Project Number: 3-WW021.02

Eastern Hills Reservoir

Pipe Alignment Assessment

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150 YEARS IN AOTEAROA

EASTERN HILLS RESERVOIR
Pipe Alignment Assessment

Wellington Water

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Executive Summary

Wellington Water Limited (WWL) commissioned WSP to identify and assess pipe alignment options for the proposed Eastern Hills reservoir for the purpose of preliminary design and consenting.

A new 15 megalitre (ML) potable water storage reservoir is proposed to serve the Lower Hutt and Taita Water Storage Areas (WSAs). The Eastern Hills reservoir is to be located adjacent to the existing Naenae reservoir at the top of Summit Road. The new reservoir can share the existing inlet main serving the existing reservoir, however a new delivery main to the distribution network is required. Additionally, a new overflow pipeline outlet is required to serve both reservoirs.

Several pipeline alignment options have been identified, including Summit Road and other alignments down the north facing hillside towards Waddington Drive, refer Figure 1. All options have advantages and disadvantages that need to be considered to identify a preferred alignment.

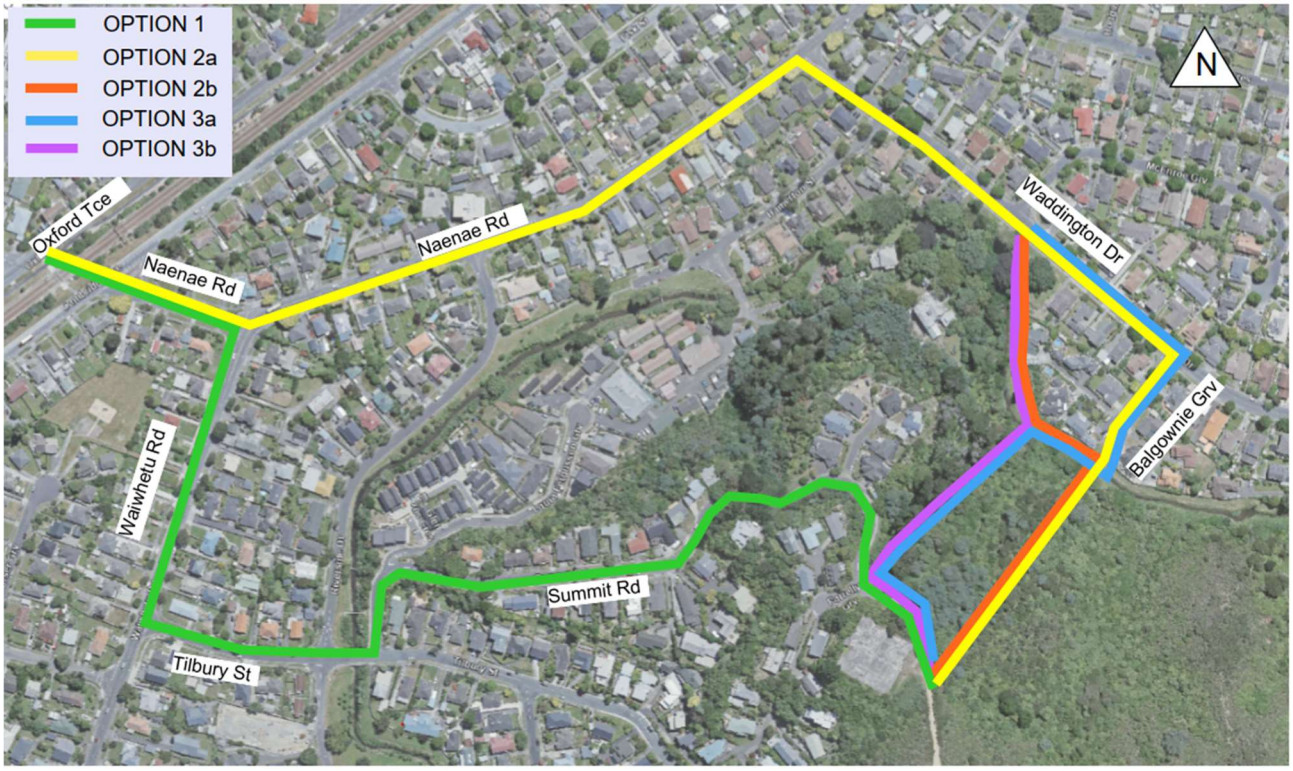


Figure 1: Pipeline alignment options overview

Community consultation identified a general preference for an alignment down the hillside north of the reservoir, towards Balgownie Grove, avoiding additional construction impacts on Summit Road properties, noting that Summit Road is the only available access alignment for reservoir construction and will already be subject to associated heavy vehicle traffic over the construction period. Balgownie Grove residents expressed concern about pipeline construction impacts along their street and proposed an alternative alignment adjacent to Waiwhetū Stream and through Waddington Drive reserve.

The hillside alignments, towards Balgownie Grove, passes through SNR12 area identified in the City of Lower Hutt District Plan (CLHDP). Construction would require removal of existing vegetation along a ~14 m wide construction corridor. Sediment runoff from the worksite also has potential to adversely impact wetlands and Waiwhetū Stream at the foot of the hill. The National

Policy Statement for Indigenous Biodiversity (NPS-IB) and the NPS for Freshwater Management (NPS-FM) broadly require avoidance of these environments/effects unless there is an operational or functional need to be located there, and no other practicable locations exist. The "effects management hierarchy" must also be applied.

An assessment of the options has determined that the Summit Road alignment (Option 1) is not practicable based on the identified constructability issues and risks taken in conjunction with the very high level of construction impacts (noise, vibration, traffic and access) on residents over an extended duration. There is an operational need for an outlet main and overflow pipeline from the proposed reservoir. The only practicable options require the pipelines to traverse the SNR12 area. The environmental impacts associated with the recommended option down the ridge north of the site (Option 2a) are manageable and the vegetation impacts can be mitigated, remediated and offset over an appropriate time period.

From the bottom of the ridge, the recommended alignment (Option 2a) crosses Waiwhetū Stream and continues along Balgownie Grove to Waddington Drive. The alternative alignment proposed by Balgownie Grove residents (Option 2b) has also been considered. This runs along the true right bank of Waiwhetū Steam for approximately 150 m which introduces construction and environmental risks, and overall construction impacts (noise, vibration, traffic) that would potentially be greater, for longer duration, and more intrusive due to the need for additional stream over-pumping and piling operations.

A multi criteria analysis (MCA) was carried out in June 2022 to select the preferred reservoir site. This MCA was based on the pipe alignment option 1. A review of the site selection MCA scoring was carried out as part of this pipe alignment assessment. The scoring review confirmed that the alternative pipe alignment for Option 2a would have made no material difference to the site selection outcome and that the Naenae site would still have been selected as the preferred site for a new reservoir.

WSP recommends that design and consenting be progressed for the recommended pipe alignment Option 2a.

Contents

Glossary of Technical Terms

TERM	DESCRIPTION
Delivery main	Pipeline from reservoir delivering potable water into the distribution network
DN	Nominal diameter, e.g. DN750 refers to a pipeline with a nominal diameter of 750 mm.
Inlet main	Pipeline to reservoir supplying potable water from water treatment plant.
Megalitre (ML)	1,000 m^3 or 1 million litres.
Overflow pipeline	Pipeline from reservoir to stormwater network or waterway to allow for drainage, also referred to as scour, of the reservoir and to accommodate any emergency overflows. This pipe will also be used to convey site stormwater.

1 Introduction

A new 15 ML potable water storage reservoir is proposed to serve the Lower Hutt/Taita WSAs. The Eastern Hills reservoir is to be located adjacent to the existing Naenae reservoir at the top of Summit Road. The reservoir is referred to in this report as the "Eastern Hills" reservoir, however previous work has referred to the reservoir as "Naenae 2" reservoir. Further project background can be found in Section 2.

The new reservoir can share the existing inlet main serving the existing reservoir, however a new delivery main to the distribution network is required. Additionally, a new overflow pipeline outlet is required to serve both reservoirs.

Several pipeline alignment options have been identified, including Summit Road and other alignments down the north facing hillside towards Waddington Drive. All options have advantages and disadvantages that need to be considered in order to identify a recommended alignment.

1.1 Purpose

The primary purpose of this report is to document the assessment of options to inform identification of the most appropriate pipeline alignment for preliminary design and consenting, following the selection of the site as the preferred site for the new reservoir.

The secondary purpose of this report is to assess if the recommended pipe alignment would have altered the outcome of the site selection multicriteria analysis (MCA). The original site selection MCA was based on the delivery pipe alignment along Summit Road

2 Background

An additional potable water storage reservoir is required to address a deficiency in storage required to meet level of service requirements in regard to peak day demands and post-disaster resilience. This is described in the Reservoir Volume Assessment Report [1] which confirmed the requirement for a new 15 ML reservoir.

An extensive site selection process was undertaken in 2022 to identify and evaluate potential sites for the reservoir and associated pipeline and access routes. A comprehensive MCA was completed for three shortlisted sites. This is described in the Site Selection Report[2], which identified the "Naenae 2" site as the highest scoring site option. Following subsequent engagement with Taranaki Whānui the Naenae site was confirmed as the preferred location for the new reservoir.

The Naenae site option considered in the MCA process assumed that the new reservoir delivery pipeline would be aligned down Summit Road. The Naenae site scored highest in all criteria groupings except for the social grouping which covers construction period impacts. Poor scoring in this grouping reflected the proximity of the Naenae site to existing residential property and site access being via residential streets. It was noted that particular consideration needed to be given to managing construction impacts on the local community should the Naenae site be adopted.

Concept design was commenced for a new 15 ML Eastern Hills reservoir at the Naenae site. The nominal pipe alignment down Summit Road was reviewed in regard to the likely construction impacts and alternative alignments were considered. Closer inspection of the Summit Road alignment identified that it would be challenging to thread a new, large diameter steel water

[1] Lower Hutt Central Storage Volume Assessment, October 2023, Connect Water
[2] Site Selection Report, June 2022, Connect Water

main down this alignment due to existing services. An alternative alignment, avoiding Summit Road was identified. This alignment runs north from the reservoir, down the hillside, across Waiwhetū Stream and along Balgownie Grove. The potential environment impacts in relation to the hillside alignment and stream crossing were considered to be manageable and provided social benefits of avoiding pipeline construction down Summit Road.

Reservoirs require a high-level overflow to prevent damage arising from overfilling the reservoir and a low-level drain or "scour" to allow periodic emptying for maintenance purposes. These two outlets from the proposed reservoir will be combined into one "overflow pipeline". It had been anticipated that the new reservoir would share a common overflow pipeline with the existing reservoir. The existing overflow discharges to an adjacent gully and was found to be deficient and in need of replacement, largely due to erosion and associated sediment discharge to Waiwhetū Stream[3]. This requires that a new overflow pipeline be constructed down Summit Road or the adjacent hill to Waiwhetū Stream, in addition to the new reservoir delivery main. This overflow pipeline is required irrespective of whether the new reservoir proceeds.

