and reservoir area) would likely outweigh benefits (slight decrease in earthworks volume). A change to geometry is not recommended.

The following changes could be considered to improve constructability.

- Assessment of any areas on site that would be suitable for placement of fill to reduce the number of truck movements. This would be difficult to construct and may increase impact on stakeholders.
- Cost/benefit analysis of stabilisation of the cut face and reducing the batter for reservoir and access road to reduce cut slope area and excavation volume.
- If hydraulically possible, raise the invert of the reservoir. A pressure reducing valve could be added to the outlet pipeline. This has the potential to reduce the required excavation volume.
- Amendment of earthworks design to allow for turning area for heavy vehicles around the reservoir.
- Inclusion of passing bays in reservoir access road.

5.9 Inlet and Outlet Pipeline

5.9.1 High-Level Construction Methodology

WSP has provided the indicative alignment required for the site's proposed inlet and outlet pipe. This alignment is shown in Figure 22.

- Inlet Pipe (approx. 3,900m length) – travels from the Waterloo WTP along Oxford Terrace via Waldie Grove, crossing the railway to the south of the Wingate Overbridge, via Cambridge Terrace before connecting to the reservoir via the Pick A Part accessway.
- Outlet Pipe (approx. 700m length) – runs along the Pick A Part accessway, via Cambridge Terrace, across the railway and connects to the existing network at Bell Rd / Whites Lines East intersection.

With an assumed pipe cover of 1000mm and a typical trench detail, the assumed trench profile will be approximately 2000mm deep x 1800 wide. As the pipeline is proposed to be concrete-lined steel, the construction method will be a traditional trenched installation.

Along Oxford Terrace the alignment is proposed to be placed in the berm alongside the road. This will require the removal of many trees and conflicts with overhead services. The alignment passes under the Daysh St overpass, which has low headroom, making it challenging to install the pipeline underneath.

Dewatering may be required (groundwater typically 2-3m deep) but is not anticipated to be a significant issue.

Figure 22 - Alignment of pipelines for Cambridge Terrace reservoir

5.9.2 Stream / Railway Crossings

The pipelines alignments do not cross any streams. The pipelines cross the rail line south of the Wingate Overbridge. The rail crossing can be completed two ways as described previously in the report.

- Trenchless Pipe Ramming (preferred).
- Traditional trenched installation.

5.9.3 Traffic Management

As the pipelines leave the site following the same alignment, there is a trade-off between the productivity of installing both pipelines simultaneously and the full road closure required to do so.

Along Eastern Hutt Rd / Cambridge Terrace a full road closure may not be possible due to the volume of traffic, and a lane closure will be required with each pipeline installed individually.

Depending on alignment, Oxford Terrace could be completed with a single lane closure (as design is currently in road berm). Parking restrictions will be required during the work.

5.9.4 Disruption to Stakeholders and Public

Residents will be significantly impacted by the traffic management required to install the pipelines, especially in Waldie Grove, requiring a full road closure. The bus route along Oxford Terrace will need to be diverted. The alignment does not pass any businesses.

The pipe ramming will create significant noise and vibration, which will require monitoring during the work. Residents and stakeholders will be adversely affected and must be carefully managed

5.9.5 Route Optimisation

The pipelines follow the Pick A Part access road before travelling along Cambridge Terrace to the rail crossing point. Realignment of the pipeline by installing a section of pipe downslope directly from the end of the reservoir access track to the rail crossing point, shown in Figure 23, could reduce the length of each pipeline by approximately 300m. This may require installation of a stabilised section (or overland section will steel casing) down the steep slope above Cambridge Terrace.

PE pipe and trenchless installation could be considered for the sloped section along the access track to reduce cost and fittings required for changes in alignment to the pipeline. The alluvial deposits of the Hutt Valley mean detailed investigation would be necessary to determine if trenchless installation methods are feasible.

A change in pipe material to PE would also assist with productivity and cost as flanged bends and connections would not be required for every change in pipe alignment.

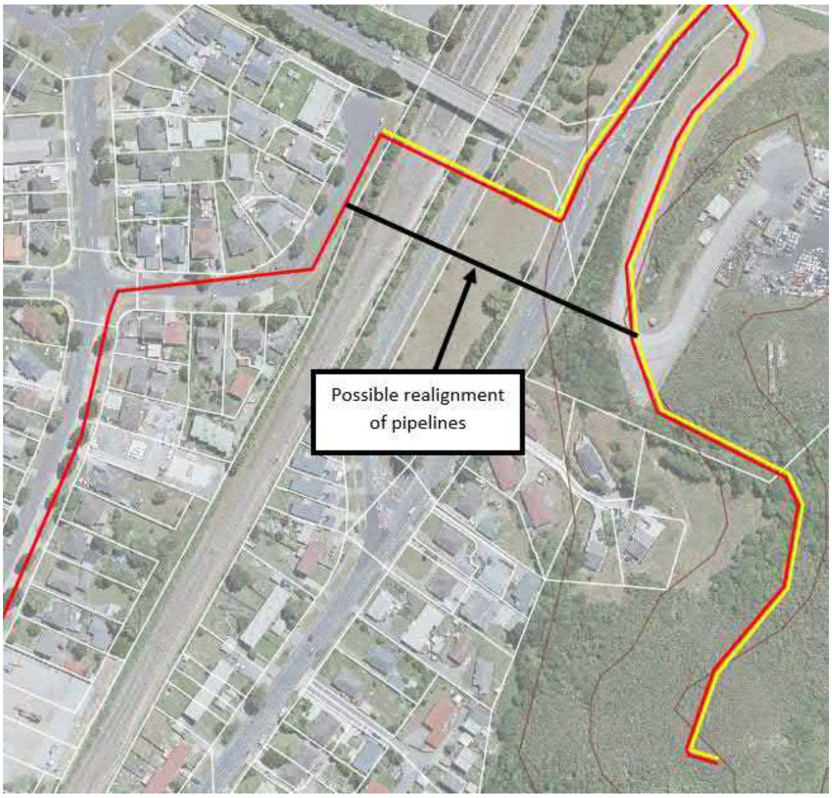

Figure 23 - Potential realignment of pipelines from Cambridge Terrace reservoir

5.10 Major Construction Risks

- Lack of nearby disposal location for clean fill disposal of excess material from the site. The requirement to find a consented location for disposal of the material or to reshape the hillside adjacent to the reservoir site could delay the design and consenting process and reduce productivity on site.
- Lack of any laydown/welfare/site office area if agreement cannot be reached with the existing landowner for the use of their land.
- Single lane 250m long access to the site will decrease productivity, increase cost, and require on-site traffic management to avoid vehicle conflicts.
- The site is immediately above residential properties, requiring substantial erosion and sediment controls to control overland flows.
- Installation of the pipeline under an existing structure and under multiple overhead powerline crossings.
- Lack of laydown/storage area on-site will require detailed planning and sequencing. This will require construction to be staged and will reduce productivity on site.
- The railway crossing is a high-risk activity that will require a specialist subcontractor, detailed planning, and an application for a permit to install a pipeline from KiwiRail.

6 Recommendations and Conclusion

6.1 Site Comparison

Each site presents unique and challenging conditions for construction with restricted access and construction footprint an issue across the sites.

Constructability only forms part of the multi-criteria analysis and this report will be used with several other inputs to determine the preferred site. An options matrix, provided in Appendix A was utilised to provide a means of comparison for the following aspects:

- Access
- Environmental Risks
- Critical Health and Safety Risks
- The complexity of the inlet/outlet pipeline construction
- Geotechnical and slope stability risks
- Construction method

The sites were compared against each other with the following rankings used:

- 4 – Exceptional benefit
- 3 – Best site
- 2 – Average site
- 1 – Worst site
- 0 – Significant issue

The assessment ranked the sites in order of constructability as below:

1. Naenae 2
2. Cambridge Terrace
3. Gracefield 2

The summary result is shown in Figure 24.

Figure 24 - Constructability analysis by site

Each aspect of constructability is compared in Figure 25 and Figure 26.

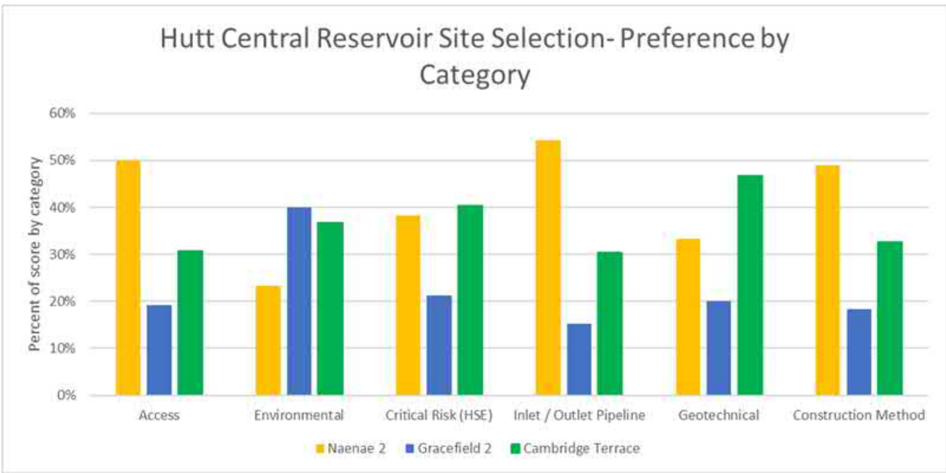

Figure 25 - Constructability analysis by category

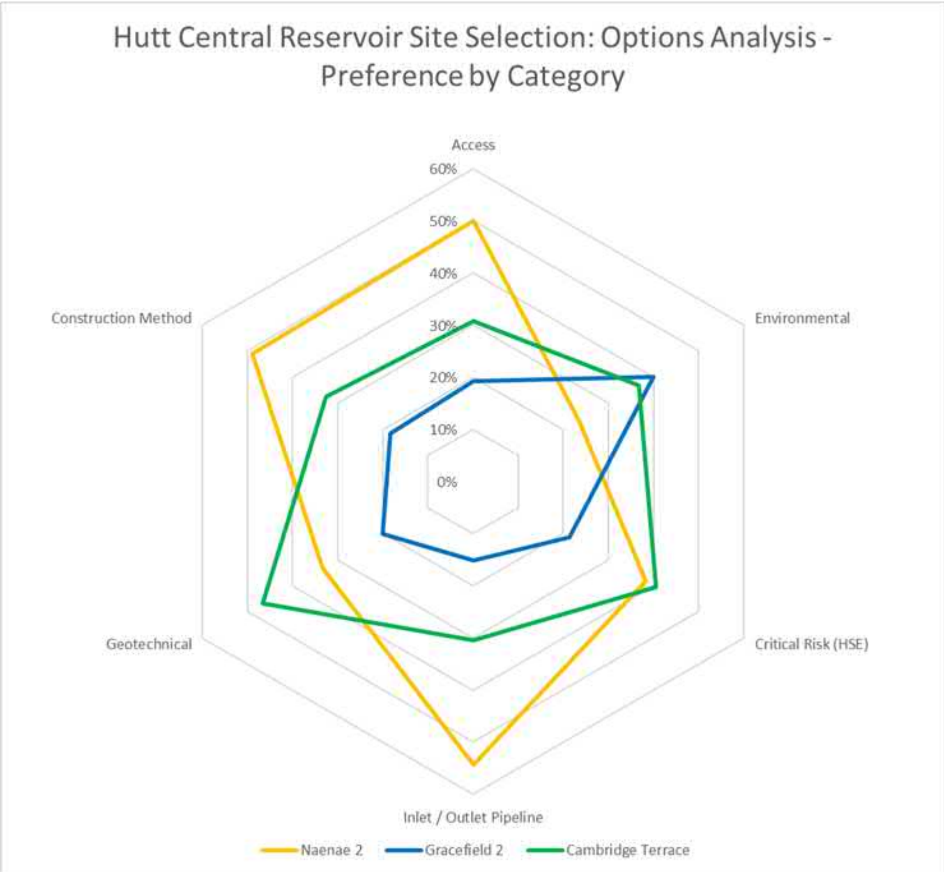

Figure 26 - Radar plot of constructability analysis by category

6.2 Conclusion

All sites present construction access issues and will be challenging to build on.

The Gracefield 2 reservoir site presents significant difficulties with traffic management, access to the site and available area for construction laydown. The Gracefield site is least preferred.

The Cambridge Terrace and Naenae reservoir sites share many characteristics, and a similar construction methodology could be employed for each. The Naenae site is preferred due to the existing access already in place and the significantly reduced length of pipeline required.

Both sites offer an opportunity for value engineering to reduce construction duration and cost. Construction risks identified in this report will need to be addressed as the design progresses and the recommendations in section 6.3 should be considered.

6.3 Recommendations

The following recommendations should be considered if the project progresses.

1. The project will be a significant earthworks project before the reservoir can be constructed and access needs to be considered within the earthworks design.

2. Disposal of excavated material is a significant risk to the project. It is recommended that early investigation of cut to fill opportunities on site are explored to help expand the available site footprint for the Contractor and reduce the volume of fill to be taken off-site.

3. A benefit vs cost assessment is carried out between steepening and stabilising the cut face vs having to cart more spoil off-site.

4. Investigation into the consenting of a local area to receive the clean fill is undertaken to reduce the distance trucks must cart spoil.

5. Different pipe material such as PE is considered when the pipe alignment is to navigate numerous changes in direction along local access roads.

6. Where possible trenchless methods are used under KiwiRail property to avoid having to use block of lines to construct the pipeline.

7. The designer engages in further ECI to establish the construction sequence regarding post-tensioning vs floor and roof construction. The Contractor will likely need to build the reservoir using cranes in the middle of the structure and work their way out. Consideration will need to be given to when the walls are post-tensioned and how they connect to the roof vs what precast roof elements can be lifted into place.

8. Positioning of the proposed reservoir should consider the future decommissioning or refurbishment of the existing reservoirs. The new reservoir location should allow suitable safe offsets to enable safe excavation and access for future projects.

Appendix A: Site Assessment Options Matrix

Option 1: Description 1	Naenae 2
Option 2: Description 2	Gracefield 2
Option 3: Description 3	Cambridge Terrace

Item	**Discription**	Notes	Weighting	Score			Average			Scores		
				Option 1	**Option 2**	**Option 3**	**Option 1**	**Option 2**	**Option 3**	**Option 1**	**Option 2**	**Option 3**
Access	Suitability for heavy plant to access the site		1	3	0	2	3.0	0.0	2.0	3.0	0.0	2.0
	Suitability for material deliveries		1	3	1	2	3.0	1.0	2.0	3.0	1.0	2.0
	Extent of enabling works required to access the site		1	3	2	1	3.0	2.0	1.0	3.0	2.0	1.0
	Land Ownership		1	2	2	0	2.0	2.0	0.0	2.0	2.0	0.0
	Traffic Management		1	2	0	3	2.0	0.0	3.0	2.0	0.0	3.0
		Total for category	5							13.0	5.0	8.0
Environmental	Potential carbon use		1	1	2	3	1.0	2.0	3.0	1.0	2.0	3.0
	Risk of environmental incident during construction		1	3	1	2	3.0	1.0	2.0	3.0	1.0	2.0
	Negative effect on stakeholders during construction		1	1	3	2	1.0	3.0	2.0	1.0	3.0	2.0
	Noise		1	1	3	2	1.0	3.0	2.0	1.0	3.0	2.0
	Vibration		1	1	3	2	1.0	3.0	2.0	1.0	3.0	2.0
		Total for category	5							7.0	12.0	11.0
Critical Risk (HSE)	Working at Height		1	2	1	2	2.0	1.0	2.0	2.0	1.0	2.0
	Suspended Loads		1	2	2	2	2.0	2.0	2.0	2.0	2.0	2.0
	Heavy Vehicle movements		1	1	2	3	1.0	2.0	3.0	1.0	2.0	3.0
	Live Traffic		1	3	1	2	3.0	1.0	2.0	3.0	1.0	2.0
	Stability of cut slope		1	2	1	3	2.0	1.0	3.0	2.0	1.0	3.0
	Trenches and open excavations		1	3	1	2	3.0	1.0	2.0	3.0	1.0	2.0
	Services and Stored Energy (such as overhead powerlines)		1	3	1	2	3.0	1.0	2.0	3.0	1.0	2.0
	Work around existing structure		1	2	1	3	2.0	1.0	3.0	2.0	1.0	3.0
	-	Total for category	8							18.0	10.0	19.0
Inlet / Outlet Pipeline	Scope of construction required		2	4	1	2	8.0	2.0	4.0	16.0	4.0	8.0
	Traffic Management		1	3	1	2	3.0	1.0	2.0	3.0	1.0	2.0
	Disruption to Stakeholders		1	3	1	2	3.0	1.0	2.0	3.0	1.0	2.0
	Critical Intersections / Crossings		1	3	1	2	3.0	1.0	2.0	3.0	1.0	2.0
		Total for category	5							25.0	7.0	14.0
Geotechnical	Ground Conditions favourable to construction method		1	1	1	1	1.0	1.0	1.0	1.0	1.0	1.0
	Risk of rock breaking required		1	2	1	3	2.0	1.0	3.0	2.0	1.0	3.0
	Slope stabilisation risk		1	2	1	3	2.0	1.0	3.0	2.0	1.0	3.0
		Total for category	3							5.0	3.0	7.0
Construction Method	Cost		1	4	1	2	4.0	1.0	2.0	4.0	1.0	2.0
	Ease of construction		2	3	1	2	6.0	2.0	4.0	12.0	4.0	8.0
	Ability to achieve quality		1	3	1	2	3.0	1.0	2.0	3.0	1.0	2.0
	Avalibility of materials and plant		1	2	2	2	2.0	2.0	2.0	2.0	2.0	2.0
	Programme		1	3	1	2	3.0	1.0	2.0	3.0	1.0	2.0
		Total for category	6							24.0	9.0	16.0
	-											
									Overall score	92.0	46.0	75.0

Appendix J

Contaminated Land Assessment

Memorandum

To	George Beveredge
Copy	Colin Jowett, Alyce Lysaght, Ben Gentile
From	Ray Forrest
Office	Hamilton
Date	10 March 2022
File/Ref	\\corp.pbwan.net\ANZ\ProjectsNZ\3w\3-WW021.02 Naenae No.2 Reservoir
Subject	Cambridge Terrace Reservoir HAIL Check

1 Introduction

WSP is working with Wellington Water Limited (the client) to provide options for delivery of the new Lower Hutt Central reservoir (the project). The new reservoir will be constructed at a suitably available location with the same top water level (TWL) as the existing Naenae/ Gracefield/Taita reservoirs. The purpose of the project is to ensure efficient water supply operation.