The possibility of constructing the delivery pipeline down the gully where the existing Naenae reservoir overflow presently discharges was raised by a contractor engaged to support the preliminary design phase of work. Construction of two adjacent pipelines has a number of benefits over construction along separate alignments. In addition to cost savings, a common pipe alignment will minimise the extent of works, with reduced overall environmental and social impacts. Routing of both the delivery main and overflow pipeline down Summit Road was considered to be impracticable, whereas a parallel pipeline down the preferred hillside alignment would impact a wider corridor but with a small marginal effect. Separating the pipelines – one down Summit Road and one down the hillside would incur both adverse social and environmental impacts (effectively the 'worst of both worlds').

The concept design was progressed with the two pipelines aligned down the hillside to Waiwhetū Stream (where the overflow pipeline discharges), with the delivery pipeline continuing along Balgownie Grove.

Community engagement during the preliminary design phase found opposition to the proposed pipe alignment along Balgownie Grove on the basis of construction impacts adversely affecting residents and home businesses. An alternative alignment along the Waiwhetū Stream left bank, crossing a recreation reserve to Waddington Drive was therefore considered.

Under the NPS-IB [in June 2023?], a portion of the site identified under the CLHDP as an SNR12 is now classified as a Significant Natural Area (SNA) under the transitionary definition of an SNA[4]. In light of the strong policy directions in relation to SNAs under the NPS-IB, it was considered necessary to more formally review the proposed pipe alignment.

This assessment gives consideration to the suggested alternative pipe alignment options.

[3] Naenae Reservoir Scour/Overflow Drain Extension, June 2022, Wellington Water

[4] *SNA, or significant natural area means:*
(b) any area that, on the commencement date, is already identified in a policy statement or plan as an area of significant indigenous vegetation or significant habitat of indigenous fauna (regardless of how it is described); in which case it remains as an SNA unless, or until a suitably qualified ecologist engaged by the relevant local authority determines that it is not an area of significant indigenous vegetation or significant habitat of indigenous fauna.

3 Objectives and Constraints

3.1 Objectives

(a) Identify a recommended pipe alignment for:

(i) a DN 750 steel delivery main from the proposed reservoir to connect to large diameter distribution mains in Oxford Terrace, and

(ii) a DN 500 steel/PE overflow pipeline from the existing and proposed reservoirs to a suitable discharge point along Waiwhetū Stream.

(b) Consider constructability, network performance and operations, resilience, cost, carbon, consenting, mana whenua, social, and natural environment impacts.

3.2 Constraints

In identifying and assessing pipe alignment options the following constraints were considered:

(a) Adjacent residential land use – construction impact sensitivity
(b) Waiwhetū Stream – environmental and cultural sensitivity
(c) Wetlands adjacent to Waiwhetū Stream – environmental and cultural sensitivity
(d) SNR12/SNA area – environmental sensitivity
(e) Land vested as reserves, which could trigger Reserves Act approvals
(f) Pipe alignment length to be minimised – cost and carbon sensitivity
(g) Private property – avoid where practicable

Figure 2 below outlines the key constraints listed above.

Figure 2: Location map showing key constraints

4 Option Identification

Three pipe alignment options have been identified for the reservoir delivery and overflow pipelines, with two variants for Options 2 and 3. All options cross Waiwhetū Stream and cross the rail corridor to Oxford Terrace near Brees Street (Figure 3).

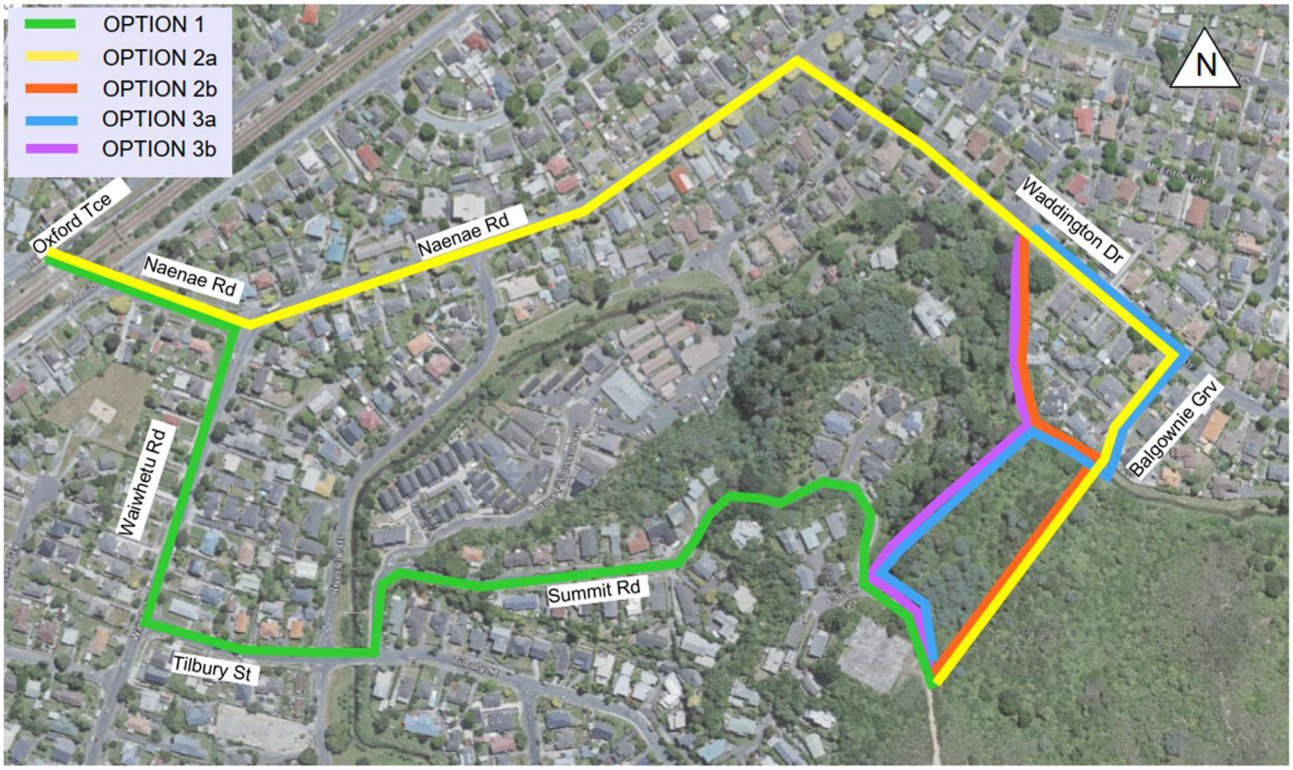


Figure 3: Pipe alignment options

4.1 Option 1 – Summit Road

The original alignment, as proposed in the Site Selection Report:

- Located within the carriageway of Summit Road, following a similar alignment as the existing DN750 supply pipeline.
- Overflow pipeline terminates at outlet structure adjacent to Waiwhetū Stream near Tilbury Street.
- New delivery pipeline crosses Waiwhetū Stream near the existing inlet and delivery pipe crossings, near the Tilbury Street bridge. As there are existing above-ground pipe crossings, that would likely impede the 100-year flood flows, the delivery pipeline could be installed above-ground in this location, but would require flood modelling and approval from GWRC.
- Connects into the DN300 Waiwhetū Road trunk main at the intersection of Tilbury Street and Waiwhetū Road.
- Connects to the DN150 Naenae Road main at the intersection of Naenae Road and Waiwhetū Road.
- Crosses the railway corridor at the intersection of Naenae Road and Cambridge Terrace, connecting into the DN375 watermain in Oxford Terrace at the intersection with Brees Street.
- Has a total pipe length of approximately 1,100 m.

4.2 Option 2 – Ridge line north of reservoir

The alternative alignment, as proposed in the Concept Design report and selected as the preferred alignment for concept design:

- Runs north-east from the reservoir site along a ridgeline through the existing vegetation, located approximately 70m southeast of the existing overflow pipeline.
- Lower section of pipe alignment designed to avoid encroachment on wetlands.
- Overflow pipeline terminates at outlet structure adjacent to Waiwhetū Stream, located to avoid wetlands.
- Delivery pipeline crosses the Waiwhetū Stream below-ground near the end of Balgownie Grove (between numbers 5 and 6).

From Waiwhetū Stream there are two potential delivery main alignments through to Waddington Drive.

Option 2a – Balgownie Grove

- Runs down Balgownie Grove, heading west up Waddington Drive. A connection to the DN150 Waddington Drive main would be made at the Waddington Drive and Balgownie Grove intersection.
- Continues west down Naenae Road with a connection to the DN150 main in Naenae Road to be installed near the intersection with Waddington Drive.
- A connection to the DN300 Waiwhetū Road trunk main would be installed near the intersection of Naenae Road and Waiwhetū Road.
- The pipeline would cross the railway corridor at the intersection of Naenae Road and Cambridge Terrace, tying into the DN375 Oxford Terrace at the intersection with Brees Street.
- Has a total pipe length of approximately 1,200 m.

Option 2b – Waddington Drive Reserve

- Runs downstream along the northern (true right) bank of the stream, between the private properties and the stream edge.
- Crosses Waddington Drive Reserve, connecting to the existing DN150 reticulation on Waddington Drive.
- As for Option 2a above, continues west down Naenae Road with a connection to the DN150 main in Naenae Road to be installed near the intersection with Waddington Drive.
- A connection to the DN300 Waiwhetū Road trunk main would be installed near the intersection of Naenae Road and Waiwhetū Road.
- The pipeline would cross the railway tracks at the intersection of Naenae Road and Cambridge Terrace, tying into the DN375 Oxford Terrace at the intersection with Brees Street.
- Has a total pipe length of approximately 1, 150 m.

4.3 Option 3 – Gully north of reservoir

- This offers an alternative alignment down the hill on the north side of the reservoir (parallel to and about 90m north of Option 2).
- Pipelines runs from the new reservoir, back down the access track to the top of Summit Road and connecting with existing reservoir overflow line.
- Runs northeast down a gully, where the existing reservoir drains, down to the Waiwhetū Stream, avoiding wetlands.
- Overflow pipeline terminates at outlet structure adjacent to Waiwhetū Stream, located to avoid wetlands.
- Delivery pipeline crosses the Waiwhetū Stream behind no. 7 Balgownie Grove.

From Waiwhetū Stream there are two potential delivery pipeline alignments through to Waddington Drive.

Option 3a – Balgownie Grove

- Runs upstream along the northern (true right) bank of the stream, between the private properties and the stream edge.
- Continues up Balgownie Grove and on to Waddington Drive as per Option 2a.
- Has a total pipe length of 1,200 m.

Option 3b – Waddington Drive Reserve

- Runs downstream along the northern (true right) bank of the stream, between the private properties and the stream edge.
- Crosses Waddington Drive Reserve, connecting to the existing DN150 reticulation on Waddington Drive.
- Continues along Waddington Drive as per Option 2b.
- Has a total pipe length of 1,150 m.

4.4 Other potential options

There are limited opportunities to run two large pipes from the reservoirs down to Waiwhetū Stream (overflow) and connect to large diameter mains in the distribution network (outlet pipeline). The alignments down Summit Road or down the hill towards Waddington Drive are covered above. Any alignment to the east would increase the length of construction through the SNA and offer no advantage over options 2a, 2b, 3a or 3b.

Any alignment to the south/west and Tilbury Street would require acquisition of private property and was not considered practicable in the context of this project. The terrain is also steep and would present significant difficulties in safely constructing a resilient pipeline and would still require additional construction through the SNA.