One of the proposed reservoir sites is located on a hill to the east side of Cambridge Terrace in Naenae. The project will include construction of the reservoir and an access road. The access road will be constructed partially within the neighbouring property to the North.

We have undertaken this hazardous activities and industries list[1] (HAIL) review to provide information on potential contaminated land risks for the site located at Cambridge Terrace, Naenae (The Site). The Ministry for the Environment (MfE) maintain the HAIL which is 'a compilation of activities and industries that are considered likely to cause land contamination resulting from hazardous substance use, storage or disposal. The HAIL is intended to identify most situations in New Zealand where hazardous substances could cause, and in many cases have caused, land contamination.' We have considered the activities and industries listed therein during this review.

1.1 Scope of Work

In providing this desktop HAIL assessment WSP have undertaken the following:

- A review of the Greater Wellington Regional Council's (WRC) Listed Land Use Register (LLUR) GIS mapping database[2].

[1] Hazardous Activities and Industries List (HAIL), 2011, Ministry for the Environment

[2] https://mapping.gw.govt.nz/GW/GWpublicMap_Mobile/?webmap=72ece62d902e4c3fb6506136104abbf9 accessed 04/03/2022

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- A review of historical aerial photographs available on Retrolens[3] Historical Image Resource and Google Earth[4] historical Imagery
- Preparation of this memorandum to document information reviewed, identification of HAIL sites, and discussion of potential contamination risks.

2 Desktop HAIL review

2.1 WRC SLUR

Greater Wellington Regional Council (GWRC) maintain an online Selected Land Use Register (SLUR) which contains information on known or suspected HAIL sites within the region. We reviewed the SLUR for the site and immediately surrounding properties. The findings are summarised in Table 2-1 and shown in Figure 1 below.

The larger property within which the site is located is not identified on the SLUR.

Table 2-1 SLUR Summary

Property	SLUR file Number	Hail Category	Potential contaminants of concern	Approximate distance to site
PICK-A-PART, 2 Eastern Hutt Road	SN/03/629/02	**G4**: Scrap yards including automotive dismantling, wrecking or scrap metal yards	Metals, petroleum hydrocarbons (particularly lube oils), solvents used for cleaning, and PCBs	155 m to the North
Taita Cemetery, Upper Hutt	SN/04/333/02	**G1**: Cemeteries	Nitrates, lead, mercury, formaldehyde, and biological hazards	102 m to the South
Wingate Landfill	SN/03/061/02	**G3**: Landfill sites	Dependent on original waste composition, wide range of hydrocarbons and metals, organic acids, landfill gas, and ammonia	267 m to the East

[3] https://retrolens.co.nz/ accessed 04/03/2022
[4] https://earth.google.com/web/ accessed 04/03/2022

Figure 1- Location of SLUR Sites

2.2 Historical Aerial Photographs

WSP reviewed the available aerial photographs for the project areas. The review did not uncover evidence to support suspected HAIL activities within the project area. The site appears to have been hillside scrubland since the earliest imagery from 1939. Copies of aerial photographs are included as Attachment A.

The aerial photography summary in Table 2-2 below is limited to summary observations considered by WSP as directly relevant to the site.

Table 2-2 Historical Imagery Summary Review

Year/s Source	Observations
1939 -1941 Retrolens	Site is undeveloped land, surrounding landscape is dominated by market gardens. Taita Cemetery is visible.
1957 Retrolens	Site is undeveloped land, surrounding landscape is residential, Wingate Landfill appears active
1966 – 1980 Retrolens	Site is undeveloped land, fire breaks have been cleared on surrounding ridgelines.
1995 - 2000 Retrolens	Site is undeveloped land, Pick A Part site can be seen with vehicles.
2005 – 2012 Google earth	Site is undeveloped land, Wingate landfill appears to be capped.
2016 – 2019 Google Earth	Site is undeveloped land,

3 Findings

As a result of this review, we have identified two HAIL activities within 200 m and one HAIL activity >200 m from the site as indicated in Table 2-1 and Figure 1.

- One HAIL activity is occurring within a part of the proposed access road and is located within 200 m of the proposed reservoir siting
    - G4 – Scrap Yards
- One HAIL activity is occurring within 200 m downgradient of the site identified on the GWRC SLUR as
    - G1 – Cemeteries
- One HAIL activity is occurring greater than 200 m from the site identified on the GWRC SLUR as:
    - G3 – Landfill Sites

4 Conclusion

Due to location and likely contaminant source/extent, the Cemetery and vehicle parts yard are highly unlikely to pose a risk to the site. The proposed access road will partly be constructed on the property where Pick a Part is located, however there is no evidence from the aerial photography that this area of the property has been used for the storage or dismantling of vehicles.

The landfill is unlikely to pose a risk; however, we would advise that further information is sought with respect to the landfill. We would recommend that an enquiry is made particularly for records in relation to groundwater or ground gas investigations or compliance monitoring at the landfill. The records would provide evidence to assist in determining if the migration of contaminated groundwater or gas may impact the proposed site.

5 Closing

If you have any questions on the information this memo, please do not hesitate to contact Ray Forrest (Ray.Forrest@WSP.com) or Colin Jowett (Colin.Jowett@wsp.com)

Prepared by

Ray Forrest
Contaminated Land Consultant

Reviewed by

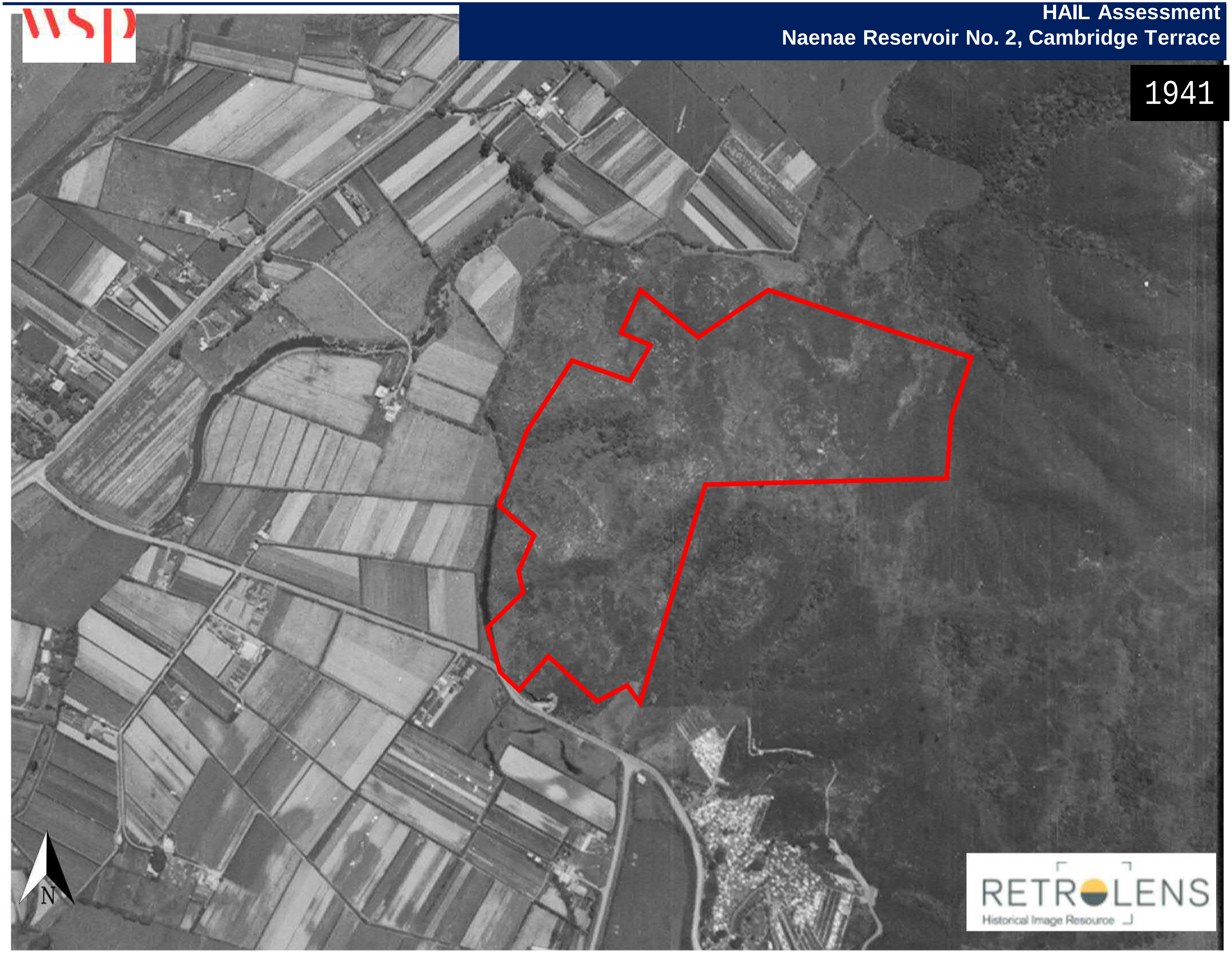
Colin Jowett
Principal Scientist- Environment