Option 3b is generally similar to the alternative option presented by a Balgownie Grove resident, which also suggested inclusion of a boardwalk above the pipeline along and across Waiwhetū Stream, continuing over the wetlands and linking up with an existing track. A sketch provided by the resident is presented in Appendix B. The provision of any recreational amenities adjacent to Waiwhetū Stream, such as boardwalks and walking tracks, are constrained by the presence of wetlands and require ongoing asset maintenance by Hutt City Council and/or WWL. A recreational assessment of the proposed reservoir and impact of the works have proposed other mitigation measures in the area such as additional seating and riparian planting.

The option of aligning the new delivery pipe adjacent to the existing Naenae reservoir DN450 delivery pipe was considered – refer to Appendix C. This pipe runs through a 1.51m wide easement under private property from the end of Farrelly Grove to where it enters the Summit Road carriageway outside of 18 Summit Road (Figure 4). The existing easement allows for a single 18 inch (DN450) pipe through the relevant properties. As this is what is currently in place the existing easement would not allow for the installation of a new DN750 delivery pipe and DN500 overflow / scour pipe. The need for new easements through multiple private properties, and the construction complexities of installing the new pipes under these properties, led to this option not being preferred. The delivery and overflow pipes will also need to navigate the remainder of Summit Road from house number 18, which has significant construction challenges.

Aside from Option 1, which is considered further in the following sections, there are no other practicable options that do not go through the SNA.

Figure 4: Existing delivery main easement (approximate location highlighted yellow)

4.5 Summary of Options

Three alignments have been identified for the delivery and overflow pipelines from the reservoir down to Waiwhetū Stream.

All options require crossing of Waiwhetū Stream, with a preference being for a below-ground crossing for options 2a, 2b, 3a and 3b (for further details refer to the Preliminary Design Report5). For options 2 and 3 there are alternative alignments from Waiwhetū Stream to Waddington Drive.

For convenience, the five options will be referred to as follows:

Option 1 – Summit Road

Option 2 – Ridge line north of reservoir:

Option 2a – Ridge line / Balgownie Grove

Option 2b – Ridge line / Waddington Reserve

Option 3 – Gully north of reservoir:

Option 3a – Gully / Balgownie Grove

Option 3b – Gully / Waddington Reserve

The primary objective of this assessment is to identify the most suitable pipe alignment from the reservoir site down to the valley floor. The delivery pipeline will then follow the road corridor to connect to existing large diameter distribution mains in Oxford Terrace, taking a direct alignment with consideration given to existing services in the road corridor, opportunities for connecting to the water distribution network and a suitable location for crossing the rail corridor.

[5] Eastern Hills Reservoir – Preliminary Design Report, October 2023, Connect Water

5 Option Assessment

5.1 Methodology

5.1.1 Criteria

Each of the pipe alignment options has been assessed against a set of criteria – refer to Table 1.

Table 1: Criteria used for assessment

CRITERIA	DESCRIPTION
Constructability	Constructability considers the ability of the contractor to build the pipe in the proposed alignment. It assesses risks with a focus on health and safety.
Network Performance and Operations	Network performance and operations considers the impact the pipe alignment has on Wellington Water's ability to meet their network levels of service e.g. pressure requirements, ability to access the pipe for repairs and maintenance.
Resilience	Resilience considers the capacity to withstand or recover from adverse impacts and can be considered at both the system level (water supply system) and the individual asset level (pipeline). In the context of this pipeline assessment the key consideration is damage to the delivery pipeline arising from slope failure, likely associated with a seismic or storm event.
Cost	Cost estimates have not been prepared for the various options under consideration and a detailed comparison has not been made. Instead general observations have been made about the various options.
Carbon	Detailed carbon assessments have not been completed for this comparison of pipe alignments as the sequestered carbon for the pipe is only one contributing factor for the entire project. However, general commentary is provided.
Consenting	Consenting assesses the degree of risk in relation to regulatory requirements that could impact delivery of the project on time and within budget. This is not intended to revisit of duplicate the assessment of other effects.
Mana Whenua Values	Impact of the option on values of significance to mana whenua and opportunities for enhancement.
Social	The social assessment focuses on the short-term impact of construction traffic, noise, vibration and dust on residents and the wider public.
Natural Environment	Natural environment focuses on ecological impacts of the pipe alignment on vegetation, watercourses, habitat and fauna, primarily during construction.

5.1.2 Scoring

The options have not been scored against each criteria, rather the pipe alignment options are each discussed in terms of each of the criteria below. The options are summarised in terms of their advantages and disadvantages (refer section 6) under each criterion as either favourable, unfavourable, or neutral.

The assessments were completed by subject matter experts and based on fieldwork, site visits and design completed as part of the preliminary design and overall reservoir consent and Notice of Requirement.

5.2 Constructability

Constructability considers the ability of the contractor to build the pipe in the proposed alignment. It assesses risks with a focus on health and safety.

Option 1 requires construction of a DN750 delivery pipeline and a DN500 overflow pipeline down Summit Road to Waiwhetū Stream. An additional stream crossing would need to be constructed in the vicinity of existing stream crossings.

Other services down the Summit Road corridor include the existing reservoir inlet (DN750) and delivery (DN450) mains, potable water supply, wastewater, stormwater, electricity, gas and communications (including fibre). The service congestion in Summit Rd presents a major obstacle in aligning the DN750 delivery pipe, particularly the existing DN750 inlet pipeline which crosses back and forth across the entire width of Summit Rd in multiple locations. The upper portion of the road corridor also narrows, with a footpath on one side and steep vegetated bank to the opposite kerb line further restricting the opportunity to install services.

The location of existing services along Summit Road along with an initial indication of potential pipe alignments based on this limited data is provided in Appendix C. Minimal information is available on existing service depths and the accuracy of the service records is uncertain. Extensive service location, survey and potholing investigations would be required to confirm feasibility of this option.

It is observed from Appendix C that there is no clear alignment for the delivery main and overflow pipeline. The indicative alignments are based on avoiding, to the extent possible, the existing large water mains and gravity (wastewater and stormwater) services which are most difficult to relocate. Crossing of these services would still be required in multiple (upwards of 10) locations. Water distribution, telecommunications, gas and power would require relocation along much of the alignment. Deep excavation will be required to construct below existing major services, and depending on the position in the road could require full road closures. There would be no alternative access for residents, or emergency vehicles.

Two contractors were asked to comment on the proposed Summit Road alignment. Their feedback on construction risks and difficulties is summarised in the points below. Both expressed a strong preference for the alignment down either the gully or the ridge to Balgownie Grove (Option 2a and Option 3a).

- A new pipeline along Summit Road would need to weave through existing services, requiring many bends and crossing the existing large water mains in perhaps eight locations. This adds considerable cost and complexity to the works, relative to a linear alignment.
- It would be necessary to construct portions of the proposed pipelines at depth, to pass below existing services. This is more likely to encounter rock which will increase construction duration, noise and vibration impacts, risk of damage to existing services and structures, and costs.
- Deep excavations have a large footprint and may necessitate full road closures to construct.
- Construction would be very close to other services, including a gas main. This increases health and safety risks, and the risk of damage to other services.
- Many services would require relocation to accommodate the proposed pipelines. This will require additional shutdowns and/or temporary services to be provided.
- The complexity of the construction will mean there is a relatively high baseline cost and long schedule. The risk of cost and schedule overruns will be high.
- There would be competition for access along Summit Road for reservoir construction, so these activities will need to occur sequentially. This will increase the overall project duration.
- A significant amount of traffic management would be required for the Summit Road section. A signal controlled one-way system is likely to be needed, along with temporary

road closures for some construction activities. It is noted that Summit Road is a dead end, with no alternative access route. Emergency service vehicle access would be compromised.
- Following completion of the pipeline installation a significant amount of work would be required to restore the roadway and landscape to pre-exiting condition.

Option 2 requires construction of a DN750 delivery pipeline and a DN500 overflow pipeline down a vegetated ridge north of the reservoir site. It is anticipated that the two pipelines would be constructed in a shared trench. Contractor advice is that a 14 m wide corridor would be needed for the trench (5 m), access track (3 m) pipe laydown and working space and topsoil stockpiles. The alignment down the ridge was preferred by one of the two contractors engaged to offer constructability advice.

The alignment is relatively direct following the ridgeline down the hill, avoiding construction on side slopes which present a higher risk of collapse during construction. Construction on the ridge will still require additional management to ensure stability and safety, and to control runoff and sediment discharges.

Installation of the pipelines by directional drilling could reduce the environmental impacts (vegetation removal, habitat disturbance) and risks associated with this alignment, although one contractor has indicated that this would be cost prohibitive and pose a risk to groundwater aquifers. The push/pull pits would have a large footprint and one may need to be sited in Balgownie Grove. Significant additional geotechnical assessments down the alignment may also be required to confirm suitability of directional drilling. This would require vegetation and soil disturbance as well as working on the ridge, offsetting any benefits provided by directional drilling.

The Contractor would require access from Balgownie Grove, which may also be needed for construction staging.

Summit Road access to the reservoir site can be maintained for construction vehicles, allowing for reservoir and pipeline construction to occur concurrently, compressing the duration of the overall project works.

The Option 2a alignment for the delivery main crosses Waiwhetū Stream and continues directly up Balgownie Grove (in all scenarios the overflow pipeline would discharge to Waiwhetū Stream). A preliminary review of underground service drawings indicates that the alignment can be feasibly placed in the Balgownie Grove carriageway, with comparatively few service crossings to be made. From Balgownie Grove the delivery main runs along Waddington Drive and Naenae Road. These roads are straight and flat, with good construction access, and have comparatively fewer services to avoid. There would be some disruption to residents and traffic impacts, but this is relatively straight forward to manage.

The Option 2b alignment for the delivery main also crosses Waiwhetū Stream but continues along the true right stream bank to Waddington Drive Reserve. This is a narrow space, reducing to as little as 3m wide in some areas. There would be restricted access for construction vehicles, and slope stabilisation of the bank would likely be required for safe construction and pipeline resilience. Construction may require piling and dewatering along the length of the bank, increasing the noise and vibration impacts on residents.

The constrained nature of the alignment along the stream introduces or exacerbates multiple risks associated with construction:

- Damage to private property or the need to access private property for works. Lifting of equipment and/or materials over private property may be required.

- Increased works in and around the stream, leading to a higher risk of negative ecological effects. The constrained working area may make establishing and maintaining erosion and sediment controls complex and increase the risk of failure.
- A constrained site increases the likelihood of an H&S incident, and it may be difficult to demobilise equipment and protect the works in a flood event.
- The duration of construction work is likely to be longer, increasing the risk of exposure to storm events.

Option 2b still requires significant construction activity along Balgownie Grove, as access would likely be required from this point as well as material storage, site facilities, and perhaps a crane platform on the grassed area at the end of Balgownie Grove. It may be necessary to lift equipment and materials over private properties using a crane.

Options 3a and 3b requires construction of a DN750 outlet pipeline and a DN500 overflow pipeline down a vegetated gully north of the reservoir site.

The initial section of the alignment down the gully would require a zig-zag access road to be cut into the hill, down the steepest section below the reservoirs. Ground conditions are such that there is a risk that this road may be washed out or fail under heavy vehicle loading, therefore additional slope stabilisation may be required. Not only will it be exceptionally difficult to develop a safe access route, while providing sufficient space to install the pipe along this steep section, but the gully access road provides a complex interface for the work areas, as it would likely impede access to the main reservoir platform. One contractor has advised that above ground construction may be necessary on the steep slopes. The constructed access route down the steep section would potentially need to be left in place for future maintenance access.