Attachment A

Historic Aerial Photos

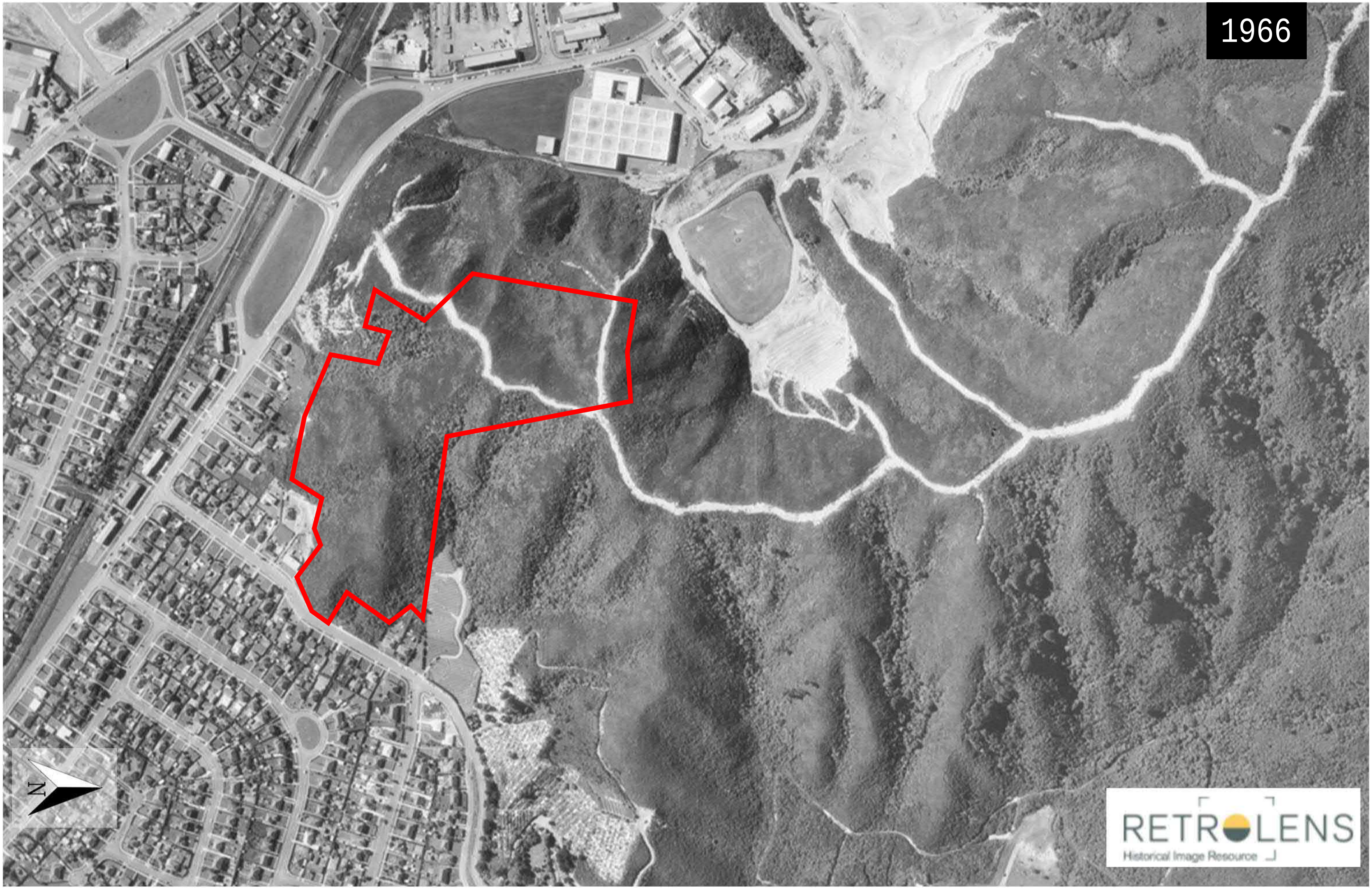
Approximate Property Location

HAIL Assessment
Naenae Reservoir No. 2, Cambridge Terrace



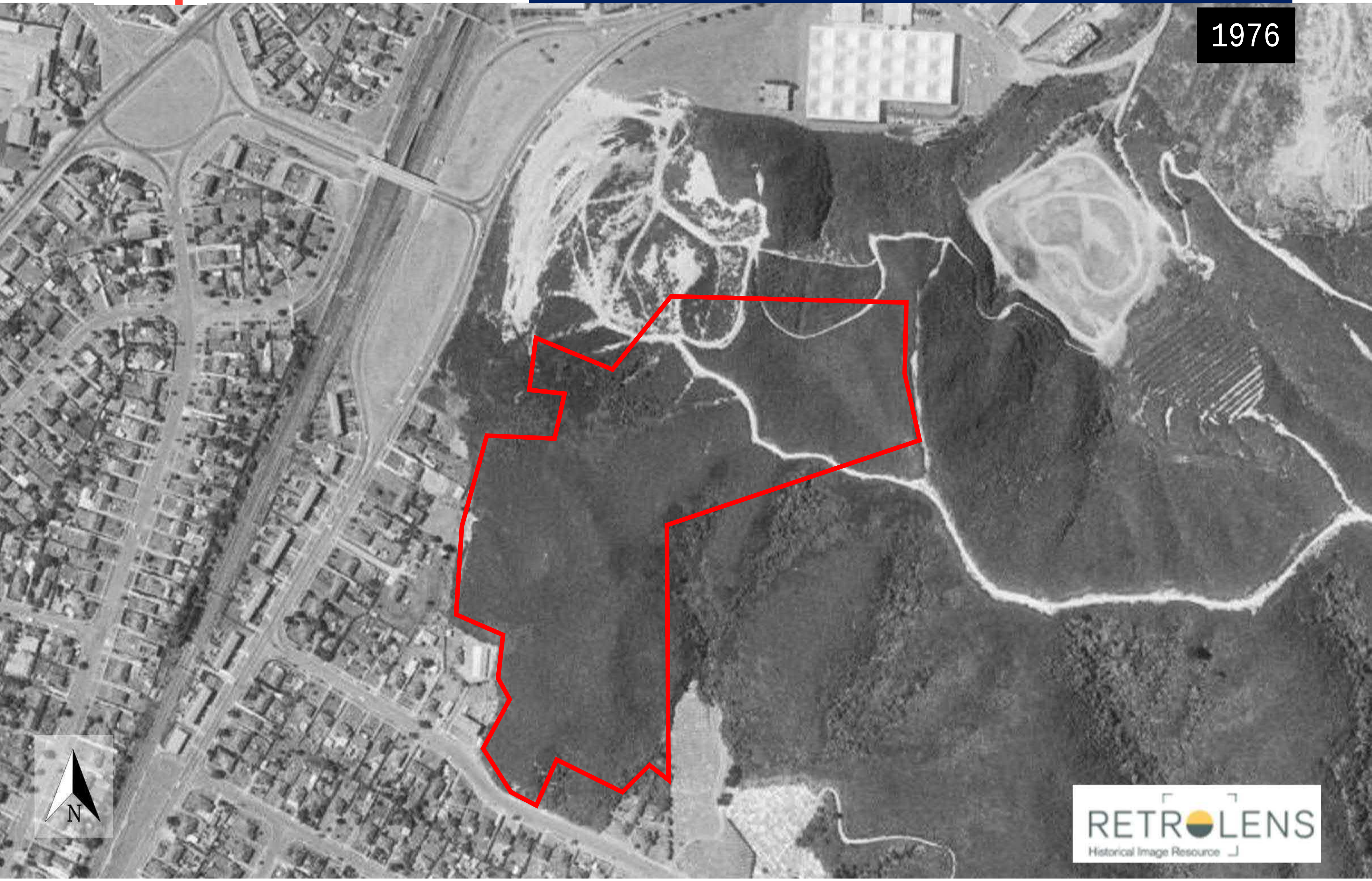
Approximate Property Location

Approximate Property Location



Approximate Property Location

Approximate Property Location



Approximate Property Location

Approximate Property Location

Approximate Property Location

Approximate Property Location

Approximate Property Location

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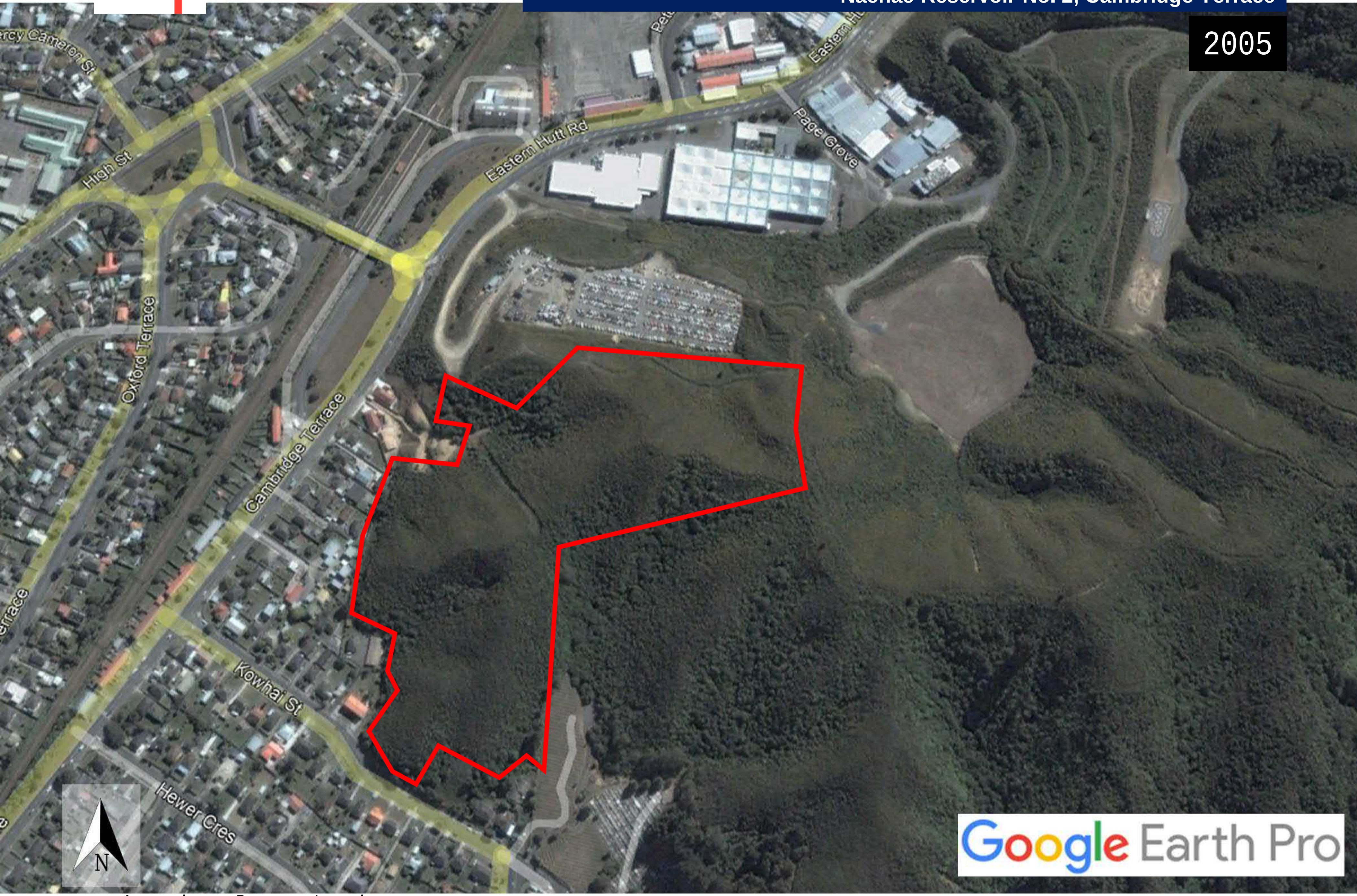
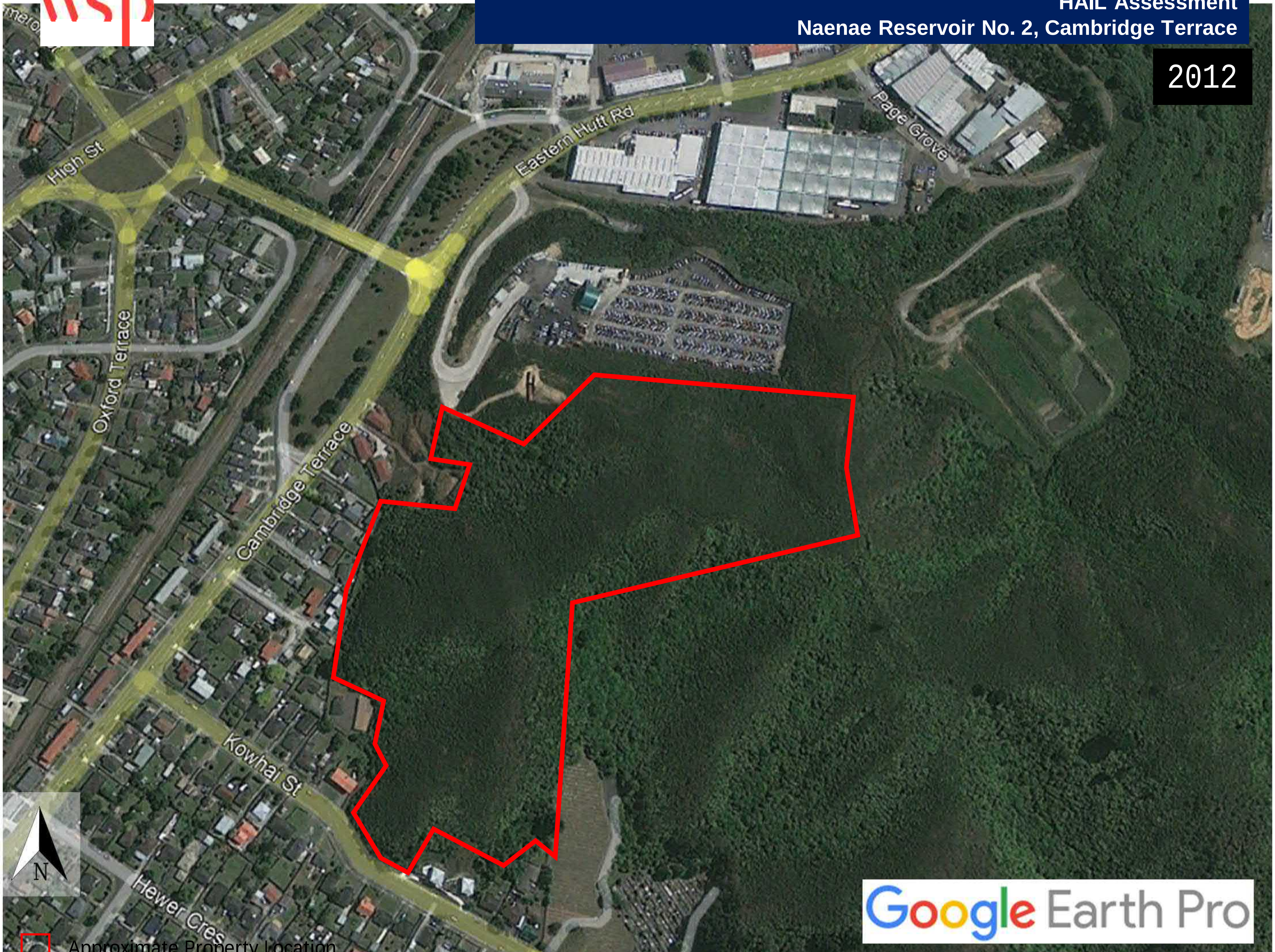


Approximate Property Location

HAIL Assessment
Naenae Reservoir No. 2, Cambridge Terrace



Approximate Property Location

Approximate Property Location

Approximate Property Location

Google Earth Pro

Appendix K

Planning Assessment

Regulatory Framework Scoring Criteria

Score		Description	Risks
7	**Strong positive**	This option meets regulatory requirements. No statutory approvals required.	Negligible
6	**Moderate positive**	The option presents few difficulties in terms of meeting regulatory requirements and obtaining statutory approvals. Likely that only one application will need to be made to each statutory authority.	Very low
5	**Slight positive**	The option presents minor areas of difficulty in terms of meeting regulatory requirements and obtaining statutory approvals. Likely that only one application will need to be made to each statutory authority.	Low
4	**Neutral**	This option presents some difficulties in terms of meeting regulatory requirements and obtaining statutory approvals.	Moderate –tolerable
3	**Slight negative**	This option presents some difficulties in terms of meeting regulatory requirements and obtaining statutory approvals. Likely that more than one application will need to be made to each statutory authority.	High
2	**Moderate negative**	This option presents extensive difficulties in terms of meeting regulatory requirements and obtaining statutory approvals. Likely that more than one application will need to be made to each statutory authority.	Very high
1	**Strong negative**	This option contradicts regulatory requirements and presents extreme difficulties obtaining statutory approvals. Likely that more than one application will need to be made to each to each statutory authority.	Extreme – unacceptable

Regulatory Framework Scoring

SITE	REGULATORY RISKS	SCORE
Cambridge Tce	This land parcel is located within a significant natural resource site. There are potentially more issues to address in the consent applications due to multiple landownership and mixed land uses in the vicinity, which is reflected in the scoring. It is noted though, that a single application to each authority is required (HCC and GWRC).	4
Naenae	This land parcel is located within a significant natural resource site. Whilst the site is located in the vicinity of an established residential area, the proposed activity is not considered to deviate from its current land use because there is an existing underground reservoir within the site. However, an existing walking track traverses the site and mitigation to minimise effects on amenity and recreational values will likely be required. Despite the presence of planning risks at this location, its proximity to a similar existing use may provide a level of acceptance for a new reservoir. In addition, a single application is required to both HCC and GWRC.	5
Gracefield	The proposed construction area is located within a significant natural resource site and is also subject to the Conservation Act and Reserves Act. As a result, in addition to the resource consent applications to HCC and GWRC, approval is required from Department of Conservation and Hutt City Council's Parks and Reserves team. There are no residential properties nearby. The site contains an existing reservoir and is surrounded by established commercial land uses. Despite the presence of the above planning risks at this location, mitigation required to minimise potential adverse is comparatively low. However, as previously noted, separate applications to HCC, GWRC and DOC are required. It is also noted that the applications to DOC and HCC's Parks and Recreation team are not subject to any statutory timeframes, which is reflected in the scoring.	3

Appendix L

Cost Estimates and Carbon Assessment

Refer Appendix O for revised estimates

Lower Hutt Reservoir Project

Cost and Carbon Estimate Report

Our water, our future.

Document information

People involved

Activity	Title	Name	Electronic signature	Date
Prepared by	Cost Manager	Dirk Jansen van Vuuren		08/03/2022
Prepared by	Sustainability Consultant	Caroline Hope		08/03/2022
Reviewed by	Cost Manager	Michael Crutchley		09/03/2022
Reviewed by	Cost Manager	Barry Wallace		09/03/2022

Revision history

Date	Version number	Description of change
03/03/2022	0.1	First draft
08/03/2022	0.2	Second draft
08/03/2022	0.3	Final

Table of contents

List of appendices

1 Executive Summary

Connect Water has been engaged to provide Feasibility Design (Level 1) Cost Estimates for the Lower Hutt Reservoir project.

The estimated Total Costs as set out in Section 4 has been developed from the feasibility design package as provided by WSP.

Please refer to the clarifications, assumptions, exclusions, and items of cost risks that are outlined within the body of this estimate report.

The report also analyses the embodied carbon content for the respective options, as summarised in Section 6.

The current design assumes a conventional 15ML circular Precast concrete reservoir structure, with 750mm CLS inlet, outlet, and overflow pipes in trenches at an average depth of 2.5m.

Please note that all values within this report and included in the attached estimate details are GST exclusive.

2 Introduction

This feasibility design estimate report has been prepared to establish the likely cost for the development of the Lower Hutt Reservoir project.

The project identifies 3 possible locations for a 15ML precast concrete Reservoir. The purpose of this report is to provide the reader with a high-level overview of the options, how they compare and to highlight where they differ.

As the same precast concrete reservoir design has been assumed for all three options it is not expected that the inclusion of a Whole of Life Costing would change the relative performance between options, and thus has not been included.

The report also reviews the embodied carbon in the structural elements of the project. It compares the 3 options and describes the methodology of how the embodied carbon is calculated.

3 Basis of Estimate

3.1 Design Documentation and Cost Basis

This level 1 cost estimate and carbon assessment has been prepared using information and modelled construction quantities provided by the engineer and accompanying design query responses.

The estimate has been prepared in accordance with the WWL Cost Estimation Manual, however it is to be noted that we are currently at Feasibility design phase and a Level 1 cost estimate would generally be prepared with a Concept design. The Feasibility design information received is of a standard that the contingencies and funding risk allowances included in a Level 1 estimate would be suitable.

We have based our estimate on the quantities provided by the engineer, Kidd Civil Report, accompanying design query responses, as well as utilising existing knowledge of the scope of works.

Some of the design information is still very limited and several areas of scope remain undefined. All aspects of the design of this current scheme are subject to further design development.

3.2 Escalation

It should be noted that an escalation allowance has been allowed for up until the 3rd quarter 2024 (excluding any major market fluctuations) has been included within this Level 1 estimate. Escalation have been calculated based on an estimated construction period provided by the engineer.

4 Estimate Summary

Table 1: Cost Estimate Assessment Comparison

Phase	Naenae 2 ($)	Gracefield 2 ($)	Cambridge Terrace ($)
Professional Costs (18%, as per WWL Manual)	**6,686,000**	**15,179,000**	**12,049,000**
WWL Management Fee (8%)	**2,972,000**	**6,746,000**	**5,355,000**
Construction			
Demolition & Site Clearance	223,000	241,000	223,000
Earthworks	5,250,000	5,250,000	3,045,000
Retaining Walls	698,000	5,022,000	0
Concrete Reservoir (15ML)	6,213,000	6,213,000	6,213,000
Inlet/outlet Pipework, Valves, fittings, etc.	12,695,000	40,800,000	35,900,000
Electrical, Instruments & Controls	150,000	150,000	150,000
Access track	38,000	413,000	238,000
Traffic Management (Site Specific)	2,224,000	5,135,000	4,545,000
Miscellaneous Items	552,000	560,000	296,000
Testing and Commissioning	100,000	100,000	100,000
Sub Total	**28,143,000**	**63,884,000**	**50,710,000**
On-Site Overheads (20%)	5,629,000	12,777,000	10,142,000
Off Site O/H & Profit (10%)	3,377,000	7,666,000	6,085,000
Total Physical Works	**37,149,000**	**84,327,000**	**66,937,000**
Base Estimate	46,807,000	106,252,000	84,341,000
Escalation (3rd Qtr 2024)	5,931,000	13,466,000	10,687,000
Escalated Base Estimate	**52,738,000**	**119,718,000**	**95,028,000**
Contingency (40%)	21,095,000	47,887,000	38,011,000
Expected Estimate	**73,833,000**	**167,605,000**	**133,039,000**

Phase	Naenae 2 ($)	Gracefield 2 ($)	Cambridge Terrace ($)
Funding Risk (60%)	31,643,000	71,831,000	57,017,000
95th Percentile Estimate	**105,476,000**	**239,436,000**	**190,056,000**

Please refer to Appendix A for the complete summaries and comparative Costing estimates.

Please refer to Section 5 for a full list of assumptions, clarifications and risks which form the basis of this preliminary estimate.

Note 1: Main Contractor Preliminary and General (P&G) is included as a separate line item in the estimate summary. P&G otherwise known as On-Site Overhead costs covers the cost of on-site overheads such as site supervision / management, site offices, stores, hoardings, amenities, plant, cranes, temporary works, etc.

The percentage allowance for Preliminaries and General have been assessed at 20%.

Note 2: Contractor Overhead & Profit is included as a separate line item in the estimate summary. This covers the cost of contributions to cover the Main Contractor's business operational costs, i.e. off-site overhead costs such as executive management, accounts, quality and health & safety systems and company profits.

Contingencies cover general design development, procurement uncertainty and other risks. We would expect these sums to be incorporated into the estimated build costs as the design progresses.

5 Estimate Notes

5.1 Assumptions and Clarifications

- A contingency to cover items of unforeseen detail and design development has been included in the estimate. This contingency is expected to be converted to scope, and therefore should not be regarded as discretionary.

- It is important to note that New Zealand is currently experiencing significant movement in pricing across many sub-trades due to the current buoyant construction market coupled with supply issues due to, amongst other reasons Covid-19. This is putting pressure on resources which is resulting in unpredictable and generally escalating pricing.

- The proposed sites still have significant uncertainty, specifically with regards to the constructability of the Reservoir at the proposed sites as well as proposed access roads, excavation volumes, etc and is subject to further design investigation.

- The cost estimates presented have been developed for the purposes of comparing options and should not be used for any other purpose.

- It is assumed that all of the work will be undertaken by a single 'Main Contractor' through a single contract for the project.
- Sufficient storage and laydown area will be provided on-site for the contractor.
- All base prices are current to 1st Qtr 2022, but escalation included to 3rd Qtr 2024.
- Elements of cost included within this estimate are based on costs from similar projects and other Beca cost benchmarks.
- It is noted that in-situ concrete construction was considered for Gracefield Reservoir, however for the purpose comparing the 3 reservoir options, Precast concrete was assumed for all 3 options.
- An average depth of 2.5m deep trench for all inlet, outlet, and overflow pipework.
- Excavations to be 50% soft rock, 50% moderate rock (moderate rock excavations assumed to be done with medium-large excavator), as per engineer.
- As there is still significant design uncertainty for the access road, a general $/m2 rate has been applied to provide indicative costing.
- Work during normal hours only.
- Professional fees and consent fees are to be developed and subsequently an allowance has been applied to the estimate to cover these anticipated costs. Allowances generally in accordance with WWL Estimating Manual.
- The working space is sufficient for temporary works.
- The project will be procured on a competitive basis.
- No allowance has been made for the impacts of extraordinary global events (such as the current COVID-19 outbreak) within the base estimate.
- Single lane access road.
- All fill to be imported fill (except were stated otherwise).
- Residential, commercial, and industrial roads – trenching assumed to be 100% in the road corridor and single lane road closure.
- Stream and Railway crossings assumed to be trenchless construction.
- Traffic management throughout the duration of the project applied to pipeline and reservoir construction.
- No allowance has been included for a transformer on the assumption that the local infrastructure has sufficient capacity to service the new reservoir.

5.2 Exclusions

- Excavation in hard rock
- Unfavourable ground and soil conditions e.g., ground water (excluded)
- Contaminated material removal and/or replacement
- Fast track or accelerated programme
- GST
- Capitalised interest
- Costs to date
- Operation and maintenance costs
- Insurance costs
- Legal and finance fees
- Property costs
- Protection to native flora and fauna

6 Capital Carbon Assessment

The objective of this assessment is to understand the relative capital carbon impact of the three reservoir location options, so cost and carbon are both used in decision making.

6.1 Introduction to Carbon

Carbon is shorthand for the carbon dioxide equivalent of all greenhouse gas emissions (GHGs). Different GHGs have varying degrees of global warming potential, over the same time period. Carbon is quantified as 'tonnes of carbon dioxide equivalent' (tCO_2-e).

Emissions produced over the life cycle of an asset are generally put into two groups, operational emissions and embodied emissions. Operational carbon emissions occur only during the use stage of an asset's life and are from the energy and other resources used when operating the asset. Embodied carbon emissions are from the materials and products that form the asset and can occur right across the asset's life cycle.

6.2 Capital Carbon Assessment Scope

Capital carbon is defined as the emissions associated with the creation of assets, also referred to as upfront embodied emissions. Typically, this would involve the emissions associated with the manufacturing of materials, transport of materials to and from site and construction emissions.

However, as this is a high level comparative assessment we have focussed on the major elements for the purpose of understanding the relative carbon impacts of the options. As a result, this capital carbon assessment of this reservoir options has the following inclusions and exclusions:

- **Inclusions**: two emissions sources that are the typical hotspots for a capital carbon assessments:
    - embodied carbon associated with the production of the major relevant materials such as the reservoir structure (concrete and steel reinforcing), inlet/outlet pipelines and retaining walls.
    - offsite disposal of waste from Construction site for the large volumes of excavation.
- **Exclusions**: transport of materials to site; onsite construction emissions from labour and plant; offsite waste disposal other than disposal of excavated material; minor items such as valves, fittings, manholes as the relative difference between the options is reflected in the length of inlet/outlet pipe; other items that are not considered material to the final outcome i.e., Electrical, Instruments & Controls.

The boundary of this capital carbon assessment is represented as cradle-to-'built asset' in Figure 1. Hence operational emissions, embodied emissions throughout the lifecycle like replacements and end of life emissions are also excluded. As a result, this is not a whole of life assessment, but because of the similar reservoir construction and operations of all three options is not expected to change the outcome.

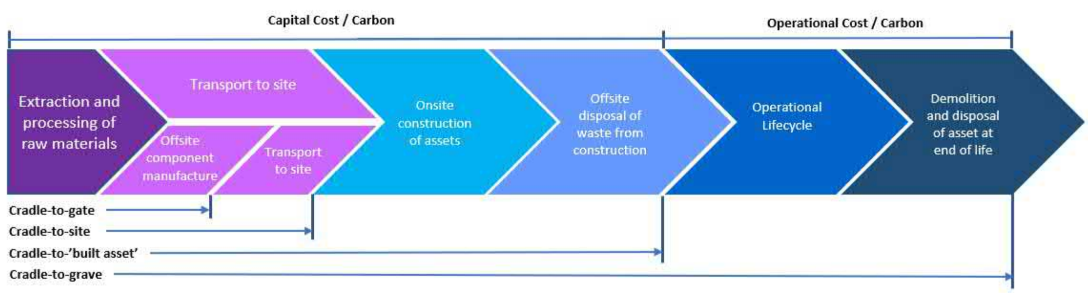


Figure 1. Life-cycle of an asset

6.3 Capital Carbon Methodology

To undertake the carbon assessment, the following inputs were used:

- **Material quantities** that were measured to form the capital cost estimate. Where required, the build-ups (unit elements) used for the rates were used as individual carbon estimate inputs. For example, a 750mm Diameter CLS pipe trench was broken into excavation, backfill, pipe and reinstatement. Each unit element then had a carbon emission factor applied as appropriate.
- **Emissions factors** were selected by the Beca Environments team from known databases of emissions factors (such as Infrastructure Council of Australasia - ISCA) for key construction materials. The emissions factors used can be provided on request.

Table 2 and Figure 2 summarise the Carbon Estimates, represented in tonnes of CO2-e.

Table 2: Carbon Estimate Assessment Comparison

Phase	Naenae 2 (tCO_2-e)	Gracefield 2 (tCO_2-e)	Cambridge Terrace (tCO_2-e)
Earthworks	762	762	457
Retaining Walls	47	339	0
Concrete Reservoir (15ML)	2,095	2,095	2,095
Inlet/outlet Pipework	764	2,483	2,183
Total (tCO_2-e)	**3,668**	**5,679**	**4,735**

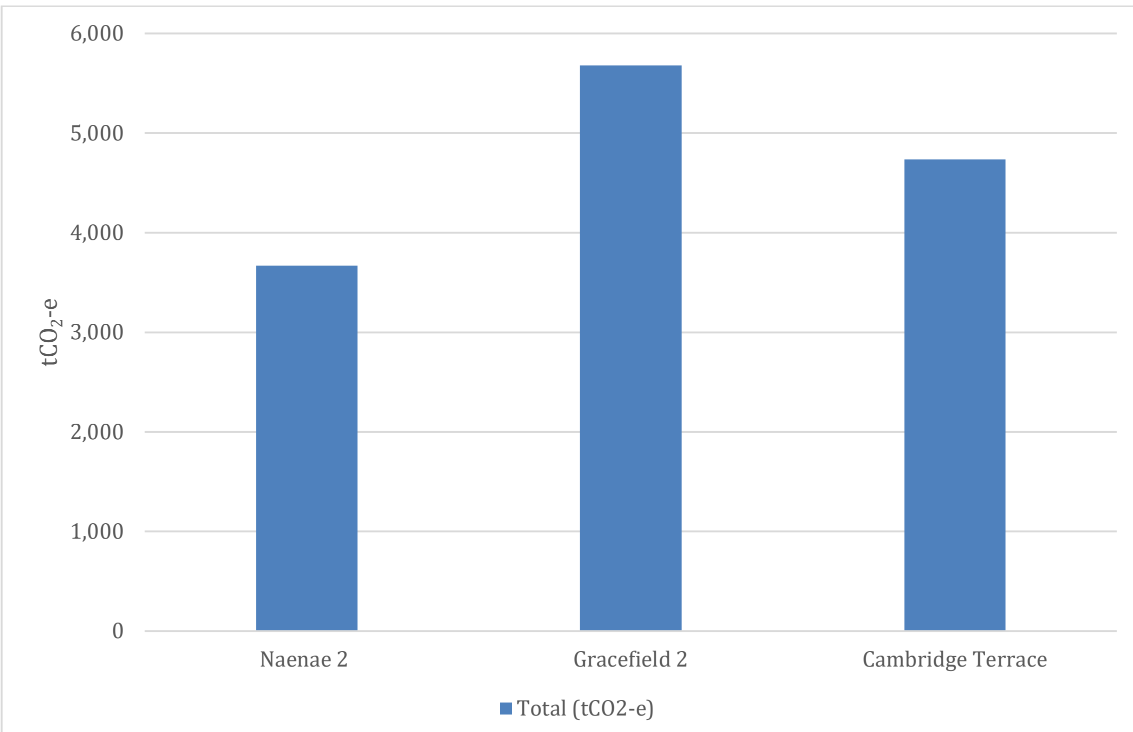


Figure 2. Reservoir location options comparison

Figure 3 highlights the key relative difference between the options:

- Earthworks: Cambridge Terrace earthworks are 40% less than the other two options due to the location that requires less excavation to provide the required construction area for the reservoir.
- Retaining walls: Compared to Naenae, Gracefield 2 has six times the carbon associated with the retaining wall while the Cambridge Terrace option does not require a retaining wall.
- Inlet/outlet pipework: Naenae is significantly closer to the main connection point hence pipework required is less. Gracefield 2 and Cambridge Terrace respectively have 325% and 286% the carbon emissions associated with the inlet/outlet pipework compared to Naenae.

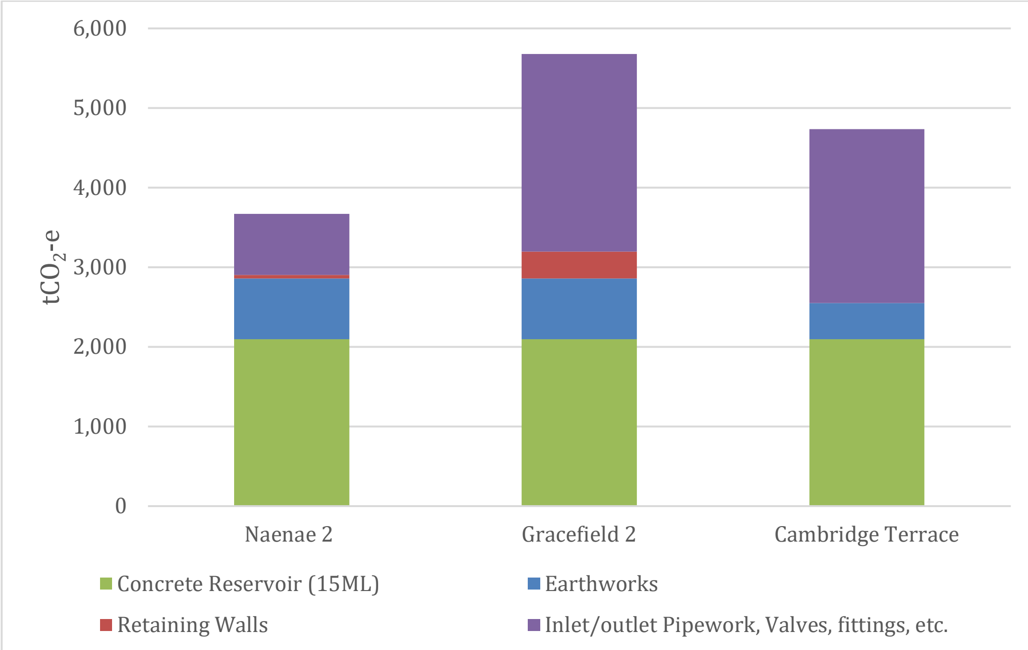


Figure 3. Reservoir location options comparison by component

6.4 Limitations

- Premiums for site-specific conditions/constraints have not been considered (access, location, confined spaces, sloping sites, contamination, and the like).
- Quantum of concrete is not reduced to account for reinforcing quantities within the concrete mass.
- All quantities are measured net and exclusive of a wastage. Wastage between different structural systems is not accounted for.
- Emissions factors can vary greatly depending on the construction material and country of origin. The factors used in this report are generic and could be looked at in further detail should the procurement strategy of the materials be known.

6.5 Exclusions

This high-level comparative assessment focusses on the major carbon contributing elements. During later design stages the carbon associated with the following items which are currently excluded could be estimated:

- Onsite construction emissions from labour and plant.
- Preliminary and General and temporary works items.
- Offsite waste disposal other than disposal of excavated material.

- Project materials other than reservoir structure, bulk excavations, inlet/outlet pipeline and retaining works. Hence minor items such as valves, fittings, manholes as well as EI&C (electrical, instruments and controls) were excluded.
- Professional services and Wellington Water direct carbon emissions.
- Carbon emissions outside the capital carbon boundary, hence emissions associated with operations, replacements, and end of life.
- Transport to site.

7 Next steps

This report shows that from a capital cost and carbon perspective Naenae 2 is the preferred site.

Note: The capital carbon assessment focussed on the major carbon contributing elements hence a number of elements were excluded. It is not expected that the inclusion of these would change the relative performance between options.

The following next steps could be considered by Wellington Water after a preferred site has been identified:

- Alternative materials and construction methodologies are explored to optimise project carbon contributions.
- Carry out more comprehensive assessments of the carbon in the Lower Hutt Reservoir project during further later design phases.
- Whole of life cost and carbon assessments conducted for the preferred option.

8 Disclaimers

8.1 Cost Estimate

This report is solely for Wellington Water Limited use for the purpose for which it is intended in accordance with the agreed scope of work.

This report must be read in its entirety and no portion of it should be relied upon without regard to the full report, especially the assumptions, limitations and disclaimers set out in the estimate notes and elsewhere in the report.

While the Cost Manager believes that the use of the assumptions, as set out elsewhere in this report, are reasonable for the purposes of this study, the Cost Manager makes no assurances with respect to the accuracy of such assumptions, and some may vary significantly due to unforeseen events and circumstances. To the extent that the conditions differ from those assumed in this report, the opinions expressed by the Cost Manager in this report may no longer be valid and should be reviewed.

In preparing this estimate, the Cost Manager has relied on the accuracy, completeness and currency of the information provided, therefore is not responsible for the information provided, and has not sought to independently verify it. To the extent that the information is inaccurate or incomplete, the opinions expressed by the Cost Manager may no longer be valid and should be reviewed.

The budget cost estimates presented in this section are typically developed based on extrapolation of recent similar project pricing, industry unit rates and the general experience of the Cost Manager. The budget estimates are based on incomplete design and other information and are not warranted or guaranteed by the Cost Manager.

8.2 Carbon Assessment

This report has been prepared by Beca Ltd (Beca) under Lower Hutt Reservoir project – Discovery Phase, dated 08 03 2022 (Agreement) between Beca and Wellington Water Limited (Client). Beca has been requested by the Client to provide a Carbon Assessment.

The contents of the report are confidential and may not be used by the Client for any purpose other than in accordance with the stated Scope. This report may not be used or relied upon by any other party and Beca accepts no liability to any person other than to the Client for issues arising out of this report.

By relying on this report, the Client confirms that:

Beca's duty of care is owed solely to the Client and no other person;

Beca's liability to the Client in relation to this report shall be subject to the same limitation of liability provided in the Agreement. To the maximum extent permitted by law, the maximum aggregate of all liability of Beca to the Client whether in contract, tort or otherwise, shall not exceed the amount of the limit provided in the Agreement;

In preparing this report Beca has relied on key information provided by the Client and information readily available in the public domain.

Unless specifically stated otherwise in this report, Beca has relied on the accuracy, completeness, currency and sufficiency of all information provided to it by, or on behalf of, any third party, including the information listed above, and has not independently verified the information provided. Beca accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the information provided. Publicly available records are often inaccurate or incomplete.

Where information has been provided by or on behalf of the Client, the Client confirms and warrants that it has the right to use such information for the purpose stated in the report.

The contents of this report are based on Beca’s understanding and interpretation of current international protocols and standards. Unless otherwise agreed, this report will not be updated to take account of subsequent changes to any standards and protocols.

Beca makes no warranties or representations to the Client or third parties (express or implied) in respect of the report, particularly with regard to any commercial investment decision made on the basis of the report. This disclaimer must accompany every copy of the report, which is an integral document and must be read in its entirety.

This report should be read in full, having regard to all stated assumptions, limitations and disclaimers. To the maximum extent permitted by law, no responsibility is accepted for the use of any part of this report in any other context or for any other purpose not stated in this report.