The shallow grade section of pipe at the base of the gully is exposed to the risk of slope failure above the works area as it is located in the gully below. To avoid the wetlands (shown in Figure 5 below), work in the gully floor would need to be completed near the slope edge, or on a side slope, which has increased risk of collapse under vehicle loading. Installing the pipe in the gully does not mitigate the risk profile of slope failure as a health and safety risk.

Construction in the gully will require additional management to ensure slope stability and safety, and to control runoff and sediment discharges. The gully drains a sizable catchment as well as being the discharge point for the Farrelly Grove stormwater and current Naenae Reservoir scour / overflow discharges. Effective management of stormwater will be more difficult to achieve in the gully, especially considering the presence of a wetland at the lower part of the gully. Compared to Options 2a and 2b, there is an increased risk of the work site being flooded and the slopes above the works collapsing.

Summit Road access to the reservoir site can be maintained for construction vehicles, allowing for reservoir and pipeline construction to occur concurrently, compressing the duration of the overall project works.

The alignment down the gully and towards Balgownie Grove (Option 3a) was recommended by one of the two contractors engaged to offer constructability advice. They expressed a preference for a short section of steep grade and then a relatively flat grade for the remaining distance, rather than a constant moderate grade as for Options 2a and 2b.

The Option 3a alignment for the delivery pipeline crosses Waiwhetū Stream behind no. 7 Balgownie Grove and along the true right bank of the stream before heading up Balgownie Grove. The section of pipe on the stream bank is approximately 40m long and at points the flat section on the bank is as narrow as 3m in some areas. A preliminary review of underground service drawings indicates that the alignment can be feasibly placed in the Balgownie Grove, Waddington Drive and Naenae Road carriageways, with comparatively few service crossings to be made.

The Option 3b alignment also crosses Waiwhetū Stream but continues along the true right stream bank for approximately 150m to Waddington Drive Reserve. This is a narrow space, with the flat section of the bank reducing to as little as 3m wide in some areas.

Even though Option 3a has a shorter section aligned along the true right stream bank, both options have the same construction risks associated with them, with a different level of exposure. There would be restricted access for construction vehicles, and slope stabilisation of the bank would likely be required for safe construction and pipeline resilience. It may be necessary to lift equipment and materials over private properties using a crane. Construction may require piling and dewatering along the length of the bank, increasing the noise and vibration impacts on residents. These risks are described in more detail under Option 2b.

5.2.1 Summary of Constructability

Option 1 is least preferred in terms of constructability. It would be extremely difficult to design/construct two large new pipelines along Summit Road through a very constrained corridor with congested utility services. Both contractors did not recommend this pipe alignment. Option 1 is deemed to be impracticable to construct

Option 3a/3b both involve work in the gully and have increased slope stability risks.

Option 2b is not preferred as it has increased risks working along the narrow streambank and greater community disruption.

Option 2a is the preferred option for constructability as it avoids work in the gully and along the narrow stream bank.

5.3 Network Performance and Operations

Network performance and operations considers the impact the pipe alignment has on Wellington Water's ability to meet their network levels of service e.g. pressure requirements, ability to access the pipe for repairs and maintenance.

All pipe alignment options connect to the Oxford Terrace trunk main at the same location. The additional pipe length required for Options 2a, 2b, 3a and 3b is insignificant in the context of hydraulic losses. The change in location of the connection to the Waiwhetū Rd main is also expected to have minimal impact on the performance of the distribution network.

The 2020 Hutt Valley Zone Management Plan identified several areas of poor service levels in the Rata and Sunville areas. Options 2a, 2b, 3a and 3b allow for a connection to the Waddington Drive trunk main, and the proposed connection to the Naenae Rd trunk main would be closer to consumers in these areas. This would help address the service level issues, and may reduce, eliminate, or delay the need for other network improvement works. Option 1 connects to the network at approximately the same location as the existing delivery main from the Naenae reservoir, and may not provide additional benefit to the Rata and Sunville areas.

Operationally, access to the Option 2a, 2b, 3a or 3b alignments on the hill section is more difficult if repairs are required, but excavation would be straightforward as the pipe would be installed with minimum cover and is not located in a road. The Option 1 pipeline location would be easier to access, but the pipeline will be very deep in some locations so excavation will be more difficult and riskier, and works are likely to cause greater traffic disruption and limit property access.

The gully location of Options 3a and 3b presents increased risk of scour associated with rainfall runoff from the large catchment. The design of pipes and trench backfill will need to take this into consideration and additional inspections and maintenance may be required following storm events to ensure that the pipeline is suitably protected.

As the overflow pipe is a gravity pipe, operationally it is preferred to have a constant fall to prevent stagnant water pooling in the pipe, and buildup of debris in low points can impact the flow

profile of the pipe in high flow scenarios. Crossing below services in Option 1 will require the pipe to either be installed:

- With low points, if the depth of installation is reduced as quickly as possible beyond each deep service crossing. This is not preferable from an operations perspective; or
- At greater depth, maintaining a constant fall on the pipe. This would increase construction risk, cost, and community impact.

5.3.1 Summary of Network Performance and Operations

Options 3a and 3b are least preferred in terms of network performance and operations, as the location at the base of the gully increases the difficulty in accessing the pipeline, while introducing potential maintenance issues such as scour of backfill.

Options 2a, 2b, 3a and 3b may have improved network performance over Option 1, in the Sunville and Rata areas due to the proximity of the Waddington Drive connection.

Option 1 has the pipeline in an easily accessible location, with works being in the road corridor, however the depth and presence of services adds risk in excavating and working on the line. For Option 2a the pipeline is more difficult to access along the ridgeline, however once accessed it is relatively simple to excavate and complete work on. Neither Option 1 or Option 2a is seen to be significantly more beneficial than the other but are both preferred over the other options.

5.4 Resilience

Resilience considers the capacity to withstand or recover from adverse impacts and can be considered at both the system level (water supply system) and the individual asset level (pipeline). In the context of this pipeline assessment the key consideration is damage to the delivery pipeline arising from slope failure, likely associated with a seismic or storm event.

Option 1 places both reservoir delivery pipelines in the same corridor down Summit Road, increasing the likelihood of both pipelines being damaged by the same event. However it is considered that Option 1 has a lower risk of slope failure causing damage to the pipe. The most likely cause of damage to the Option 1 pipelines would be caused by works in the road on adjacent services. Options 2a, 2b, 3a and 3b separate the existing and new delivery pipelines, which would be considered a more resilient solution. However, Option 1 has better access to repair damage.

From a geotechnical perspective it is preferable to run the pipe down the ridgeline (Options 2a and 2b), rather than down the gully (Options 3a and 3b). Ridge tops are the preferable alignment for a pipeline because they avoid stream crossings, have little or no contributing catchment (i.e. reduced seepage and drainage issues), and they avoid many of the sensitive geotechnical areas that would be encountered on side and planar slopes of a gully. If the pipeline or work areas deviate from the ridge top, or cross up and over it, then less-stable conditions may be encountered. Depth to bedrock is commonly shallow at ridge tops and may be encountered within the design pipeline depth. Options 3a and 3b would require the pipe to traverse a side slope to skirt around the wetland at the base of the hill, through an area of unfavourable conditions. Without specific geotechnical assessment, Options 2a and 2b are expected to be more resilient than Option 3a and 3b.

Access to the Option 2a, 2b, 3a and 3b alignments for maintenance activities and any large-scale repairs is restricted, making it more difficult to undertake emergency works. The steep access from the top of the hill would need to be maintained to provide access; or access would need to be made as required which would increase repair times. Access for Options 2a and 2b would be easier to reinstate than Options 3a and 3b, as a zigzag path down a steep slope would not need to be cut.

The northern bank of the Waiwhetū Stream is steep and could be at risk of failure during a heavy rain event, or from lateral spread in a seismic event. Due to the narrow width of the strip of land

between the bank edge and the properties where the pipe would be aligned in Option 2b and 3b, it is likely that additional slope stabilisation measures would be required to provide an adequate level of resilience. The restricted access also limits the speed at which repairs could be undertaken if needed.

5.4.1 Summary of Resilience

Options 3a and 3b are the least preferred in terms of resilience. Both are in a difficult location to access in an emergency. The pipeline traverses a side slope near the base of the gully and runs along the stream bank, increasing risk of damage due to slope failure.

Option 2b has increased risk of slope failure along the stream bank. The ridgeline poses a risk of failure, however this is easier to mitigate than traversing a side slope.

Option 1 and 2a are the preferred options for resilience, both options have advantages and disadvantages with no clear preference.

5.5 Cost

Cost estimates have not been prepared for the various options under consideration and a detailed comparison has not been made. Instead, general observations have been made against the various options.

Further investigations and preliminary design work, including detailed consideration of construction methodologies, would be needed for all options to establish a basis for cost estimating to a level of detail that would allow cost differentiation between options .

The following general observations have been made:

- All options require construction of two pipelines of the same size and similar length, thus any cost difference will largely be driven by complexity of construction and risk.
- Option 1 has good access for construction compared to Options 2a, 2b, 3a and 3b, with access for Options 3a and 3b being particularly difficult down the steep upper section of the alignment.
- Option 1 involves a high level of risk in relation to existing services and is expected to require significant service relocations and deep excavations potentially into rock, all at significant cost. Options 2a, 2b, 3a and 3b have no existing services to contend with and can be installed with minimum cover (depth), which reduces earthworks.
- Option 1 is expected to require significant costs associated with service locations (survey, GPR scanning, trial pits), in order to prove the alignment is feasible.
- Option 1 would require significant, costly traffic management over an extended period of time, whereas the hillside portions of Options 2a, 2b, 3a and 3b will not require traffic management.
- Option 1 would have minimal impacts on the natural environment and would avoid the need for vegetation loss offsetting within an SNA and avoid the need for most, if not all management plan development and implementation. There is a significant cost associated with the ongoing offsetting planting and pest control.
- Option 1 would necessitate extensive road/footpath/landscape reinstatement along Summit Road. Imported backfill material would be needed for the pipeline trenches. Options 2a, 2b, 3a and 3b could potentially utilise site won backfill material and have less costly reinstatement requirements.
- Options 2a, 2b, 3a and 3b have high levels of geotechnical risk, potentially requiring additional stabilisation works and some portions of the pipeline may need to be installed above ground. There are localised areas of geotechnical risk for Option 1 where deep excavation is anticipated adjacent to steep slopes.
- Significant costs are anticipated for Options 2a, 2b, 3a and 3b which have high levels of environmental impact, requiring vegetation, bird, lizard, and freshwater fauna management plan development and implementation prior to and during enabling works.

Site remediation with native vegetation post construction is required, however vegetation impacts require offsetting, pursuant to the NPS-IB. Weed control (wattle, pine, and gorse) and native restoration planting of these areas as well as pest control across 18 hectares for several years, all within SNR12 adjacent to the site is required.

- Construction of Options 3a and 3b in the gully would introduce significant additional costs for erosion and sediment control management and likely require additional design detailing to address risk of damage from surface water runoff.
- Significant additional costs are anticipated for all alignment options adjacent to Waiwhetū Stream (2b, 3a and 3b), potentially requiring bank stabilisation and piling, and temporary stream over pumping during construction. Access will be difficult and may require cranage for plant and materials. Additional environmental protection will be required given proximity to stream and there is a risk of worksite flooding.

5.5.1 Summary of Cost

There are construction challenges and risks associated with all options and there is no clear 'lower cost' or 'higher cost' options evident. For the purpose of this assessment it is assumed that all options are comparable in regards to cost.

5.6 Carbon

Detailed carbon assessments have not been completed for this comparison of pipe alignments, and only general commentary is provided.

A carbon assessment, prepared to understand the relative capital carbon requirement of three shortlisted site options, demonstrated that the three project components with the greatest carbon requirement are a) concrete reservoir; b) earthworks; and c) inlet/outlet pipework. This suggests that the overall pipe length will be the dominant factor for any comparative carbon assessment. The nominal pipe lengths for each option under consideration are within about 10% of each other. The Option 2a, 2b, 3a and 3b pipe alignments are marginally longer so can be expected to have a slightly higher embodied carbon, although this may be balanced by additional pipe relocation works needed for Option 1.

In terms of earthworks, Options 2a, 2b, 3a and 3b will require additional track formation for construction, while there could be a reduced quantity of imported fill material required if the off-road portion of the pipe trench can be filled with site sourced material.

No carbon assessment has been carried out in terms of carbon sequestration impacts due to vegetation removal. Remediation of the pipe alignments within SNR12 is proposed to be low growing shrubs which will result in a fundamental change from arborescent vegetation currently present. Although remediation will result in a positive effect due to weed removal and indigenous vegetation plantings, it can be assumed that sequestered carbon within arborescent vegetation removed will not be remediated with the proposed shrubs. Offsetting vegetation losses and impacts is required, as such weed control within SNR12 adjacent to the site will see further exotic vegetation losses and native vegetation remediation. It can be assumed the offsetting requirements will work towards a long-term carbon sequestration, such that losses will be compensated for. Furthermore, offsetting requires pest control which will see possum control across 18 hectares for no less than 10 years, resulting in a biodiversity net gain and benefiting carbon sequestration through the reduction of herbivore impacts. Option 1 would have almost no carbon sequestration impacts due to the avoidance of vegetation removals while Options 2a, 2b, 3a and 3b are expected to be identical.

5.6.1 Summary of Carbon

Overall, the difference in carbon emissions between options is not considered to be a significant differentiator.

5.7 Consenting

Consenting *assesses the degree of risk in relation to regulatory requirements that could impact delivery of the project on time and within budget. This is not intended to revisit of duplicate the assessment of other effects.*

Option 1 – provides for trenching within Summit Road, and would be able to be undertaken largely as a permitted activity. That is, the trenching would comply with the permitted activity network utility standards within the CLHDP which provides for trenching within the road reserve to occur as a permitted activity with no earthworks limitations. Consequently, no resource consent would be required.

The key consenting issue identified for Options 2a, 2b, 3a and 3b is that the works feature alignments within SNR12 area identified in the CLHDP. If the works were not designated, they would require resource consent from Hutt City Council for earthworks, aerial crossing of Waiwhetu Stream and works in a Significant Natural Area overlay. The works also have potential to impact on wetlands and Waiwhetū Stream through sediment laden runoff from the construction site. An image of the pipe alignment options and the location of SNR12 is shown below in Figure 5.

Figure 5: Pipe options and how they interact with SNR12.

As identified in the previous figure Options 2a, 2b, 3a and 3b all traverse through SNR12. Due to the promulgation of the NPS-IB and NPS-FM, careful consideration has to be afforded to selecting one of these alignment options as both policy statements require avoidance of these environments/effects unless there is an operational or functional need to be located there, and no other practicable locations exist. The "effects management hierarchy" also needs to be applied.

Section 5.2 of this report has considered the constructability of the various pipe alignment options, and notably concluded that Option 1 was impracticable to construct. From a consenting perspective, if Option 1 were practicable to construct it would be the preferred consenting pipe alignment option.

Acknowledging that Option 1 is not practicable to construct, and there are no other practicable options that would avoid the SNA, it is concluded that there is an operational need for the pipelines to traverse the SNA due to the topographical constraints of the site as discussed in Section 4 of this report. (Options 2a, 2b, 3a and 3b) all provide alignment options that can connect to the bulk water supply network.

The works can be designed to avoid encroaching on the identified wetlands and managed to prevent sediment discharge impacts on the waterway. The effects associated with vegetation removal within the SNR will require offsetting as the pipeline alignments will not be able to avoid, remedy or mitigate effects associated with the removal of vegetation. It is noted that all options require pipeline construction upgradient of Waiwhetū Stream and construction of a stream crossing.

Whilst Option 1 could be reasonably assumed as being able to be progressed as a permitted activity, Options 2a, 2b, 3a and 3b would require a suite of resource consents (including from HCC for earthworks, aerial crossing of a waterway and works in a Significant Natural Area overlay, if the pipelines were not being authorised by way of designation). Activities requiring resource consent include;

- From Greater Wellington Regional Council:
    - Earthworks, including within 100m of a natural inland wetland and within the bed of a stream;
    - The removal of vegetation;
    - Damming, diverting, and discharging water within a 100m setback from a natural inland wetland;
    - Construction of a temporary access bridge; and
    - Construction of permanent discharge structures and associated erosion protection structures.
    - Discharge of stormwater and potable water
- From Hutt City Council (if not authorised by designation):
    - Earthworks exceeding 25m2 in a riparian zone, and exceeding 100m2 in residential and recreation zones
    - Aerial crossing of a network utility over a waterway
    - Works within a Significant Natural Area overlay

Due to the location of Options 2 and 3, environmental effects associated with the construction of a pipeline need to be carefully managed. An environmental risk associated with Options 2a, 2b, 3a and 3b is the proximity of works to several identified natural inland wetlands located adjacent to Waiwhetū Stream, refer Figure 6. Under the National Environmental Standard for Freshwater Management (2022) vegetation clearance within a 10 m buffer zone around these wetlands requires resource consent as a Discretionary Activity under Clause 45(1). Construction activities must therefore be managed to avoid adverse impacts on the wetlands. The confirmed alignment must avoid any wetland buffer to allow sufficient vegetation clearance for pipe installation (14 m corridor). Options 2a and 2b can more easily avoid the wetland buffer zone with a small alignment change to the west, refer Figure 6.

Similarly, the works will require structures to be constructed within the Waiwhetū Stream, and for the pipe to cross the stream itself. Through the implementation of standard construction methodologies, deployment of mitigation measures, and construction design refinement it is

anticipated that the effects of the works can be understood and managed so that adverse effects will be minor and can be mitigated.

Figure 6: Wetlands adjacent to Waiwhetū Stream, including 10 m buffer zone (indicative pipe alignments shown)

The alignment for **Options 3a and 3b** would traverse the western-most wetland and the overflow pipeline would also be within the wetland buffer zone.

Options 2a/2b originally traversed through the 10m buffer of middle wetland. However, through application of the effects management hierarchy the design has been refined so that the pipeline does not traverse the identified natural inland wetland, by traversing the eastern slope, outside the wetland buffer zone (as indicated in Figure 6.

Options 2a, 2b, 3a and 3b traverse land that is owned by Lower Hutt City Council. Generally, the land is not identified, or vested, as a reserve except for a small portion of Option 2b which would have to traverse land that has been vested as a recreation reserve, as shown on Figure 7.

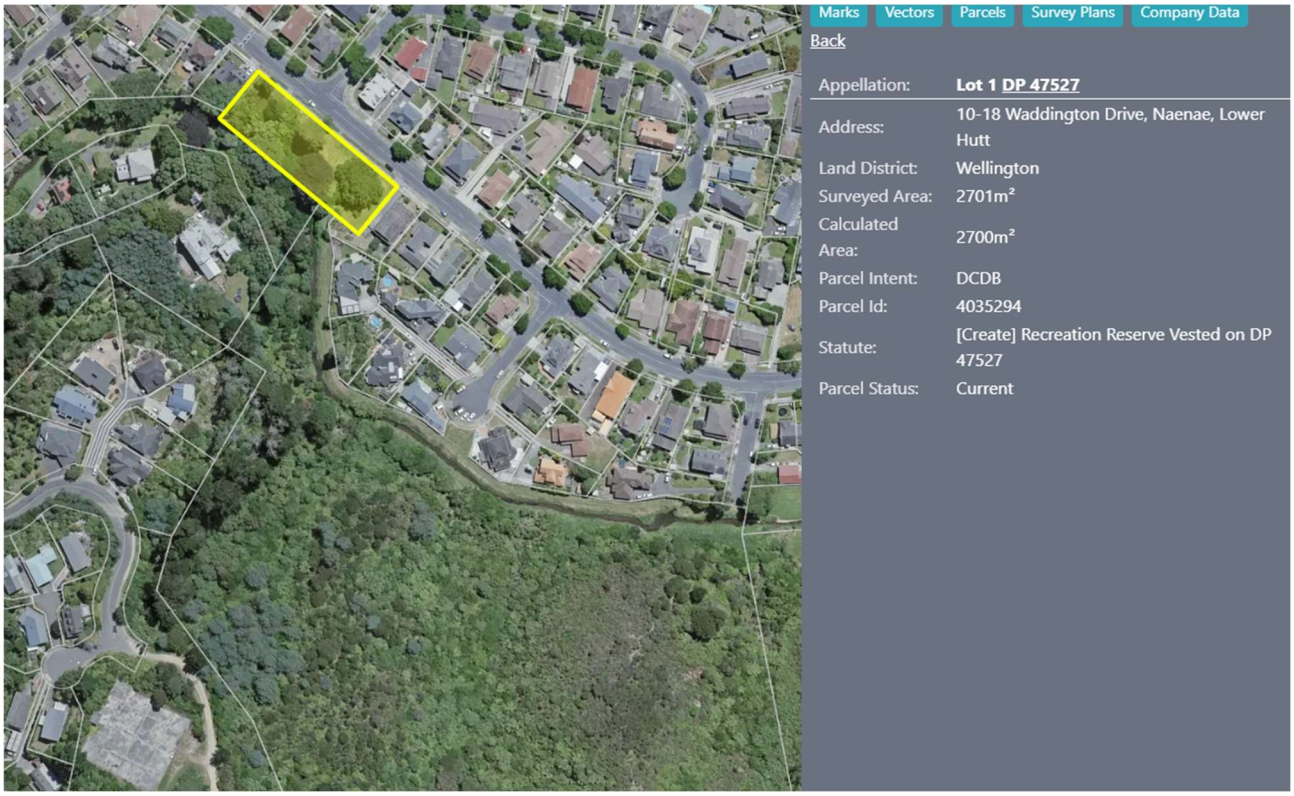


Figure 7: Recreation reserve lot (highlighted yellow)

The Project team have had discussions with Hutt City Councils Parks and Recreation team to confirm the suitability of the proposed alignment. No significant concerns have been identified with the proposed pipe alignments subject to the effects of the alignment being appropriately addressed.

5.7.1 Summary of Consenting

In summary, Option 1 would present the simplest option from a consenting perspective (despite having potentially significant effects on the local community in the event of road closure).

However, Options 2a, 2b, 3a and 3 are also feasible from a consenting perspective provided that significant regional benefits arising from the reservoir can be demonstrated, and on the basis that Option 1 is not practicable. Through detailed design, site surveys, and implementation of standard construction methodologies the effects can be clearly understood and appropriately addressed through application of the effects management hierarchy.