Appendix A: Cost Estimate Summaries

Sensitivity: General

LEVEL 1 ESTIMATE

Project Name:	Naenae 2
Current Phase:	Feasibility
Base Date:	Mar-22

Phase	Description	Base Estimate	Escalation (3rd Quarter 2024)	Total
Professional Costs				
	Development	$ 1,114,000	$ 141,000	$ 1,255,000
	Consenting	$ 1,114,000	$ 141,000	$ 1,255,000
	Detailed design	$ 2,415,000	$ 306,000	$ 2,721,000
	Procurement	$ 186,000	$ 24,000	$ 210,000
	Construction	$ 1,857,000	$ 235,000	$ 2,092,000
	Total Project Professional Costs	$ 6,686,000	$ 847,000	$ 7,533,000
Wellington Water Management Fee				
	WWL Management Fee	$ 2,972,000	$ 377,000	$ 3,349,000
	Total WWL Management Fee	$ 2,972,000	$ 377,000	$ 3,349,000
Construction				
	Physical Works			
	Demolition & Site Clearance	$ 223,000	$ 28,000	$ 251,000
	Earthworks	$ 5,250,000	$ 665,000	$ 5,915,000
	Retaining Walls	$ 698,000	$ 88,000	$ 786,000
	Concrete Reservoir (15ML)	$ 6,213,000	$ 787,000	$ 7,000,000
	Inlet/outlet Pipework, Valves, fittings, etc.	$ 12,695,000	$ 1,609,000	$ 14,304,000
	Electrical, Instruments & Controls	$ 150,000	$ 19,000	$ 169,000
	Access track	$ 38,000	$ 5,000	$ 43,000
	Traffic Management (Site Specific)	$ 2,224,000	$ 282,000	$ 2,506,000
	Miscellaneous Items	$ 552,000	$ 70,000	$ 622,000
	Testing and Commissioning	$ 100,000	$ 13,000	$ 113,000
	SubTotal	$ 28,143,000	$ 3,566,000	
	On Site Overheads (20%)	$ 5,629,000	$ 713,000	$ 6,342,000
	Off Site O/H & Profit (10%)	$ 3,377,000	$ 428,000	$ 3,805,000
	Total Physical Works	$ 37,149,000	$ 4,707,000	$ 41,856,000
Base Estimate				
	Base Estimate	$ 46,807,000		
	Escalation (3rd Quarter 2024)	12.7%	$ 5,931,000	
	Escalated Base Estimate			$ 52,738,000
Expected Estimate				
	Contingency	40.0%	21,095,000	$ 21,095,000
	Expected Estimate			**$ 73,833,000**
95th Percentile Estimate				
	Funding Risk	60.0%	31,643,000	$ 31,643,000
	95th Percentile Estimate			**$ 105,476,000**

Notes: This estimate is exclusive of GST.

Approvals	Name	Signature	Date
Prepared by:	Dirk Jansen van Vuuren		3/03/2022
Verified by:	Barry Wallace		7/03/2022

Sensitivity: General

LEVEL 1 ESTIMATE

Project Name:	Cambridge Terrace
Current Phase:	Feasibility
Base Date:	Mar-22

Phase	Description	Base Estimate	Escalation (3rd Quarter 2024)	Total
Professional Costs				
	Development	$ 2,008,000	$ 254,000	$ 2,262,000
	Consenting	$ 2,008,000	$ 254,000	$ 2,262,000
	Detailed design	$ 4,351,000	$ 551,000	$ 4,902,000
	Procurement	$ 335,000	$ 42,000	$ 377,000
	Construction	$ 3,347,000	$ 424,000	$ 3,771,000
	Total Project Professional Costs	$ 12,049,000	$ 1,525,000	$ 13,574,000
Wellington Water Management Fee				
	WWL Management Fee	$ 5,355,000	$ 679,000	$ 6,034,000
	Total WWL Management Fee	$ 5,355,000	$ 679,000	$ 6,034,000
Construction				
	Physical Works			
	Demolition & Site Clearance	$ 223,000	$ 28,000	$ 251,000
	Earthworks	$ 3,045,000	$ 386,000	$ 3,431,000
	Retaining Walls	$ -	$ -	$ -
	Concrete Reservoir (15ML)	$ 6,213,000	$ 787,000	$ 7,000,000
	Inlet/outlet Pipework, Valves, fittings, etc.	$ 35,900,000	$ 4,550,000	$ 40,450,000
	Electrical, Instruments & Controls	$ 150,000	$ 19,000	$ 169,000
	Access track	$ 238,000	$ 30,000	$ 268,000
	Traffic Management (Site Specific)	$ 4,545,000	$ 576,000	$ 5,121,000
	Miscellaneous Items	$ 296,000	$ 38,000	$ 334,000
	Testing and Commissioning	$ 100,000	$ 13,000	$ 113,000
	SubTotal	$ 50,710,000	$ 6,427,000	
	On Site Overheads (20%)	$ 10,142,000	$ 1,285,000	$ 11,427,000
	Off Site O/H & Profit (10%)	$ 6,085,000	$ 771,000	$ 6,856,000
	Total Physical Works	$ 66,937,000	$ 8,483,000	$ 75,420,000
Base Estimate				
	Base Estimate	$ 84,341,000		
	Escalation (3rd Quarter 2024)	12.7%	$ 10,687,000	
	Escalated Base Estimate			$ 95,028,000
Expected Estimate				
	Contingency	40.0%	38,011,000	$ 38,011,000
	Expected Estimate			**$ 133,039,000**
95th Percentile Estimate				
	Funding Risk	60.0%	57,017,000	$ 57,017,000
	95th Percentile Estimate			**$ 190,056,000**

Notes: This estimate is exclusive of GST.

Approvals	Name	Signature	Date
Prepared by:	Dirk Jansen van Vuuren		3/03/2022
Verified by:	Barry Wallace		7/03/2022

LEVEL 1 ESTIMATE

Project Name:	Gracefield 2
Current Phase:	Feasibility
Base Date:	Mar-22

Phase	Description	Base Estimate	Escalation (3rd Quarter 2024)	Total
Professional Costs				
	Development	$ 2,530,000	$ 321,000	$ 2,851,000
	Consenting	$ 2,530,000	$ 321,000	$ 2,851,000
	Detailed design	$ 5,481,000	$ 695,000	$ 6,176,000
	Procurement	$ 422,000	$ 53,000	$ 475,000
	Construction	$ 4,216,000	$ 534,000	$ 4,750,000
	Total Project Professional Costs	$ 15,179,000	$ 1,924,000	$ 17,103,000
Wellington Water Management Fee				
	WWL Management Fee	$ 6,746,000	$ 855,000	$ 7,601,000
	Total WWL Management Fee	$ 6,746,000	$ 855,000	$ 7,601,000
Construction				
	Physical Works			
	Demolition & Site Clearance	$ 241,000	$ 31,000	$ 272,000
	Earthworks	$ 5,250,000	$ 665,000	$ 5,915,000
	Retaining Walls	$ 5,022,000	$ 636,000	$ 5,658,000
	Concrete Reservoir (15ML)	$ 6,213,000	$ 787,000	$ 7,000,000
	Inlet/outlet Pipework, Valves, fittings, etc.	$ 40,800,000	$ 5,171,000	$ 45,971,000
	Electrical, Instruments & Controls	$ 150,000	$ 19,000	$ 169,000
	Access track	$ 413,000	$ 52,000	$ 465,000
	Traffic Management (Site Specific)	$ 5,135,000	$ 651,000	$ 5,786,000
	Miscellaneous Items	$ 560,000	$ 71,000	$ 631,000
	Testing and Commissioning	$ 100,000	$ 13,000	$ 113,000
	SubTotal	$ 63,884,000	$ 8,096,000	
	On Site Overheads (20%)	$ 12,777,000	$ 1,619,000	$ 14,396,000
	Off Site O/H & Profit (10%)	$ 7,666,000	$ 972,000	$ 8,638,000
	Total Physical Works	$ 84,327,000	$ 10,687,000	$ 95,014,000
Base Estimate				
	Base Estimate	$ 106,252,000		
	Escalation (3rd Quarter 2024)	12.7%	$ 13,466,000	
	Escalated Base Estimate			$ 119,718,000
Expected Estimate				
	Contingency	40.0%	47,887,000	$ 47,887,000
	Expected Estimate			**$ 167,605,000**
95th Percentile Estimate				
	Funding Risk	60.0%	71,831,000	$ 71,831,000
	95th Percentile Estimate			**$ 239,436,000**
Notes:	This estimate is exclusive of GST.			

Approvals	Name	Signature	Date
Prepared by:	Dirk Jansen van Vuuren		3/03/2022
Verified by:	Barry Wallace		7/03/2022

Appendix M

MCA Workshop Minutes

MINUTES OF MEETING

File: 3-WW021.02	**Pages:** 6	**Date:** 24 March 2022	**Time:** 2pm to 4pm
Subject	Proposed Hutt City Central Reservoir MCA workshop		
Location	Microsoft Teams	**Minutes By:**	Dougal Quayle

	Persons Present	Organisation	Copy Received
1	John Duggan (JD)	WWL	Yes
2	Paul Winstanley (PW)	WWL	Yes
3	Gareth Penhale (GP)	WWL	Yes
4	Laurence Edwards (LE)	WWL	Yes
5	George Beveridge (GB)	Connect Water	Yes
6	Dougal Quayle (DQ)	Connect Water	Yes
7	Alistair Allan (AA)	Connect Water	Yes
8	Paul Carran (PC)	Connect Water	Yes
9	Cathy Crooks	Connect Water	Yes
10	Laura van Ginkel	Connect Water	Yes
11	Jeremy Head	Connect Water	Yes
12	Bruce Hodgins (BH)	HCC	Yes
13	Richard Williams (RW)	WWL	Yes
14	Ezekiel Hudspith (EH)	Dentons Kensington Swan	Yes
15	Sabrina Young	GHD (on behalf of Taranaki Whanui)	Yes
	Persons Absent	**Organisation**	**Copy Received**
	n/a		

Item	Discussion and Action	By Whom	By When
1.0	**Introductions & Notes**		
1.1	Brief introductions around the table. Sabrina Young has joined the workshop to observe on behalf of Taranaki Whanui. It is not intended that Mana whenua values be discussed or assessed as part of the MCA workshop today. Connect Water will engage with Taranaki Whanui of the coming weeks.		

Item	Discussion and Action	By Whom	By When
1.2	Mentimeter will be used throughout the presentation. This is to encourage participation and prompt discussion. The results from Mentimeter are not intended to be taken as the agreed score. Scores need to be discussed and agreed with the team. Connect Water will only submit 1 vote into the Mentimeter. This is to avoid skewing results if many inputs are received from the consultancy side.		
2.0	**Purpose**		
2.1	The project purpose is to provide a 15 ML reservoir for the Lower Hutt Central area. This workshop will not go into detail on the background of the reservoir sizing, long listing and shortlisting of sites as this has been covered in previous workshops and is documented. The workshop will focus on the MCA of the shortlisted sites.		
3.0	**MCA Process and Objectives**		
	• Three options for a new 15 ML reservoir serving Lower Hutt Central – Cambridge Terrace, Naenae 2 and Gracefield 2 • Present assessment criteria • Agree criteria weightings • Agree criteria scoring • Combine weights and scores for an overall value • Sensitivity analysis • Agree highest scoring option		
4.0	**Overview of Shortlisted Options**		
	Cambridge Terrace • Reservoir platform would be cut down on a relatively flat spur. • The site has the lowest earthworks volumes of the 3 sites. • Would require the construction of an access road off an existing private access • A land purchase or easement would be required. • The site is far away from the water treatment plant so extensive DN750 pipework would be required to connect the reservoir to the water network.		
	Naenae 2 • The reservoir platform would be cut into a ridgeline behind the existing Naenae reservoir. • The site is close to an existing public access road. • The site is close to the water treatment plant and could utilise an existing DN750 pipeline to the Naenae reservoir. This option would require the lowest length of DN750 pipeline. • Site is beside a residential area.		
	Gracefield 2 • The reservoir platform would be cut into the hillside behind the Gracefield reservoir. • The site has an existing step access road. • The existing pipework to the Gracefield reservoir cannot accommodate an additional 15ML reservoir. A long length of DN750 pipe would be required to connect the new reservoir to the water network. • The site is in an industrial area.		

Item	Discussion and Action	By Whom	By When
	RW asked if the reservoirs will have scour pipelines connected to the Waiwhetu Stream. Yes, Naenae 2 and Gracefield 2 would have scour pipelines directly to this stream. Cambridge Terrace would have a scour pipeline to the nearby stormwater pipe network which feeds into the Waiwhetu Stream.		
5.0	**MCA Criteria**		
	MCA criteria discussed. Team agreed that criteria was appropriate.		
	Proposed Criteria Weightings		
	Bruce suggested that the financial group weighting was too low at 20% and that carbon was too high at 10%. Group discussion and Mentimeter agreed that financial at 25% and carbon at 5% was appropriate. Team agreed with Environmental, Social and Technical weightings.		
	Paul Winstanley asked whether the criteria considers the pipeline impacts? Yes, this feeds into the cost of each option and social impacts.		
	Scoring Approach		
	Criteria will be scored on a 1-7 scale. 4 is a neutral impact or moderate risk. 5-7 has benefits or lower risk. 3-1 has negative impacts or higher risk.		
	Ecological Assessment		
	All sites scored the same in terms of ecological impact. Minor adverse ecological effects, with proposed scoring of 4 for each site.		
	Ezekiel Hudspith suggested that all sites should be a 3 since it is a slight negative for all. However, team agreed that 4 for all sites was appropriate. Either way all the sites score the same and will have the same impact on the MCA assessment.		
	Landscape/Visual Impacts		
	Proposed scoring: Cambridge Terrace (3), Naenae 2 (4), Gracefield 2 (5)		
	Cambridge Terrace and Naenae 2 have similar theoretical viewsheds. Gracefield 2 has the smallest viewshed. Cambridge Terrace has the highest landscape effect as it is a new reservoir and is not adjacent to existing reservoirs. It was discussed that Gracefield 2 will have the highest cuts out of all the sites which increase the visual impact.		
	Ezekiel Hudspith suggested that if the impacts are negative (i.e. less than a 4) then the scoring should reflect this.		
	Team agreed to score the sites Cambridge (2), Naenae 2 (3) and Gracefield 2 (3).		
	Heritage/Culture		
	Proposed scoring: Cambridge Terrace (4), Naenae 2 (4) and Gracefield 2 (3)		
	Archaeological desktop assessment carried out. There has been a previous archaeological find in the vicinity of the Gracefield 2 reservoir site. An archaeological authority would be required for this site. The other options did not have any identified archaeological sites.		
	Team agreed to score the sites Cambridge Terrace (4), Naenae 2 (4) and Gracefield 2 (3).		

Item	Discussion and Action	By Whom	By When
	Noise Vibration and Dust		
	Proposed scoring: Cambridge Terrace (2), Naenae 2 (2) and Gracefield 2 (3)		
	Considers the short-term impact of construction noise, vibration and dust on residents, businesses and the wider public.		
	Team discussed that Gracefield should score the highest as it is not located near residential areas. Naenae 2 should score lower than Cambridge as there are many houses and the Laura Fergusson Facility near the Summit Road. Team agreed that the scoring should be focused more on the reservoir construction impacts than the pipeline construction impacts. Primarily due to the reservoir construction timeframe and this being in one location. The pipeline construction area will move over time and will have a lesser impact compared to the reservoir construction impact.		
	Team agreed to score the sites Cambridge Terrace (3), Naenae 2 (2) and Gracefield 2 (4).		
	Traffic and Access		
	Proposed scoring: Cambridge Terrace (4), Naenae 2 (3) and Gracefield 2 (2)		
	Short-term impact of temporary traffic management on residents, businesses and the wider public including disruption to public transport and access restrictions.		
	Bruce asked why the bus route would be affected by the Naenae 2 option. This would be during the pipeline construction.		
	John Duggan raised that the corner from the road to the reservoir access at Gracefield is tight and this may need to be improved. Agreed and picked up in constructability report.		
	There is a median barrier separating the flow of traffic on the Wainuiomata Road. This means construction vehicles will have to drive to Wainuiomata and back up the hill to access the site. This would require an extensive traffic management plan and would impact Wainuiomata Road users.		
	Team agreed to score the sites Cambridge Terrace (3), Naenae 2 (2) and Gracefield 2 (1).		
	Recreation		
	Proposed scoring: Cambridge Terrace (4), Naenae 2 (4) and Gracefield 2 (3)		
	Short-term impact of construction activities on access to or use of existing recreational facilities (walking, biking tracks etc).		
	Naenae 2 and Gracefield 2 would close mountain bike and walkway tracks during construction.		
	Team agreed to score the sites Cambridge Terrace (4), Naenae 2 (3) and Gracefield 2 (3).		
	Vulnerability and Resilience		
	Proposed scoring: Cambridge Terrace (5), Naenae 2 (4) and Gracefield 2 (3)		

Item	Discussion and Action	By Whom	By When
	Degree of vulnerability to external impacts and ability to withstand and recover from such impacts (including repairability), considered at both site (reservoir) and network (WSA) level.		
	Cambridge terrace has some advantage over the other sites in adding another reservoir site. 4 reservoir sites vs 3 reservoir sites.		
	The pipeline to Gracefield 2 is likely to be more vulnerable than the pipeline to Naenae 2 as the pipeline is longer and traverses increased thicknesses of soft sediments.		
	Team agreed to score the sites Cambridge Terrace (5), Naenae 2 (4) and Gracefield 2 (3).		
	Operability and Maintainability		
	Proposed scoring: Cambridge Terrace (4), Naenae 2 (4) and Gracefield 2 (4)		
	Ability to safely and effectively operate and maintain the system to reliably deliver service outcomes while meeting compliance obligations.		
	No appreciable difference in ease of operation and maintenance.		
	Team agreed to score the sites Cambridge Terrace (4), Naenae 2 (4) and Gracefield 2 (4).		
	Performance and Opportunity		
	Proposed scoring: Cambridge Terrace (4), Naenae 2 (4) and Gracefield 2 (4)		
	Connect Water asked WWL. Do any of the sites add any performance benefits? No great advantage of either site over the others.		
	Team agreed to score the sites Cambridge Terrace (4), Naenae 2 (4) and Gracefield 2 (4).		
	Regulatory Framework		
	Proposed scoring: Cambridge Terrace (4), Naenae 2 (5) and Gracefield 2 (3)		
	Degree of risk in relation to regulatory requirements that could impact delivery of project on time and within budget. (This criterion is not intended to revisit or duplicate the assessment of effects under other criteria.)		
	Sabrina asked if stream crossing consents would identify Taranaki Whanui as an affected party? Yes that’s correct.		
	Team thought that the scoring should be reduced for all sites. Team agreed to score the sites Cambridge Terrace (3), Naenae 2 (4) and Gracefield 2 (2).		
	Property		
	Proposed scoring: Cambridge Terrace (2), Naenae 2 (4) and Gracefield 2 (4)		
	Degree of risk in relation to land acquisition that could impact delivery of project on time and within budget.		
	Ezekiel asked if sites in council land should be scored higher than a 4.		
	Team agreed to score the sites Cambridge Terrace (2), Naenae 2 (5) and Gracefield 2 (5).		
	Construction Risk		

Item	Discussion and Action	By Whom	By When
	Proposed scoring: Cambridge Terrace (4), Naenae 2 (4) and Gracefield 2 (3)		
	Degree of risk in relation to geotechnical conditions, potential for contaminated land, and other environmental conditions that could impact delivery of project safely, on time and within budget.		
	Team agreed to suggested scoring. Cambridge Terrace (4), Naenae 2 (4) and Gracefield 2 (3).		
	Cost		
	Proposed scoring: Cambridge Terrace (4), Naenae 2 (6) and Gracefield 2 (2). Discussed that if a formula used in a previous Bell Road assessment is applied to this assessment, then Naenae 2 scores 7.		
	Level 1 estimates Cambridge Tce $135m Naenae 2, $75 m Gracefield 2 , $170 m Noted that estimates may be overstated due to blanket application of contingency and risk percentage markups as per L1 estimating approach. All estimates have been prepared in the same way so relative comparison for purpose of MCA scoring is valid, but the estimates do need closer examination.		
	Team agreed to score the sites Cambridge Terrace (4), Naenae 2 (7) and Gracefield 2 (2).		
	Carbon		
	Proposed scoring: Cambridge Terrace (4), Naenae 2 (5) and Gracefield 2 (3)		
	Comparative assessment of upfront embodied carbon emissions: • Manufacture of construction materials • Transport of materials • Offsite disposal of earthworks		
	Team agreed to score the sites Cambridge Terrace (4), Naenae 2 (5) and Gracefield 2 (3).		
	MCA Assessment		
	Naenae 2 is the highest scoring option followed by Cambridge Terrace and then Gracefield 2.		
	Team suggested that Connect Water run a further sensitivity analysis to reduce the financial weighting and increase the social weighting.		
	Closeout Comments		
	While the Naenae 2 site option scores most favourably overall it is acknowledged that particular attention will need to be given to managing the construction effects on the surrounding community.		
	Māna whenua discussion will be facilitated through Sabrina Young.	SY/AA	8/04/22
	Laurence to Bruce – What do we need to do to socialise the results of the MCA assessment?		
	Bruce noted that the level 1 cost estimates are higher than what is allowed for in the long term plan.		

Lower Hutt Reservoir Site Selection - MCA Sensitivity Analysis

Base Weightings / **Scoring**

Criteria Grouping	Group Weighting (%)	Criteria	Sub Weighting (%)	Criteria Weighting (%)	Cambridge	Naenae 2	Gracefield 2
Environmental	20	Ecology	40	8.0	4	4	4
		Landscape	30	6.0	2	3	3
		Heritage and Culture	30	6.0	4	4	3
Social	15	Noise, Vibration and Dust	40	6.0	3	2	4
		Traffic and Access	40	6.0	3	2	1
		Recreation	20	3.0	4	3	3
Technical	35	Vulnerability and Resilience	20	7.0	5	4	3
		Operability and Maintainability	20	7.0	4	4	4
		Performance and Opportunity	10	3.5	4	4	4
		Regulatory Framework	10	3.5	3	4	2
		Property Risk	20	7.0	2	5	5
		Construction Risk	20	7.0	4	4	3
Financial	25	Capital Cost	100	25.0	4	7	2
Carbon	5	Embodied Carbon	100	5.0	4	5	3
Total	100			100			

Criteria	Decrease Financial weighting: Group Weighting (%)	Sub Weighting (%)	Criteria Weighting (%)	Increase Financial weighting: Group Weighting (%)	Sub Weighting (%)	Criteria Weighting (%)	Increase Environmental weighting: Group Weighting (%)	Sub Weighting (%)	Criteria Weighting (%)	Increase Social weighting: Group Weighting (%)	Sub Weighting (%)	Criteria Weighting (%)
Ecology	26.7	40	10.7	18.7	40	7.5	40.0	40	16.0	14.1	40	5.6
Landscape		30	8.0		30	5.6		30	12.0		30	4.2
Heritage and Culture		30	8.0		30	5.6		30	12.0		30	4.2
Noise, Vibration and Dust	20.0	40	8.0	14.0	40	5.6	11.3	40	4.5	40.0	40	16.0
Traffic and Access		40	8.0		40	5.6		40	4.5		40	16.0
Recreation		20	4.0		20	2.8		20	2.3		20	8.0
Vulnerability and Resilience	46.7	20	9.3	32.7	20	6.5	26.3	20	5.3	24.7	20	4.9
Operability and Maintainability		20	9.3		20	6.5		20	5.3		20	4.9
Performance and Opportunity		10	4.7		10	3.3		10	2.6		10	2.5
Regulatory Framework		10	4.7		10	3.3		10	2.6		10	2.5
Property Risk		20	9.3		20	6.5		20	5.3		20	4.9
Construction Risk		20	9.3		20	6.5		20	5.3		20	4.9
Capital Cost	0.0	100	0.0	30.0	100	30.0	18.75	100	18.8	17.6	100	17.6
Embodied Carbon	6.7	100	6.7	4.7	100	4.7	3.75	100	3.8	3.5	100	3.5
Total	100		100	100		100	100		100	100		100

Criteria	Increase Technical weighting: Group Weighting (%)	Sub Weighting (%)	Criteria Weighting (%)	Decrease Technical weighting: Group Weighting (%)	Sub Weighting (%)	Criteria Weighting (%)	Increase Carbon weighting: Group Weighting (%)	Sub Weighting (%)	Criteria Weighting (%)	Decrease Carbon weighting: Group Weighting (%)	Sub Weighting (%)	Criteria Weighting (%)
Ecology	15.4	40	6.2	24.6	40	9.8	18.9	40	7.6	21.1	40	8.4
Landscape		30	4.6		30	7.4		30	5.7		30	6.3
Heritage and Culture		30	4.6		30	7.4		30	5.7		30	6.3
Noise, Vibration and Dust	11.5	40	4.6	18.5	40	7.4	14.2	40	5.7	15.8	40	6.3
Traffic and Access		40	4.6		40	7.4		40	5.7		40	6.3
Recreation		20	2.3		20	3.7		20	2.8		20	3.2
Vulnerability and Resilience	50.0	20	10.0	20.0	20	4.0	33.2	20	6.6	36.8	20	7.4
Operability and Maintainability		20	10.0		20	4.0		20	6.6		20	7.4
Performance and Opportunity		10	5.0		10	2.0		10	3.3		10	3.7
Regulatory Framework		10	5.0		10	2.0		10	3.3		10	3.7
Property Risk		20	10.0		20	4.0		20	6.6		20	7.4
Construction Risk		20	10.0		20	4.0		20	6.6		20	7.4
Capital Cost	19.2	100	19.2	30.8	100	30.8	23.7	100	23.7	26.3	100	26.3
Embodied Carbon	3.8	100	3.8	6.2	100	6.2	10.0	100	10.0	0.0	100	0.0
Total	100		100	100		100	100		100	100		100

Criteria	Increased Resilience: Group Weighting (%)	Sub Weighting (%)	Criteria Weighting (%)	Increase Social, Decrease Financial: Group Weighting (%)	Sub Weighting (%)	Criteria Weighting (%)	Increase Social, Zero Financial: Group Weighting (%)	Sub Weighting (%)	Criteria Weighting (%)
Ecology	20.0	40	8.0	20.0	40	8.0	20.0	40	8.0
Landscape		30	6.0		30	6.0		30	6.0
Heritage and Culture		30	6.0		30	6.0		30	6.0
Noise, Vibration and Dust	15.0	40	6.0	35	40	14.0	40	40	16.0
Traffic and Access		40	6.0		40	14.0		40	16.0
Recreation		20	3.0		20	7.0		20	8.0
Vulnerability and Resilience	35.0	40	14.0	35.0	20	7.0	35.0	20	7.0
Operability and Maintainability		15	5.3		20	7.0		20	7.0
Performance and Opportunity		7.5	2.6		10	3.5		10	3.5
Regulatory Framework		7.5	2.6		10	3.5		10	3.5
Property Risk		15	5.3		20	7.0		20	7.0
Construction Risk		15	5.3		20	7.0		20	7.0
Capital Cost	25.0	100	25.0	5	100	5.0	0	100	0.0
Embodied Carbon	5	100	5.0	5	100	5.0	5	100	5.0
Total	100		100	100		100	100		100

Criteria Grouping Analysis	Cambridge	Naenae	Gracefield	Comments
Environmental	3.4	3.7	3.4	
Social	3.2	2.2	2.6	Naenae 2 scores highest in all groupings except Social
Technical	3.7	4.2	3.6	
Financial	4.0	7.0	2.0	
Carbon	4.0	5.0	3.0	

Overall Scores

	Sensitivity Analysis Scenario	Cambridge	Naenae	Gracefield	Comments
	Base Weightings	3.7	4.5	3.0	**Naenae 2 scores highest across all weighted criteria**
a	Decrease Financial weighting	3.5	3.7	3.3	
b	Increase Financial weighting	3.7	4.7	2.9	
c	Increase Environmental weighting	3.6	4.3	3.1	
d	Increase Social weighting	3.5	3.9	2.9	A significant increase in Social weighting (to 40%) with proportional decreases across other criteria has no impact on the overall outcome.
e	Increase Technical weighting	3.7	4.5	3.1	
f	Decrease Technical weighting	3.6	4.6	2.8	
g	Increase Carbon weighting	3.7	4.6	3.0	
h	Decrease Carbon weighting	3.6	4.5	3.0	
i	Increased Resilience	3.8	4.5	2.9	
j	Increase Social, Decrease Financial	3.5	3.6	3.1	Increasing Social weighting (15% up to 35%), at expense of Financial weighting (25% to 5%) brings Cambridge level with Naenae.
k	Increase Social, Zero Financial	3.5	3.3	3.1	Increasing Social weighting (15% up to 40%), and excluding Financial criteria altogether shifts the balance to favour Cambridge.

Appendix N

Taranaki Whanui Feedback

TARANAKI WHĀNUI
KI TE UPOKO O TE IKA

8 June 2022

Paul Carran
Principal Engineer, Water
ConnectWater

By email: paul.carran@wsp.com

New drinking water reservoir in Hutt City, Wellington

Dear Paul,

Thank you for engaging with Taranaki Whānui regarding the 'Hutt City Drinking Water Reservoir' project.

1. Our understanding of the project

Wellington Water Limited is scoping locations for a new drinking water reservoir in Hutt City. The current reservoir storage across Lower Hutt Central and Taita Water Storage Areas does not meet target levels of service.

There is a combined shortfall of around 15 mega litres. The shortfall is primarily driven by Peak Day Demand and fire flow. Any growth in demand will reduce the hours of available supply and make the system more vulnerable to bulk supply failures.

Wellington Water has reviewed 25 potential locations throughout Hutt City and have narrowed the preferred reservoir locations to three sites on the Eastern Hills.

2. Engagement with Taranaki Whānui

A completed Taranaki Whānui Engagement Form was provided (dated 22/03/22), as well as preliminary site plans of the three shortlisted locations.

Input and feedback are being sought from Taranaki Whānui as part of the site selection analysis. In particular, you have asked for our knowledge on mana whenua sites and values to be incorporated into the analysis.

1. Both Sabrina Young and I met with members of the project team on 10 May 2022 to go over the project thus far, including a discussion about the process undertaken to review 25 potential locations

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throughout Hutt City, with the preferred reservoir locations narrowed to three sites on the Eastern Hills, being:

- Option 1 – Cambridge Terrace, above the Taita Cemetery near the Pick a Part industrial area heading between Naenae township and Taita College.
- Option 2 - Naenae 2, an area off Tilbury Street, Fairfield. Already has an existing reservoir.
- Option 3 – Gracefield 2 - an area above the Ngāti Ira Pā site on the Wainuiomata Hill. Already has an existing reservoir. Above the Callaghan Innovation site.

3. Initial feedback from Taranaki Whānui

In line with the verbal feedback provided at the project meeting on 10 May 2022, Options 1 and 3 have the potential for higher adverse effects on mana whenua values due to the proximity of the urupa below the proposed location at Taita, and the proximity of the Gracefield site in relation to the Ngāti Ira Pā site.

Option 2 is the current preferred location in terms of our current understanding of the location presenting the lowest risk of significant impacts on mana whenua values out of the three location options presented.

In providing this initial feedback, we acknowledge that not all design information is currently available for Option 2 to understand the impacts of construction, discharges to and any stream crossings required in relation to Waiwhetu Stream (being of significance to Taranaki Whanui), and impacts of the water reservoir structure itself. We understand this information will be forthcoming around September this year.

Once this additional design information is provided, Taranaki Whanui confirms that a Cultural Impact Assessment (CIA) is required for the preferred Option 2 – Naenae 2. Taranaki Whanui will procure the preparation of this, to be authored by Morrie Love. All costs of the CIA will be on-charged to Wellington Water.

4. Recommended next steps with Taranaki Whānui

Provision of further design information to increase our understanding of the potential impacts on mana whenua values, and to facilitate the preparation of a CIA.

Nāku iti nei, na,

Lee Hunter
Chief Executive, Taranaki Whānui ki Te Upoko o Te Ika

Appendix O

Level 1.5 Cost Estimate – Naenae 2

Lower Hutt Reservoir Project

Cost and Carbon Estimate Report

Our water, our future.

Document information

People involved

Activity	Title	Name	Electronic signature	Date
Prepared by	Cost Manager	Dirk Jansen van Vuuren		08/03/2022
Prepared by	Sustainability Consultant	Caroline Hope		08/03/2022
Reviewed by	Cost Manager	Michael Crutchley		09/03/2022
Reviewed by	Cost Manager	Barry Wallace		16/05/2022
Approved by	Team Lead	Malcolm Franklin		31/05/2022

Revision history

Date	Version number	Description of change
03/03/2022	0.1	First draft
08/03/2022	0.2	Second draft
08/03/2022	0.3	Final
13/05/2022	0.4	Revised
19/05/2022	0.5	Revised 1
31/05/2022	0.6	Revised 2

Wellington Water

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List of appendices

1 Executive Summary

Connect Water has been engaged to provide Concept Design (Level 1) Cost Estimates for the Lower Hutt Reservoir project.

The estimated total costs as set out in Section 4 has been developed from the Concept design package as provided by WSP.

Please refer to the clarifications, assumptions, exclusions, and items of cost risks that are outlined within the body of this estimate report.

The report also analyses the embodied carbon content for the respective options, as summarised in Section 6.

The current design assumes a conventional 15ML circular Precast concrete reservoir structure, with 750mm CLS inlet, outlet, and overflow pipes in trenches at an average depth of 2.5m.

Please note that all values within this report and included in the attached estimate details are GST exclusive.

2 Introduction

This concept design estimate report has been prepared to establish the likely cost for the development of the Lower Hutt Reservoir project.

The project identifies 3 possible locations for a 15ML precast concrete Reservoir. The purpose of this report is to provide the reader with a high-level overview of the options, how they compare and to highlight where they differ.

As the same precast concrete reservoir design has been assumed for all three options it is not expected that the inclusion of a Whole of Life Costing would change the relative performance between options, and thus has not been included.

The report also reviews the embodied carbon in the structural elements of the project. It compares the 3 options and describes the methodology of how the embodied carbon is calculated.

3 Basis of Estimate

3.1 Design Documentation and Cost Basis

This level 1 cost estimate and carbon assessment has been prepared using information and modelled construction quantities provided by the engineer and accompanying design query responses.

The estimate has been prepared in accordance with the WWL Cost Estimation Manual. It is to be noted that this stage of design would generally make use of the Simple Approach, however some of the information is more defined than a level 1.

Taking all of the above into account, the General Approach has been incorporated with the contingencies and funding risk allowances to reflect the level of design being between a level 1 and 2. The deviation from The WWL Estimating Manual was discussed and agreed with Wellington Water.

We have based our estimate on the quantities provided by the engineer, Kidd Civil Report, accompanying design query responses, as well as utilising existing knowledge of the scope of works.

Some of the design information is still very limited and several areas of scope remain undefined. All aspects of the design of this current scheme are subject to further design development.

3.2 Escalation

The assumed construction period is 3rd quarter 2024 to 3rd quarter 2026. An escalation allowance has been assessed up until the 3rd quarter 2024 when it is anticipated that a physical works contract will be awarded. The escalation assessment is applied to the base cost estimate (contingency is not escalated) and excludes any major market fluctuations.

3.3 Contingency and Project Expected Estimate

Connect Water and the Client have agreed that although the design is not yet at a Preliminary (Level 2) stage, that the General Approach is suitable with Contingencies and funding risk adjusted as appropriate for each components relative design definition.

Following the general approach in the WWL Cost Estimation Manual, a percentage contingency has been added to each category based on the level of estimating uncertainty in that category described below. This also includes some risk allowance. The contingency amount is added to the base estimate to provide the Project Expected Estimate.