5.8 Mana Whenua Values

Impact of the option on values of significance to mana whenua and opportunities for enhancement.

Consultation was undertaken with Taranaki Whānui as part of the MCA site selection and subsequently a cultural impact assessment (CIA)[6] was prepared for the proposed site. The CIA, based on pipe alignment Option 2a concluded that it was unlikely that pre-European Māori cultural material would be found anywhere in the soil around the proposed water reservoir site. An accidental discovery protocol was recommended. Particular note was made that the construction method should avoid any potential discharges of contaminated water into the Waiwhetū Stream.

[6] Cultural Impact Report – Naenae Drinking Water Reservoir, February 2023, Raukura Consultants

Comment from Taranaki Whānui was sought on the various pipe alignment options and works adjacent to the Waiwhetū Stream. Their preference is for "the pipeline alignment with the lowest environmental impact on Raumānuka (Eastern Hills) and the Waiwhetū Stream".

5.8.1 Summary of Mana Whenua Values

Taranaki Whānui prefer the option with fewest environmental impacts. Therefore Option 1 is inferred to be preferred by Mana Whenua as it has the lowest risk of negative environmental impacts on the hillside and Waiwhetū Stream. Options 2a, 2b, 3a and 3b will all have a higher risk of environmental impact, particularly on the hillside vegetation and stream, when compared to Option 1. Effects of the pipeline options will be mitigated through specialist assessments and proposed consent conditions and construction-stage controls.

5.9 Social

The social assessment focuses on the short-term impact of construction traffic, noise, vibration and dust on residents and the wider public.

All options will have some degree of community impact during construction in terms of traffic disruption, property access, noise, dust and vibration. The MCA made specific note of the community impacts associated with the Naenae site option, based on nominal pipe alignment Option 1 considered here, which scored poorly under the Social criterion. The MCA report identified that "particular consideration will need to be given to managing construction impacts on the local community should the Naenae 2 site be adopted."

5.9.1 Concept Design and Initial Consultation

Concept design presented alignment Option 2a as this was considered to alleviate some of the disruption to Summit Road residents (associated with Option 1), noting that Summit Road would still be utilised by reservoir construction traffic. Option 2a addresses, to some extent, the specific concerns reported from the MCA. While this transfers some impacts to another location, the community impact of Option 2a is considered to be no greater than any other horizontal infrastructure project permitted in the road corridor (because the roads affected are much less constrained than Summit Road).

Public consultation on the concept design noted that many residents were concerned about the impact of traffic disruption and access restrictions arising from the works; especially those with children, home businesses, or who commute to work. This consultation included social media posts, in person drop-in sessions, signage, and online surveys. Option 1 would significantly increase these disruptions. Community consultation confirmed Option 2a as the preferred option for the alignment.

However, residents of Balgownie Grove expressed concern about the impact that construction activities and traffic will have, citing a number of small businesses in the street. An alternative alignment, presented here as Option 3b was suggested.

5.9.2 Noise, Dust and Vibration

Option 1 utilises the Summit Road corridor for the delivery main and overflow pipeline alignment. Summit Road is approximately 500 m long. There are 40 residential properties with access from Summit Road and Farrelly Grove.

Construction of the pipeline up Summit Road will generate some noise and dust nuisance for adjacent residents, as is typical of any on-road construction works. The deep excavation anticipated to install pipes below existing services will likely encounter rock, removal of which will generate additional noise and vibration above less dense ground conditions. Environmental management plans will be in place to mitigate such effects and ensure noise levels are maintained within allowable standards.

As Summit Road is the only access available for reservoir construction, this work cannot be constructed concurrently with the Summit Road pipeline works. This will result in an extended duration over which Summit Road residents will be impacted. Reservoir construction will require a large number of heavy vehicle movements on Summit Road. This construction traffic will generate a noise impact along Summit Road, particularly during the period while material is being hauled from site.

Options 2a and 3a utilise the Balgownie Grove road corridor, a 75 m long residential cul-de-sac serving 11 residential properties.

Construction of the pipeline along Balgownie Grove will generate some noise and dust nuisance for adjacent residents, as is typical of any on-road construction works. It is not anticipated that excavation of rock will be required. Environmental management plans will be in place to mitigate such effects and ensure noise levels are maintained within allowable standards.

Option 3a involves construction of the pipeline for about 40 m along the true right stream bank, directly behind No 6 and 7 Balgownie Grove. This work will be in close proximity to the dwellings and will likely involve piling operations and dewatering to construct along the stream edge, extending the duration of construction and generating additional noise and vibration. This involves some increased risk of damage to private property, requiring specific management and monitoring. Dewatering will require pumps and generators to be operational 24 hours a day, providing additional disruption to residents.

Additional earthworks for both Options 2a and 3a, and removal of vegetation, will generate more dust during construction than Option 1. This will be managed on site through temporary soil stabilisation and water carts, while covered loads will be used when removing spoil from site. There is not anticipated to be a significant difference in noise generated between the alignment down the ridgeline or gully.

Options 2b and 3b avoid pipeline construction along the Balgownie Grove road corridor, a 75 m long residential cul-de-sac serving 11 residential properties.

However, Balgownie Grove would be used for contractor access for construction of the pipeline down the hill, the stream crossing and the pipeline along Waiwhetū Stream.

These options involve construction of the pipeline for 110 to 150 m along the true right stream bank, directly behind No 6, 7, 8 and 9 Balgownie Grove. This work will be in close proximity to the dwellings and may involve piling operations and dewatering to construct along the stream edge, extending the duration of construction and generating additional noise and vibration. This involves some increased risk of damage to private property, requiring specific management and monitoring. Dewatering will require pumps and generators to be operational during the night, providing additional disruption to residents.

Options 1 and 2a are considered to have the lowest dust, vibration and noise impacts.

5.9.3 Construction Traffic, Traffic Management and Property Access

Option 1 utilises the Summit Road corridor for the delivery main and overflow pipeline alignment. Summit Road is approximately 500 m long. There are 40 residential properties with access from Summit Road and Farrelly Grove. Additionally, there will be some access disruption to Laura Ferguson Drive, affecting the Laura Fergusson residential facility and a further 28 dwellings.

Pipeline construction would require that at least the upper part of Summit Road be intermittently closed, with the remainder of the road severely impacted during construction of the pipeline. This would include lane closures with stop/go or temporary signal controls, and no on-street parking. There is no alternative access to these properties for residents or emergency services. The deep excavation anticipated to install pipes below existing services will likely encounter rock, increasing construction difficulty and duration.

As Summit Road is the only access available for reservoir construction, this work cannot be constructed concurrently with the Summit Road pipeline works. This will result in an extended duration over which Summit Road residents will be impacted. Reservoir construction will require a large number of heavy vehicle movements on Summit Road. Parking restrictions along some or all of the road may be needed for safety, and road closures required from time to time to facilitate access for large machinery.

Options 2a and 3a utilise the Balgownie Grove road corridor, a 75 m long residential cul-de-sac serving 11 residential properties.

Pipeline construction along the road would require a shoulder or lane closure, removal of off-street parking, and some disruption to private property access. The proposed works are routine in nature and not dissimilar to other horizontal infrastructure projects permitted in the road corridor and routinely undertaken across the city. Balgownie Grove would also be used for contractor access during construction of the stream crossing and pipeline up the hillside. The road would remain open and property access maintained., although parking may be limited, and the Contractor may establish a construction staging area at the cul-de-sac head.

Option 3a may require contractors to access private property to install the pipe along the stream bank.

The reservoir construction works will be accessed from Summit Road so Balgownie Grove will only be affected for the duration of the localised pipeline construction works.

Options 2b and 3b avoid pipeline construction along the Balgownie Grove road corridor, a 75 m long residential cul-de-sac serving 11 residential properties.

However, Balgownie Grove would be used for contractor access for construction of the pipeline down the hill, the stream crossing and the pipeline along Waiwhetū Stream. The road would remain open and property access maintained, although parking may be limited, and the Contractor may establish a construction staging area at the cul-de-sac head.

Both options would likely require the contractor to access private properties to complete construction.

The reservoir construction works will be accessed from Summit Road so Balgownie Grove will only be affected for the duration of the localised pipeline construction works.

Options 3a and 3b will require contractors to access the gully directly from Summit Road, using the top of Summit Road as a staging platform to crane equipment down into the gully. This may disrupt traffic to Farrelly Grove and could disrupt works on the reservoir, increasing project duration.

Options 2a has the lowest impact on traffic and private property.

5.9.4 Summary of Social

Option 1 is considered to have significant community impacts as works occur in the Summit Road corridor, resulting in significant noise and dust vibration. The works will likely shut down Summit Road for periods with a traffic disruption throughout construction. Construction in the road will increase the duration of the overall programme, extended the disruptive period for residents.

Options 2b, 3a and 3b will all likely require access through private property for the installation of the pipeline and have significant amounts of dewatering and overpumping associated with them. This dewatering and overpumping will be 24 hours a day and create noise disturbance, while piling along the stream bank will likely create significant noise and vibration.

Option 2a is considered to have the lowest impact on the community.

5.10 Natural Environment

Natural environment focuses on ecological impacts of the pipe alignment on vegetation, watercourses, habitat and fauna, primarily during construction.

All options involve construction of an overflow pipeline to Waiwhetū Stream, and a underground crossing of Waiwhetū Stream for the reservoir outlet main. The environmental considerations of these project elements are recognised but not specifically considered in this assessment as they are essentially common to all options.

The Option 1 pipe alignment runs entirely through the developed urban area, therefore has no material impact on indigenous flora and fauna. Erosion and sediment management controls will be needed to protect adjacent properties and the Waiwhetū Stream receiving environments. Option 1 is the preferred option from an ecological perspective, due to the lack of ecological features and values impacted.

The initial ~200 m of Options 2a, 2b, 3a and 3b run down the vegetated hillside north of the proposed reservoir site within SNR12. While it may be possible to install the pipelines down the slope using trenchless techniques this assessment assumes that open cut trenching methods will be adopted. This would require vegetation clearance to form an approximately 14 m wide corridor for pipeline installation. The exposed site will be revegetated following completion of the works but exclude large arborescent tree planting, which would have potential to damage the pipelines and preclude access for future maintenance, i.e. shallow rooted plants/shrubs only. The works will Have a temporary (construction phase) visual impact. Site remediation plantings must occur within the first available planting season after construction commencement (winter) and planted at a density to ensure prompt canopy closure and reduce erosion and sediment risk to Waiwhetū Stream.

The vegetation on the hillside north of the proposed reservoir site is consistent with the wider Eastern Hills having suffered extensive impacts since human occupation and being fundamentally changed from a pre-1840 state. The site is dominated by indigenous vegetation, though exotic trees and weeds are present. Vegetation provides suitable habitat for regionally 'Threatened' and 'At Risk' terrestrial fauna (birds and lizards). Following implementation of appropriate management plans and remediation of the site, Options 2 and 3 will have less than minor effects on terrestrial fauna. More than minor adverse effects on vegetation will remain, however, these effects will be offset within SNR12 through weed control, replacement of indigenous vegetation planting and pest management.

Options 2a and 2b will avoid all Waiwhetū stream tributaries. Option 3a and 3b will affect freshwater values of one of the tributaries and it will be difficult to manage erosion and sediment control.