Percentages take into account the level of certainty in quantities and cost rates at this phase of the project considering no consents have yet been granted and preliminary designs have not been developed. For reference the WWL cost estimation manual guidance is for 40% contingency to be applied to all components if a simple approach is used, but as we're following a hybrid approach between level 1 and level 2 a 30% contingency would be appropriate.

Non-Physical Work Items

- **Development** 20% - Moderate contingency allowance. Assumed that a preferred option has been identified.
- **Consenting** 20% - On consultancy fees.
- **Detail Design** 20% - On consultancy fees.
- **Procurement** 30% - On consultancy fees. Slightly higher given the current market and limited available contractors.
- **Construction Consultancy (MSQA) Services** 30% - On consultancy fees, depending on the contractor and chosen contract conditions.

Physical Work Items

- **Environmental Compliance** 50%, which is a relatively large allowance due to the risk of consents imposing higher requirements than allowed for in the base.
- **Earthworks** 50% which on a multi-million dollar item is a relatively large allowance for the level of certainty but reflects the risk that the stockpile and excavation volumes are high level.
- **Ground Improvements** 30% moderate contingency for this item which has no investigation.
- **Water** 30% which is moderate for a relatively high value item, but is reflective of the level of information at this concept stage.
- **Roads** 70% is a high contingency, but on a relatively low value item due to the uncertainty of scope.
- **Structures** 30% which is moderate on this very high value item. It is subject to risk from material price fluctuations and structural volume increases due to increased seismic design criteria.
- **Traffic Management** 30% which is moderate considering the risk of onerous requirements being placed on access route traffic management.
- **Other Construction Costs** 30% which is moderate considering the uncertainty of scope.

3.4 Risk and 95th Percentile Estimate

The Hong Kong method was used to calculate the funding risk allocation. This was calculated by applying a percentage maximum risk allowance to each base component of the estimate to create a “maximum” estimate for each item.

The funding risk component is then calculated by the following formula:

Funding Risk = $\sqrt{}$(Σ(Component Maximum estimate – Component expected estimate)^2)

The maximum risk allowances were applied based on the estimators understanding of project risk. A full quantitative risk analysis has not been undertaken. The funding risk amount is added to the Project Expected Estimate to provide the 95th Percentile Project Estimate. The project is expected to be completed within this 95th percentile cost estimate 19 times out of 20. The maximum risk allowances applied to the base estimate for each component were:

Non-Physical Work Items

- **Development** 50% - Moderate allowance. Assumed that a preferred option has been identified.

- **Consenting** 100% - On consultancy fees.
- **Detail Design** 120% - On consultancy fees.
- **Procurement** 110% - On consultancy fees. Slightly higher given the current market and limited available contractors.
- **Construction Consultancy (MSQA) Services** 120% - On consultancy fees, due to the moderate to high risk of programme delays or quality issues requiring additional supervision.

Physical Work Items

- **Environmental Compliance** 120%, which is a relatively large allowance due to the risk of consents imposing higher requirements than allowed for in the base.
- **Earthworks** 120% which on a multi-million dollar item is a relatively large allowance for the level of certainty but reflects the risk that the stockpile and excavation volumes are high level.
- **Ground Improvements** 100% moderate allowance for this item which has no investigation.
- **Water** 90% which is moderate for a relatively high value item but is reflective of the level of information at this concept stage.
- **Roads** 150% is a high allowance, but on a relatively low value item due to the uncertainty of scope.
- **Structures** 80% which is moderate on this very high value item. It is subject to risk from material price fluctuations and structural volume increases due to increased seismic design criteria.
- **Traffic Management** 90% which is moderate considering the risk of onerous requirements being placed on access route traffic management.
- **Other Construction Costs** 130% which is moderate considering the uncertainty of scope.

4 Estimate Summary

Table 1: Cost Estimate Assessment Comparison

Phase	Naenae 2 ($)	Gracefield 2 ($)	Cambridge Terrace ($)
Professional Costs (18%, as per WWL Manual)	**6,686,000**	**15,179,000**	**12,049,000**
Development	1,114,000	2,530,000	2,008,000
Consenting	1,114,000	2,530,000	2,008,000
Detail Design	2,415,000	5,481,000	4,351,000
Procurement	186,000	422,000	335,000
Construction	1,857,000	4,216,000	3,347,000
Physical Works			
Environmental Compliance	42,000	50,000	36,000
Earthworks	5,473,000	5,491,000	3,268,000
Ground Improvements	698,000	5,022,000	-
Water	12,795,000	40,900,000	36,000,000
Wastewater	-	-	-
Stormwater	-	-	-
Roads	38,000	413,000	238,000
Structures	6,363,000	6,363,000	6,363,000
Services	-	-	-
Landscaping	-	-	-
Traffic Management	2,224,000	5,135,000	4,545,000
Temporary Works	-	-	-
Other Construction Costs	510,000	510,000	260,000
Sub Total	**28,143,000**	**63,884,000**	**50,710,000**
On-Site Overheads (20%)	5,629,000	12,777,000	10,142,000
Off Site O/H & Profit (10%)	3,377,000	7,666,000	6,085,000
Total Physical Works	**37,149,000**	**84,327,000**	**66,937,000**
Base Estimate	43,835,000	99,506,000	78,986,000
Contingency	13,186,000	28,667,000	22,502,000
Expected Estimate	**57,021,000**	**128,173,000**	**101,488,000**
Funding Risk	15,023,000	38,420,000	32,358,000
95th Percentile Estimate	**72,044,000**	**166,593,000**	**133,846,000**

Please refer to Appendix A for the complete summaries and comparative Costing estimates.

Please refer to Section 5 for a full list of assumptions, clarifications and risks which form the basis of this preliminary estimate.

Table 2: Cost Estimate Assessment Summary (excluding Escalation)

Phase (Excl Escalation)	Naenae 2 ($)	Gracefield 2 ($)	Cambridge Terrace ($)
WWL MGMT Fee (Capped at $2M)	**2,000,000**	**2,000,000**	**2,000,000**
Base Estimate (including mgmt fee)	**45,835,000**	**101,506,000**	**80,986,000**
Expected Estimate (including mgmt fee)	**59,021,000**	**130,173,000**	**103,488,000**
95th Percentile Estimate (including mgmt fee)	**74,044,000**	**168,593,000**	**135,846,000**

Table 3: Cost Estimate Assessment Summary (including Escalation)

Phase (Incl Escalation)	Naenae 2 ($)	Gracefield 2 ($)	Cambridge Terrace ($)
WWL MGMT Fee (Capped at $2M)	**2,000,000**	**2,000,000**	**2,000,000**
Escalation to 3rd Qtr 2024 (12.67%)	**5,555,000**	**12,611,000**	**10,010,000**
Base Estimate (including mgmt fee)	**51,390,000**	**114,117,000**	**90,996,000**
Expected Estimate (including mgmt fee)	**66,248,000**	**146,417,000**	**116,350,000**
95th Percentile Estimate (including mgmt fee)	**83,175,000**	**189,706,000**	**152,809,000**

Note 1: Main Contractor Preliminary and General (P&G) is included as a separate line item in the estimate summary. P&G otherwise known as On-Site Overhead costs covers the cost of on-site overheads such as site supervision / management, site offices, stores, hoardings, amenities, plant, cranes, temporary works, etc.

The percentage allowance for Preliminaries and General have been assessed at 20%.

Note 2: Contractor Overhead & Profit is included as a separate line item in the estimate summary. This covers the cost of contributions to cover the Main Contractor's business operational costs, i.e., off-site overhead costs such as executive management, accounts, quality and health & safety systems and company profits.

Contingencies cover general design development, procurement uncertainty and other risks. We would expect these sums to be incorporated into the estimated build costs as the design progresses.

5 Estimate Notes

5.1 Assumptions and Clarifications

- A contingency to cover items of unforeseen detail and design development has been included in the estimate. This contingency is expected to be converted to scope, and therefore should not be regarded as discretionary.

- It is important to note that New Zealand is currently experiencing significant movement in pricing across many sub-trades due to the current buoyant construction market coupled with supply issues due to, amongst other reasons Covid-19. This is putting pressure on resources which is resulting in unpredictable and generally escalating pricing.

- The proposed sites still have significant uncertainty, specifically with regards to the constructability of the Reservoir at the proposed sites as well as proposed access roads, excavation volumes, etc and is subject to further design investigation.

- The cost estimates presented have been developed for the purposes of comparing options and project reporting, and should not be used for any other purpose. A further estimate for budget setting purposes should be prepared following completion of concept design for the preferred site.

- It is assumed that all the work will be undertaken by a single ‘Main Contractor’ through a single contract for the project.

- Sufficient storage and laydown area will be provided on-site for the contractor.

- Elements of cost included within this estimate are based on costs from similar projects and other Beca cost benchmarks.

- An average depth of 2.5m deep trench for all inlet, outlet, and overflow pipework.

- Excavations to be 50% soft rock, 50% moderate rock (moderate rock excavations assumed to be done with medium-large excavator), as per engineer.

- Work during normal hours only.

- Professional fees and consent fees have been calculated based on percentage of construction costs in lieu of actual fees as these amounts have not yet been determined

- The working space is sufficient for construction works. As this is yet to be confirmed additional costs may be incurred for more extensive more temporary works to facilitate construction activities

- All fill to be imported fill (except were stated otherwise).

- Residential, commercial, and industrial roads – trenching assumed to be 100% in the road corridor and single lane road closure.

- Stream and Railway crossings assumed to be trenchless construction.

- Traffic management throughout the duration of the project applied to pipeline and reservoir construction.

- No allowance has been included for a transformer on the assumption that the local infrastructure has sufficient capacity to service the new reservoir.

5.2 Exclusions

- Unfavourable ground and soil conditions e.g., ground water (excluded)
- Contaminated material removal and/or replacement
- Fast track or accelerated programme
- GST
- Capitalised interest
- Costs incurred to date
- Operation and maintenance costs
- Insurance costs
- Legal and finance fees
- Property costs
- Protection to native flora and fauna

6 Capital Carbon Assessment

The objective of this assessment is to understand the relative capital carbon impact of the three reservoir location options, so cost and carbon are both used in decision making.

6.1 Introduction to Carbon

Carbon is shorthand for the carbon dioxide equivalent of all greenhouse gas emissions (GHGs). Different GHGs have varying degrees of global warming potential, over the same time period. Carbon is quantified as 'tonnes of carbon dioxide equivalent' (tCO_2-e).

Emissions produced over the life cycle of an asset are generally put into two groups, operational emissions and embodied emissions. Operational carbon emissions occur only during the use stage of an asset's life and are from the energy and other resources used when operating the asset. Embodied carbon emissions are from the materials and products that form the asset and can occur right across the asset's life cycle.

6.2 Capital Carbon Assessment Scope

Capital carbon is defined as the emissions associated with the creation of assets, also referred to as upfront embodied emissions. Typically, this would involve the emissions associated with the manufacturing of materials, transport of materials to and from site and construction emissions.

However, as this is a high level comparative assessment we have focussed on the major elements for the purpose of understanding the relative carbon impacts of the options. As a result, this capital carbon assessment of this reservoir options has the following inclusions and exclusions:

- **Inclusions**: two emissions sources that are the typical hotspots for a capital carbon assessments:
    - o embodied carbon associated with the production of the major relevant materials such as the reservoir structure (concrete and steel reinforcing), inlet/outlet pipelines and retaining walls.
    - o offsite disposal of waste from Construction site for the large volumes of excavation.
- **Exclusions**: transport of materials to site; onsite construction emissions from labour and plant; offsite waste disposal other than disposal of excavated material; minor items such as valves, fittings, manholes as the relative difference between the options is reflected in the length of inlet/outlet pipe; other items that are not considered material to the final outcome i.e., Electrical, Instruments & Controls.

The boundary of this capital carbon assessment is represented as cradle-to-'built asset' in Figure 1. Hence operational emissions, embodied emissions throughout the lifecycle like replacements and end of life emissions are also excluded. As a result, this is not a whole of life assessment, but because of the similar reservoir construction and operations of all three options is not expected to change the outcome.

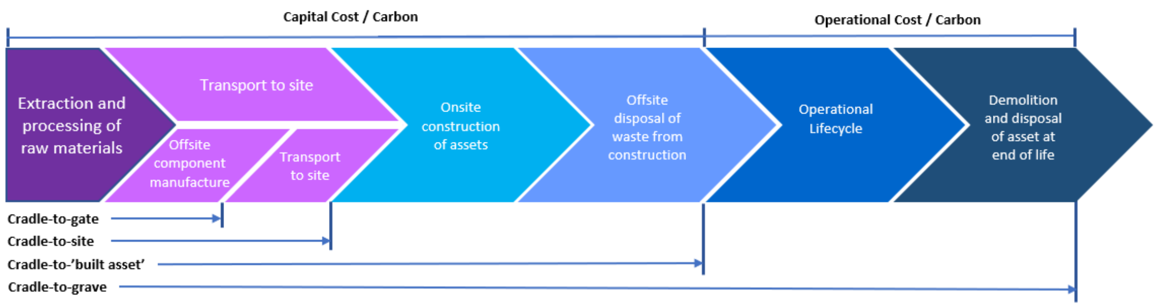


Figure 1. Life-cycle of an asset

6.3 Capital Carbon Methodology

To undertake the carbon assessment, the following inputs were used:

- **Material quantities** that were measured to form the capital cost estimate. Where required, the build-ups (unit elements) used for the rates were used as individual carbon estimate inputs. For example, a 750mm Diameter CLS pipe trench was broken into excavation, backfill, pipe and reinstatement. Each unit element then had a carbon emission factor applied as appropriate.
- **Emissions factors** were selected by the Beca Environments team from known databases of emissions factors (such as Infrastructure Council of Australasia - ISCA) for key construction materials. The emissions factors used can be provided on request.

Table 2 and Figure 2 summarise the Carbon Estimates, represented in tonnes of CO2-e.

Table 2: Carbon Estimate Assessment Comparison

Phase	Naenae 2 (tCO_2-e)	Gracefield 2 (tCO_2-e)	Cambridge Terrace (tCO_2-e)
Earthworks	762	762	457
Retaining Walls	47	339	0
Concrete Reservoir (15ML)	2,095	2,095	2,095
Inlet/outlet Pipework	764	2,483	2,183
Total (tCO_2-e)	**3,668**	**5,679**	**4,735**

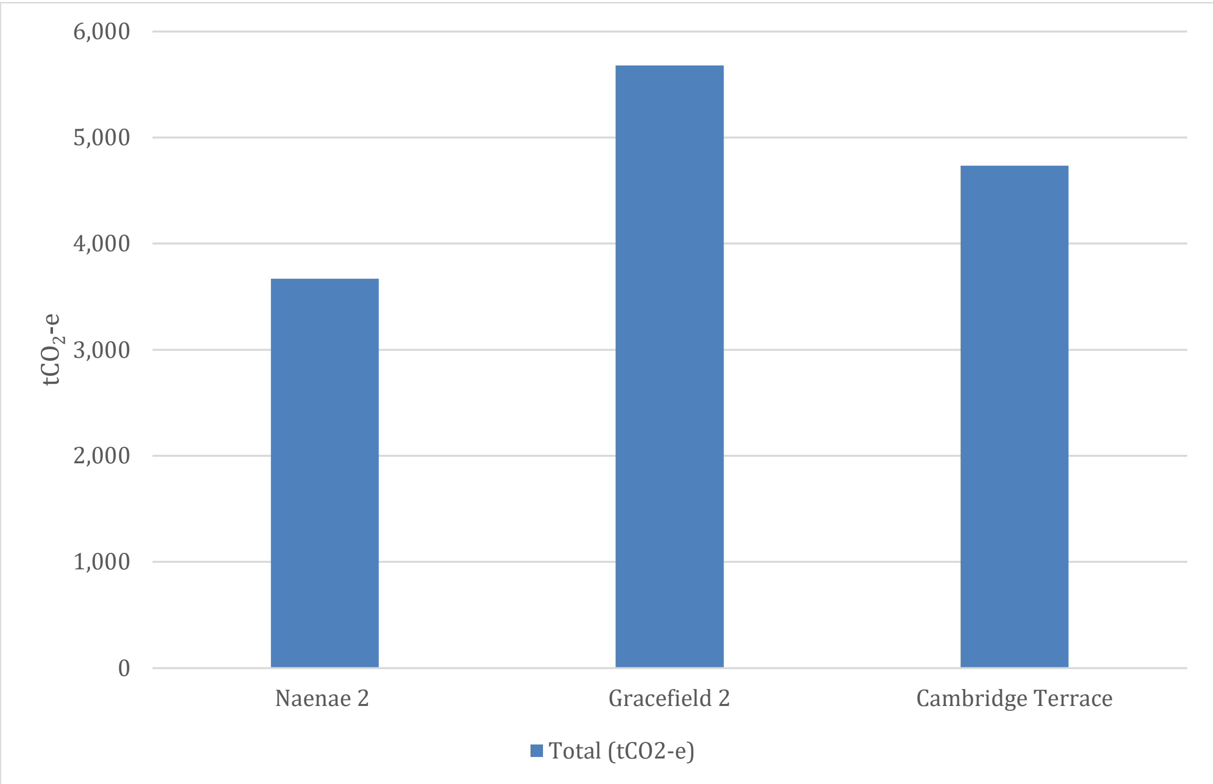


Figure 2. Reservoir location options comparison

Figure 3 highlights the key relative difference between the options:

- Earthworks: Cambridge Terrace earthworks are 40% less than the other two options due to the location that requires less excavation to provide the required construction area for the reservoir.
- Retaining walls: Compared to Naenae, Gracefield 2 has six times the carbon associated with the retaining wall while the Cambridge Terrace option does not require a retaining wall.
- Inlet/outlet pipework: Naenae is significantly closer to the main connection point hence pipework required is less. Gracefield 2 and Cambridge Terrace respectively have 325% and 286% the carbon emissions associated with the inlet/outlet pipework compared to Naenae.