There are several existing wetland areas at the base of slope, adjacent to Waiwhetū Stream. Options 2a and 2b can be aligned outside of the 10 m wetland protection zone but Options 3a and 3b pose greater difficulty in avoiding the wetlands at the base of the gully.

Comparatively Options 2a and 2b are the preferred option compared to Option 3a and 3b from an ecological perspective:

- Options 2a, 2b, 3a and 3b have similar terrestrial values (vegetation, birds, lizards) that would be impacted.
- Options 3a and 3b would affect freshwater ecosystems located in the gully and will be more difficult to manage erosion and sediment control and poses a greater risk to the freshwater environment.
- Additional dewatering requirements would be needed to install the pipelines for Options 3a and 3b within the gully which introduces more potential groundwater drawdown effects.
- The alignment for Options 3a and 3b has a wetland directly in the path, which will be more difficult to avoid than Options 2a and 2b.

Options 2b and 3b would be constructed along the true right bank of Waiwhetū Stream from Balgownie Grove to Waddington Drive reserve. This corridor between the stream and private property is narrow, as little as 3 m wide in places. It is anticipated that bank stabilisation, including instream works, would be necessary for construction along this alignment.. Overpumping of the stream flow may be necessary. Erosion and sediment management controls will be needed to protect adjacent property and the Waiwhetū Stream receiving environment, including protected wetland areas. Options 2a and 3a are both preferred over 2b and 3b.

5.10.1 Summary of Natural Environment

Option 1 is the preferred option from an ecological perspective, due to the lack of ecological features and values impacted.

Of the remaining options, Option 2a is preferred from an ecological perspective as it minimises impact on freshwater ecosystems and minimises work adjacent to Waiwhetu Stream.

6 Discussion

6.1 General

The proposed reservoir requires construction of two pipelines down the hill from the reservoir. Firstly, a dedicated delivery main that will cross Waiwhetū stream and continue through the urban roading network, connecting to the existing distribution network in Oxford Terrace. Secondly, an overflow pipeline that will discharge to Waiwhetū Stream.

Three pipe alignment options down the hillside have been identified for consideration here. Option 1 follows Summit Road down to Waiwhetū Stream. Options 2a and 2b (ridgeline), and 3a and 3b (gully), take different alignments down the vegetated hillside north of the reservoir to a common location at Waiwhetū Stream.

The downhill alignment options are discussed below in Section 6.2.

Two variants (Options 2a and 3a and Options 2b and 3b) for the continuation of alignment Options 2 and 3 through to Waddington Drive are discussed in Section 6.3.

This assessment does not consider options for the remainder of the pipe alignment through to Oxford Terrace, as this is relatively straight forward work in the road corridor (refer to section 5.2). This portion of the alignment has been selected on the basis of minimising the pipe length, feasibility of construction and ability to connect to the existing potable water distribution network. The overall alignments are similar in length (Options 2a, 2b, 3a and 3b are approximately 50-100 m longer), all require crossing of the rail corridor and none have particular environmental sensitivities.

This assessment assumes that both pipes will be constructed along the same alignment, sharing a common trench where practicable. This will minimise community and environmental impacts and there is no operational benefit to separation of the pipelines. The overflow pipe must be constructed irrespective of the proposed reservoir as it is needed to replace the inadequate existing outlet from the existing reservoir which has resulted in erosion in the catchment and sediment discharge to Waiwhetū Stream.

6.2 Options Assessment

The options have not been scored against each criteria, rather the pipe alignment options were each discussed in terms of each of the criteria in Section 5. The options are summarised in terms of their advantages and disadvantages (refer to *Table 2*) under each criterion as either favourable, unfavourable, or neutral:

- Favourable: the pipe alignment has a relative advantage over the other options,
- Unfavourable: the pipe alignment is worse compared to the other options,
- Impracticable: the pipe alignment has a 'fatal flaw',
- Not scored: the pipe alignments have not been scored, therefore no options are deemed favourable nor unfavourable for comparison purposes.

Table 2: Comparison of all options

KEY:	Favourable	Unfavourable	Impracticable	Not scored

	Option 1 – Summit Rd	Option 2a – Ridgeline and Balgownie Grove	Option 2b – Ridgeline and Waddington Drive	Option 3a - Gully and Balgownie Grove	Option 3b - Gully and Waddington Drive
Constructability	It would be extremely difficult to design/construct two large new pipelines through a very constrained corridor with congested utility services. Existing services would need to be relocated; deep excavations would be required. Maintaining property access would be particularly difficult and full road closures are likely to be needed for some activities. This option is not recommended by either of the contractors, with both showing a strong preference to go through the SNR.	Complex construction with close proximity to slope edges. Construction will require additional erosion and sediment control and management of water. Ridgeline section is fully contained on site and while the terrain is complex, construction can be simplified by not having to manage underground services and significant public interface. Balgownie Grove and Waddington Drive are significantly less complex than Summit Road, with wide flat streets and relatively few services. This option was preferred by one of the contractors.	Complex construction with close proximity to slope edges. Construction will require significant additional erosion and sediment control and management of water. Ridgeline section contained on site and while the terrain is complex, construction can be simplified by not having to manage underground services and significant public interface. Section along stream bank will likely require access from private property and a complex interface with property owners Constrained corridor between private properties and stream with poor access. Bank stabilisation required, may require piling. In-stream works and/or stream diversion (over-pumping) likely. Added health and safety risks. Limited space introduces or exacerbates multiple HSE risks.	Complex construction below steep slopes. Construction requires additional erosion and sediment control and management of water. Gully serves a large catchment and the overflow pipeline from Naenae reservoir, increasing water management complexity and introducing potential of site inundation. Work will be required on a side slope around the wetlands at the base of the gully, increased risk of slope failure. Constrained corridor between private properties and stream with poor access. Bank stabilisation required, may require piling. In-stream works and/or stream diversion (over-pumping) likely. Added health and safety risks. Limited space introduces or exacerbates multiple HSE risks. This option was preferred by one of the contractors.	Complex construction below steep slopes. Construction requires additional erosion and sediment control and management of water. Gully serves a large catchment and the overflow pipeline from Naenae reservoir, increasing water management complexity and introducing potential of site inundation. Work will be required on a side slope around the wetlands at the base of the gully, increased risk of slope failure. `Constrained corridor between private properties and stream with poor access. Bank stabilisation required, may require piling. In-stream works and/or stream diversion (over-pumping) likely. Added health and safety risks. Limited space introduces or exacerbates multiple HSE risks..
Network Performance and Operations	As pipe is in road it can be easily accessed, but increased complexity in managing public interface, adjacent services and deep excavations	Difficult maintenance access down hillside, however relatively moderate slope for access. Pipes will be shallow and only shallow rooted plants used.	Difficult maintenance access down hillside, however relatively moderate slope for access. Pipes will be shallow and only shallow rooted plants used. Difficult access to the section on the stream bank, would likely require access from private property. Scour from stream may increase maintenance works.	Difficult maintenance access down hillside, steep grade from Summit Rd will require vehicle assess to be maintained or significant time to reestablish access. Pipelines may need additional maintenance checks to ensure backfill has not scoured out. Difficult access to the section on the stream bank, would likely require access from private property. Scour from stream may increase maintenance works.	Difficult maintenance access down hillside, steep grade from Summit Rd will require vehicle assess to be maintained or significant time to reestablish access. Pipelines may need additional maintenance checks to ensure backfill has not scoured out. Difficult access to the section on the stream bank, would likely require access from private property. Scour from stream may increase maintenance works.
Resilience	Disadvantage in having both reservoir delivery mains in same corridor down hillside. Easier access for repair and low risk of slope failure causing damage. Increased risk from works on adjacent services causing damage.	Benefit in having new outlet pipeline separate from existing reservoir outlet main down Summit Road. Potential for slope failure causing damage, can use engineering controls such as positioning on ridgeline, slope stabilisation and material selection to mitigate. Difficult access if needed for repairs, however relatively moderate slope and open access for the stream crossing. Balgownie Grove and Waddington provide easy access for repairs.	Benefit in having new outlet pipeline separate from existing reservoir outlet main down Summit Road. Potential for slope failure causing damage, can use engineering controls such as positioning on ridgeline, slope stabilisation and material selection to mitigate. Significant length of pipe on stream bank which would be at risk of lateral spread in an earthquake and scour from the stream. Significant work to increase resilience and difficult to access to make repairs.	Benefit in having new outlet pipeline separate from existing reservoir outlet main down Summit Road. Section of pipe which will need to traverse side slope around wetland has an increased risk of failure when compared to ridge top. Complex access off Summit Rd in an emergency, with a new zigzag access way likely required to be cut. Stream crossing likely inaccessible without using access from private property. Length of pipe on stream bank which would be at risk of lateral spread in an earthquake and scour from the stream. Significant work to increase resilience and difficult to access to make repairs.	Benefit in having new outlet pipeline separate from existing reservoir outlet main down Summit Road. Section of pipe which will need to traverse side slope around wetland has an increased risk of failure when compared to ridge top. Complex access off Summit Rd in an emergency, with a new zigzag access way likely required to be cut. Stream crossing likely inaccessible without using access from private property. Significant length of pipe on stream bank which would be at risk of lateral spread in an earthquake and scour from the stream. Significant work to increase resilience and difficult to access to make repairs.
Cost	Cost estimates have not been developed for all options and for the purpose of this report, all options are considered to cost the same.				
Carbon	No material difference in capital carbon across the three options on basis that they are all of comparative length – Option 1 is slightly shorter. Options 2 and 3 may require less imported fill material, however, require vegetation clearance and significant earthworks. Option 1 will require significant service rerouting which will have an embodied carbon cost				