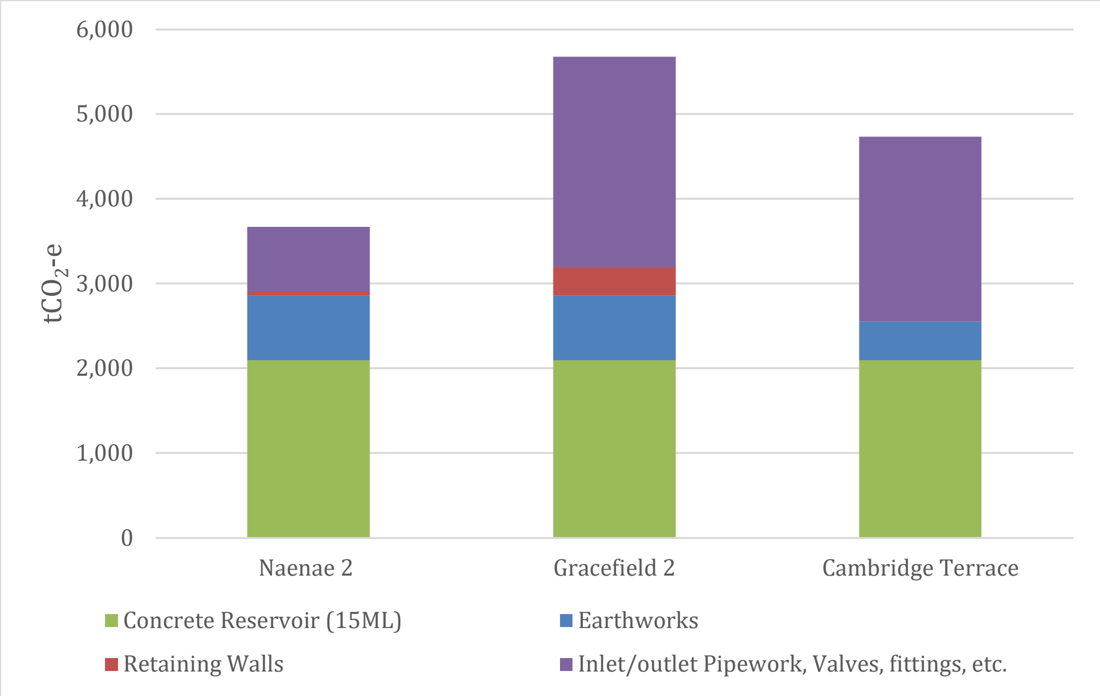


Figure 3. Reservoir location options comparison by component

6.4 Limitations

- Premiums for site-specific conditions/constraints have not been considered (access, location, confined spaces, sloping sites, contamination, and the like).
- Quantum of concrete is not reduced to account for reinforcing quantities within the concrete mass.
- All quantities are measured net and exclusive of a wastage. Wastage between different structural systems is not accounted for.
- Emissions factors can vary greatly depending on the construction material and country of origin. The factors used in this report are generic and could be looked at in further detail should the procurement strategy of the materials be known.

6.5 Exclusions

This high-level comparative assessment focusses on the major carbon contributing elements. During later design stages the carbon associated with the following items which are currently excluded could be estimated:

- Onsite construction emissions from labour and plant.
- Preliminary and General and temporary works items.
- Offsite waste disposal other than disposal of excavated material.

- Project materials other than reservoir structure, bulk excavations, inlet/outlet pipeline and retaining works. Hence minor items such as valves, fittings, manholes as well as EI&C (electrical, instruments and controls) were excluded.
- Professional services and Wellington Water direct carbon emissions.
- Carbon emissions outside the capital carbon boundary, hence emissions associated with operations, replacements, and end of life.
- Transport to site.

7 Next steps

This report shows that from a capital cost and carbon perspective Naenae 2 is the preferred site.

Note: The capital carbon assessment focussed on the major carbon contributing elements hence a number of elements were excluded. It is not expected that the inclusion of these would change the relative performance between options.

The following next steps could be considered by Wellington Water after a preferred site has been identified:

- Alternative materials and construction methodologies are explored to optimise project carbon contributions.
- Carry out more comprehensive assessments of the carbon in the Lower Hutt Reservoir project during further later design phases.
- Whole of life cost and carbon assessments conducted for the preferred option.

8 Disclaimers

8.1 Cost Estimate

This report must be read in its entirety and no portion of it should be relied upon without regard to the full report, especially the assumptions, limitations and disclaimers set out in the estimate notes and elsewhere in the report.

While the Cost Manager believes that the use of the assumptions, as set out elsewhere in this report, are reasonable for the purposes of this study, the Cost Manager makes no assurances with respect to the accuracy of such assumptions, and some may vary significantly due to unforeseen events and circumstances. To the extent that the conditions differ from those assumed in this report, the opinions expressed by the Cost Manager in this report may no longer be valid and should be reviewed.

In preparing this estimate, the Cost Manager has relied on the accuracy, completeness and currency of the information provided, therefore is not responsible for the information provided, and has not sought to independently verify it. To the extent that the information is inaccurate or incomplete, the opinions expressed by the Cost Manager may no longer be valid and should be reviewed.

The budget cost estimates presented in this section are typically developed based on extrapolation of recent similar project pricing, industry unit rates and the general experience of the Cost Manager. The budget estimates are based on incomplete design and other information and are not warranted or guaranteed by the Cost Manager.

Appendix A: Cost Estimate Summaries

PROJECT ESTIMATE

Project Name: Naenae 2

Phase: Level 1 Estimate

Phase	Description	Base Estimate	Expected Estimate	Maximum Risk Allowance
Development				
	Consultancy Fees - Concept Design	$ 1,114,000	$ 1,337,000	$ 1,671,000
	Total Project Development	**$ 1,114,000**	**$ 1,337,000**	$ 1,671,000
Consenting				
	Consenting Fees	$ 1,114,000	$ 1,337,000	$ 2,228,000
	Total Consenting	**$ 1,114,000**	**$ 1,337,000**	**$ 2,228,000**
Detailed Design				
	Consultancy Fees	$ 2,415,000	$ 2,898,000	$ 5,313,000
	Total Detailed Design	**$ 2,415,000**	**$ 2,898,000**	**$ 5,313,000**
Procurement				
	Consultancy Fees	$ 186,000	$ 242,000	$ 391,000
	Total Procurement	**$ 186,000**	**$ 242,000**	**$ 391,000**
Construction				
	Consultancy Fees	$ 1,857,000	$ 2,414,000	$ 4,085,000
	Contractor			
	Environmental Compliance	$ 42,000	$ 63,000	$ 92,000
	Earthworks	$ 5,473,000	$ 8,210,000	$ 12,041,000
	Ground Improvements	$ 698,000	$ 907,000	$ 1,396,000
	Water	$ 12,795,000	$ 16,634,000	$ 24,311,000
	Wastewater	$ -	$ -	$ -
	Stormwater	$ -	$ -	$ -
	Roads	$ 38,000	$ 65,000	$ 95,000
	Structures	$ 6,363,000	$ 8,272,000	$ 11,453,000
	Services	$ -	$ -	$ -
	Landscaping	$ -	$ -	$ -
	Traffic Management	$ 2,224,000	$ 2,891,000	$ 4,226,000
	Temporary Works	$ -	$ -	$ -
	Other Construction Costs	$ 510,000	$ 663,000	$ 1,173,000
	SubTotal	**$ 28,143,000**	**$ 37,705,000**	**$ 54,787,000**
	Preliminary and General	$ 5,629,000	$ 7,036,000	$ 8,444,000
	Off Site O/H & Profit	$ 3,377,000	$ 4,052,000	$ 5,910,000
	Total Contractor	**$ 37,149,000**	**$ 48,793,000**	**$ 69,141,000**
	Total Construction	**$ 39,006,000**	**$ 51,207,000**	**$ 73,226,000**
Base Estimate				
	Base Estimate	**$ 43,835,000**		
Expected Estimate				
	Contingency		$ 13,186,000	
	Project Expected Estimate			**$ 57,021,000**
Expected Outturn Cost				
	Funding Risk			$ 15,023,000
	95th percentile Project Estimate			**$ 72,044,000**

Project Cost Summary (Excl Escalation)

	Base Estimate	Expected Estimate	95th percentile Estimate
WWL MGMT Fee (Capped at $2M)	$ 2,000,000	$ 2,000,000	$ 2,000,000
Project Estimates including WWL MGMT fee	$ 45,835,000	$ 59,021,000	$ 74,044,000

Project Cost Summary (Incl Escalation to 3rd Quarter 2024)

	Base Estimate	Expected Estimate	95th percentile Estimate
WWL MGMT Fee (Capped at $2M)	$ 2,000,000	$ 2,000,000	$ 2,000,000
Escalation to 3rd Quarter 2024 (12.67%)	$ 5,555,000	$ 7,227,000	$ 9,131,000
Project Estimates including WWL MGMT fee	$ 51,390,000	$ 66,248,000	$ 83,175,000

Notes:

Key notes from this cost estimate

- Escalation beyond 3rd Quarter 2024
- WWL Management Fees Capped at $2,000,000
- GST Excluded

Approvals

	Name	Signature	Date
Prepared by:	Dirk Jansen van Vuuren		9/05/2022
Reviewed by:	Barry Wallace		16/05/2022
Approved by:			

PROJECT ESTIMATE

Project Name: Cambridge Terrace
Phase: Level 1 Estimate

Phase	Description	Base Estimate	Expected Estimate	Maximum Risk Allowance
Development				
	Consultancy Fees - Concept Design	$ 2,008,000	$ 2,410,000	$ 3,012,000
	Total Project Development	**$ 2,008,000**	**$ 2,410,000**	$ 3,012,000
Consenting				
	Consenting Fees	$ 2,008,000	$ 2,410,000	$ 4,016,000
	Total Consenting	**$ 2,008,000**	**$ 2,410,000**	**$ 4,016,000**
Detailed Design				
	Consultancy Fees	$ 4,351,000	$ 5,221,000	$ 9,572,000
	Total Detailed Design	**$ 4,351,000**	**$ 5,221,000**	**$ 9,572,000**
Procurement				
	Consultancy Fees	$ 335,000	$ 436,000	$ 704,000
	Total Procurement	**$ 335,000**	**$ 436,000**	**$ 704,000**
Construction				
	Consultancy Fees	$ 3,347,000	$ 4,351,000	$ 7,363,000
	Contractor			
	Environmental Compliance	$ 36,000	$ 54,000	$ 79,000
	Earthworks	$ 3,268,000	$ 4,902,000	$ 7,190,000
	Ground Improvements	$ -	$ -	$ -
	Water	$ 36,000,000	$ 46,800,000	$ 68,400,000
	Wastewater	$ -	$ -	$ -
	Stormwater	$ -	$ -	$ -
	Roads	$ 238,000	$ 405,000	$ 595,000
	Structures	$ 6,363,000	$ 8,272,000	$ 11,453,000
	Services	$ -	$ -	$ -
	Landscaping	$ -	$ -	$ -
	Traffic Management	$ 4,545,000	$ 5,909,000	$ 8,636,000
	Temporary Works	$ -	$ -	$ -
	Other Construction Costs	$ 260,000	$ 338,000	$ 598,000
	SubTotal	**$ 50,710,000**	**$ 66,680,000**	**$ 96,951,000**
	Preliminary and General	$ 10,142,000	$ 12,678,000	$ 15,213,000
	Off Site O/H & Profit	$ 6,085,000	$ 7,302,000	$ 10,649,000
	Total Contractor	**$ 66,937,000**	**$ 86,660,000**	**$ 122,813,000**
	Total Construction	**$ 70,284,000**	**$ 91,011,000**	**$ 130,176,000**
Base Estimate				
	Base Estimate	**$ 78,986,000**		
Expected Estimate				
	Contingency		$ 22,502,000	
	Project Expected Estimate			**$ 101,488,000**
Expected Outturn Cost				
	Funding Risk			$ 32,358,000
	95th percentile Project Estimate			**$ 133,846,000**

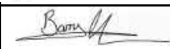
Project Cost Summary (Excl Escalation)

	Base Estimate	Expected Estimate	95th percentile Estimate
WWL MGMT Fee (Capped at $2M)	$ 2,000,000	$ 2,000,000	$ 2,000,000
Project Estimates including WWL MGMT fee	$ 80,986,000	$ 103,488,000	$ 135,846,000

Project Cost Summary (Incl Escalation to 3rd Quarter 2024)	Base Estimate	Expected Estimate	95th percentile Estimate
WWL MGMT Fee (Capped at $2M)	$ 2,000,000	$ 2,000,000	$ 2,000,000
Escalation to 3rd Quarter 2024 (12.67%)	$ 10,010,000	$ 12,862,000	$ 16,963,000
Project Estimates including WWL MGMT fee	$ 90,996,000	$ 116,350,000	$ 152,809,000

Notes: Key notes from this cost estimate
- Escalation beyond 3rd Quarter 2024
- WWL Management Fees Capped at $2,000,000
- GST Excluded

Approvals

	Name	Signature	Date
Prepared by:	Dirk Jansen van Vuuren		9/05/2022
Reviewed by:	Barry Wallace		16/05/2022
Approved by:			

PROJECT ESTIMATE

Project Name: Gracefield 2
Phase: Level 1 Estimate

Phase	Description	Base Estimate	Expected Estimate	Maximum Risk Allowance
Development				
	Consultancy Fees - Concept Design	$ 2,530,000	$ 3,036,000	$ 3,795,000
	Total Project Development	**$ 2,530,000**	**$ 3,036,000**	$ 3,795,000
Consenting				
	Consenting Fees	$ 2,530,000	$ 3,036,000	$ 5,060,000
	Total Consenting	**$ 2,530,000**	**$ 3,036,000**	**$ 5,060,000**
Detailed Design				
	Consultancy Fees	$ 5,481,000	$ 6,577,000	$ 12,058,000
	Total Detailed Design	**$ 5,481,000**	**$ 6,577,000**	**$ 12,058,000**
Procurement				
	Consultancy Fees	$ 422,000	$ 549,000	$ 886,000
	Total Procurement	**$ 422,000**	**$ 549,000**	**$ 886,000**
Construction				
	Consultancy Fees	$ 4,216,000	$ 5,481,000	$ 9,275,000
	Contractor			
	Environmental Compliance	$ 50,000	$ 75,000	$ 110,000
	Earthworks	$ 5,491,000	$ 8,237,000	$ 12,080,000
	Ground Improvements	$ 5,022,000	$ 6,529,000	$ 10,044,000
	Water	$ 40,900,000	$ 53,170,000	$ 77,710,000
	Wastewater	$ -	$ -	$ -
	Stormwater	$ -	$ -	$ -
	Roads	$ 413,000	$ 702,000	$ 1,033,000
	Structures	$ 6,363,000	$ 8,272,000	$ 11,453,000
	Services	$ -	$ -	$ -
	Landscaping	$ -	$ -	$ -
	Traffic Management	$ 5,135,000	$ 6,676,000	$ 9,757,000
	Temporary Works	$ -	$ -	$ -
	Other Construction Costs	$ 510,000	$ 663,000	$ 1,173,000
	SubTotal	**$ 63,884,000**	**$ 84,324,000**	**$ 123,360,000**
	Preliminary and General	$ 12,777,000	$ 15,971,000	$ 19,166,000
	Off Site O/H & Profit	$ 7,666,000	$ 9,199,000	$ 13,416,000
	Total Contractor	**$ 84,327,000**	**$ 109,494,000**	**$ 155,942,000**
	Total Construction	**$ 88,543,000**	**$ 114,975,000**	**$ 165,217,000**
Base Estimate				
	Base Estimate	**$ 99,506,000**		
Expected Estimate				
	Contingency		$ 28,667,000	
	Project Expected Estimate			**$ 128,173,000**
Expected Outturn Cost				
	Funding Risk			$ 38,420,000
	95th percentile Project Estimate			**$ 166,593,000**

Project Cost Summary (Excl Escalation)

	Base Estimate	Expected Estimate	95th percentile Estimate
WWL MGMT Fee (Capped at $2M)	$ 2,000,000	$ 2,000,000	$ 2,000,000
Project Estimates including WWL MGMT fee	$ 101,506,000	$ 130,173,000	$ 168,593,000

Project Cost Summary (Incl Escalation to 3rd Quarter 2024)

	Base Estimate	Expected Estimate	95th percentile Estimate
WWL MGMT Fee (Capped at $2M)	$ 2,000,000	$ 2,000,000	$ 2,000,000
Escalation to 3rd Quarter 2024 (12.67%)	$ 12,611,000	$ 16,244,000	$ 21,113,000
Project Estimates including WWL MGMT fee	$ 114,117,000	$ 146,417,000	$ 189,706,000

Notes:

Key notes from this cost estimate
- Escalation beyond 3rd Quarter 2024
- WWL Management Fees Capped at $2,000,000
- GST Excluded

Approvals

	Name	Signature	Date
Prepared by:	Dirk Jansen van Vuuren		9/05/2022
Reviewed by:	Barry Wallace		16/05/2022
Approved by:			