	Option 1 – Summit Rd	Option 2a – Ridgeline and Balgownie Grove	Option 2b – Ridgeline and Waddington Drive	Option 3a - Gully and Balgownie Grove	Option 3b - Gully and Waddington Drive
Consenting	No particular consenting matters noted.	Additional requirements in relation to works in Significant Natural Resource (SNR12) area and proximity of works to Waiwhetū Stream and adjacent wetlands. Must determine that there is an operational need to traverse SNR12 and that other options are impracticable.	Additional requirements in relation to works in Significant Natural Resource (SNR12) area and proximity of works to Waiwhetū Stream and adjacent wetlands. Must determine that there is an operational need to traverse SNR12 and that other options are impracticable. Would have to traverse land that has been vested as a recreation reserve	Additional requirements in relation to works in SNR12 area and proximity of works to Waiwhetū Stream and adjacent wetlands. Must determine that there is an operational need to traverse SNR12 and that other options are impracticable.	Additional requirements in relation to works in Significant Natural Resource (SNR12) area and proximity of works to Waiwhetū Stream and adjacent wetlands. Must determine that there is an operational need to traverse SNR12 and that other options are impracticable. Would have to traverse land that has been vested as a recreation reserve
Mana Whenua	Preferred as it has fewest impacts on the hillside (Raumānuka) and Waiwhetū Stream,	Mana Whenua prefer "the pipe alignment with the lowest environmental impact on the Raumānuka and Waiwhetū Stream". Options 2a, 2b, 3a and 3b will have some environmental impact that will be mitigated through the implementation of the Construction Environmental Management Plan and Erosion and Sediment Control Plan, which will be a condition of consent.			
Community	Very high level of construction impact and disruption to Summit Rd, Farrelly Grove and Laura Ferguson Grove residents, and Laura Ferguson residential care facility. This is in addition to reservoir construction activity (Summit Road pipeline and reservoir cannot be constructed concurrently). Deep excavation may require sheet piling. Noise and vibration from rock excavation. Road closures will limit emergency service access.	Works are not immediately adjacent to residential property and can be undertaken concurrently with reservoir construction reducing overall duration. Some construction related disruption on Balgownie Grove, which would likely be used for access and as a construction staging area.	Works are not immediately adjacent to residential property and can be undertaken concurrently with reservoir construction reducing overall duration. Option will require significant of works along the stream bank (approximately 150m). This will require extensive dewatering and piling, as well as potential access to private property. Some construction related disruption on Balgownie Grove, which would likely be used for access and as a construction staging area.	Works are not immediately adjacent to residential property and can be undertaken concurrently with reservoir construction reducing overall duration. Option will require some extent of works along the stream bank (at least 40m). This will require extensive dewatering and piling, as well as potential access to private property. Some construction related disruption on Balgownie Grove, which would likely be used for access and as a construction staging area.	Works are not immediately adjacent to residential property and can be undertaken concurrently with reservoir construction reducing overall duration. Option will require significant of works along the stream bank (approximately 150m). This will require extensive dewatering and piling, as well as potential access to private property. Some construction related disruption on Balgownie Grove, which would likely be used for access and as a construction staging area.
Natural Environment	No natural environmental concerns noted beyond routine erosion and sediment control requirements.	Vegetation will need to be removed from a construction corridor nominal 14 m wide. This will be revegetated at conclusion of works., but large trees cannot be planted where they may cause damage to the pipelines. Works can be designed to avoid wetlands adjacent to Waiwhetū Stream. Specific erosion and sediment control measures will be required to protect the wetlands and stream.	Vegetation will need to be removed from a construction corridor nominal 14 m wide. This will be revegetated at conclusion of works., but large trees cannot be planted where they may cause damage to the pipelines. Works can be designed to avoid wetlands adjacent to Waiwhetū Stream. Specific erosion and sediment control measures will be required to protect the wetlands and stream. Significant works along the stream bank increases the risk of negative environmental events.	Vegetation will need to be removed from a construction corridor nominal 14 m wide. This will be revegetated at conclusion of works but large trees cannot be planted where they may cause damage to the pipelines. Works can be designed to avoid wetlands adjacent to Waiwhetū Stream. Specific erosion and sediment control measures will be required to protect the wetlands and stream. Significant works along the stream bank increases the risk of negative environmental events. The gully is seen as less favourable than the ridgeline, due to the presence of additional freshwater ecosystems.	Vegetation will need to be removed from a construction corridor nominal 14 m wide. This will be revegetated at conclusion of works but large trees cannot be planted where they may cause damage to the pipelines. Works can be designed to avoid wetlands adjacent to Waiwhetū Stream. Specific erosion and sediment control measures will be required to protect the wetlands and stream. Significant works along the stream bank increases the risk of negative environmental events. The gully is seen as less favourable than the ridgeline, due to the presence of additional freshwater ecosystems.

Option 1 is considered to be impracticable based on the identified constructability issues and risks taken in conjunction with the very high level of construction impacts (noise, vibration, traffic and access) on residents over an extended duration.

There is an operational need for an outlet main and overflow pipeline from the proposed reservoir. The only practicable options require the pipelines to traverse SNR12. The environmental risks associated with Option 2 and 3 construction are manageable and the vegetation impacts will be remediated and offset over time.

Option 2a is preferred over Options 2b, 3a and 3b. In assessing the four options which traverse SNR12, Option 2a is considered to have:

- The least complex construction
- The lowest community impact
- Best operability and resilience
- Smallest environmental impact
- Potential for the lowest cost

6.3 MCA scoring

The secondary purpose of this report is to assess if the recommended pipe alignment would have altered the outcome of the site selection MCA. The original site selection MCA was based on the delivery pipe alignment along Summit Road (**Option 1**). The alternative hillside / Balgownie Grove (**Option 2a)** conservatively scored lower for the following criteria:

- Ecology: alternative alignment will impact ecological values down the hillside corridor.
- Landscape: alternative alignment will have a greater visual impact.
- Regulatory framework: construction in a Significant Natural Resource area introduces additional consenting requirements.

Review of the MCA scoring confirmed that the alternative pipe alignment would have made no material difference to the site selection outcome (refer Appendix A for MCA scoring).

7 Conclusion

A pipeline is required from the proposed reservoir to deliver stored water back to the distribution network at Oxford Terrace. A second pipeline is also needed to convey overflow and allow for drainage of the reservoir.

Several alignment options have been considered.

Option 1 is considered to be impracticable based on the identified constructability issues and risks taken in conjunction with the very high level of social and construction impacts (noise, vibration, traffic, parking and access) on residents over an extended duration.

Option 3a and 3b are considered to be less favourable than Option 2a and 2b based on the additional freshwater ecological constraints, environmental effects and slope stability and construction risks.

Option 2b and 3b are less favourable than **Option 2a and 3a** due to the constructability risks and disruption for residents caused by work along the narrow stream bank.

The recommended alignment is Option 2a, down the vegetated ridge north of the reservoir, across Waiwhetū Stream and out to Waddington Road via Balgownie Grove. This option traverses SNR12. Provisions of the NPS-IB and the NPS-FM will apply.

There is an operational need for a delivery pipe (outlet main) and overflow pipeline from the proposed reservoir. The only practicable options require the pipelines to traverse SNR12. The environmental risks to waterways and wetlands can be avoided or manged. The vegetation and habitat impacts through SNR12 can be remediated over time.

An alternative alignment, Option 2b, was considered in response to construction impact concerns raised by some Balgownie Grove residents. The alternative alignment along the stream edge has been discounted on the basis that the recommended alignment (Option 2a) will have lesser environmental impact and risk, simplified construction and consenting, and have no greater community impact than any other routine in-street infrastructure works.

Review of the site selection MCA scoring confirmed that the alternative pipe alignment for **Option 2a** would have made no material difference to the site selection outcome and that the Naenae site would still have been identified as the preferred site for a new reservoir.

8 Recommendations

We recommend that design and consenting be progressed for the recommended pipe alignment Option 2a as indicated in Figure 3.

9 Limitations

This report ('Report') has been prepared by WSP New Zealand Limited ('WSP') exclusively for Wellington Water ('Client') in relation to this Eastern Hills Reservoir Pipe Alignment Assessment ('Purpose') and in accordance with the Wellington Water Consultant Project Engagement form dated 10th March 2023 ('Agreement'). The findings in this Report are based on and are subject to the assumptions specified in the Report and Offer of Services dated 10th March 2023. WSP accepts no liability whatsoever for any use or reliance on this Report, in whole or in part, for any purpose other than the Purpose or for any use or reliance on this Report by any third party.

Appendix A
MCA Scoring Review

Eastern Hills Reservoir Site Selection - MCA soring review for alternative delivery pipeline route

Original Scoring The original MCA scoring for the Naenae 2 site was based on a nominal delivery pipe route (route option 1) from the reservoir down Summit Road. Preliminary design identified that this route would be impracticable.

Alternative Route An alternative delivery pipe route (route option 2a) down a ridge to the north of the reservoir and along Balgownie Grove was identified.

Reassessment This MCA scoring review has been competed to confirm that the alternative pipe route (2a) does not change the overall MCA site selection outcome.
It is important to note that the MCA scoring is for the reservoir project as a whole - not just the pipeline route considered in isolation.

Conclusion A conservative rescoring of the Naenae 2 site option with alternative pipe route option 2a (to Balgownie Grove) does not change the outcome of the MCA. A detailed rescoring is not required for this change.

Criteria and Weightings					Original Scoring			Alternative Route	Review Comments
Criteria Grouping	Group Weighting (%)	Criteria	Sub Weighting (%)	Criteria Weighting (%)	Cambridge	Gracefield 2	Naenae 2	Naenae 2 Pipe Route 2a	Take a **conservative** approach to rescoring the Naenae 2 site option with alternative pipe route Option 2a (to Balgownie Grove). Only consider aspects that **downgrade** the score. Ignore favourable aspects that would improve score.
Environmental	20	Ecology	40	8.0	4	4	4	3	Alternative route will impact ecological values down the hillside coridor. Assume score is downgraded
		Landscape	30	6.0	2	3	3	2	Alternative route will have a greater visual impact. Assume score is downgraded
		Heritage and Culture	30	6.0	4	3	4	4	No known heritage/cultural impacts along Alternative route. No change in scoring
Social	15	Noise, Vibration and Dust	40	6.0	3	4	2	2	Alternative route has a reduced overall construction impact. Assume no change in scoring
		Traffic and Access	40	6.0	3	1	2	2	Alternative route has a reduced overall construction impact. Assume no change in scoring
		Recreation	20	3.0	4	3	3	3	No change in scoring
Technical	35	Vulnerability and Resilience	20	7.0	5	3	4	4	No change in scoring
		Operability and Maintainability	20	7.0	4	4	4	4	No change in scoring
		Performance and Opportunity	10	3.5	4	4	4	4	No change in scoring
		Regulatory Framework	10	3.5	3	2	4	3	Working through a Significant Natural Resource area introduces additional requirements. Conservatively assume score is downgraded
		Property Risk	20	7.0	2	5	5	5	Alternative Route does not require property acquisition. Assume no change in scoring
		Construction Risk	20	7.0	4	3	4	4	Alternative route has differing but similar (or less) construction risk. Assume no change in scoring
Financial	25	Capital Cost	100	25.0	4	2	7	7	Assume similar overall construction cost, but test impact of downgrading score*
Carbon	5	Embodied Carbon	100	5.0	4	3	5	5	Pipes routes are similar length so no material change in embodied carbon. No change in scoring
Total	100			100	3.7	3.0	4.5	4.4	* Downgrading cost score reduces overall total to 4.1 - this would still be the highest scoring option overall

Criteria Grouping Analysis	Cambridge	Gracefield 2	Naenae 2	Naenae 2 Pipe Route 2a	
Environmental	3.4	3.4	3.7	3.0	Reduced score under Environmental Criteria - now the lowest scoring option
Social	3.2	2.6	2.2	2.2	No score change under Social Criteria - still the lowest scoring option
Technical	3.7	3.6	4.2	4.1	Small score reduction under Technical Criteria - still highest scoring option
Financial	4.0	2.0	7.0	7.0	No score change under Financial Criteria - still the highest scoring option
Carbon	4.0	3.0	5.0	5.0	No score change under Carbon Criteria - still the highest scoring option
Overall Scores	3.7	3.0	4.5	4.4	When rescored for the alternative pipe route (Option 2a) the Naenae 2 site is still the highest scoring and still the preferred site option.

Appendix B
Alternative Alignment Proposal

WADDINGTON WETLANDS RESERVE / WALK.

Google Maps

Imagery ©2023 Airbus, CNES / Airbus, Maxar Technologies, Terralink International Ltd, Map data ©2023 50 m

proposed pipe location

NEW TANK

CUSTOMERS SUGGESTION.

SUGGESTED BOARD WALK ON TOP OF APE.

CONTINUATION OF BOARD WALK OVER WETLANDS TO EXISTING TRACK.

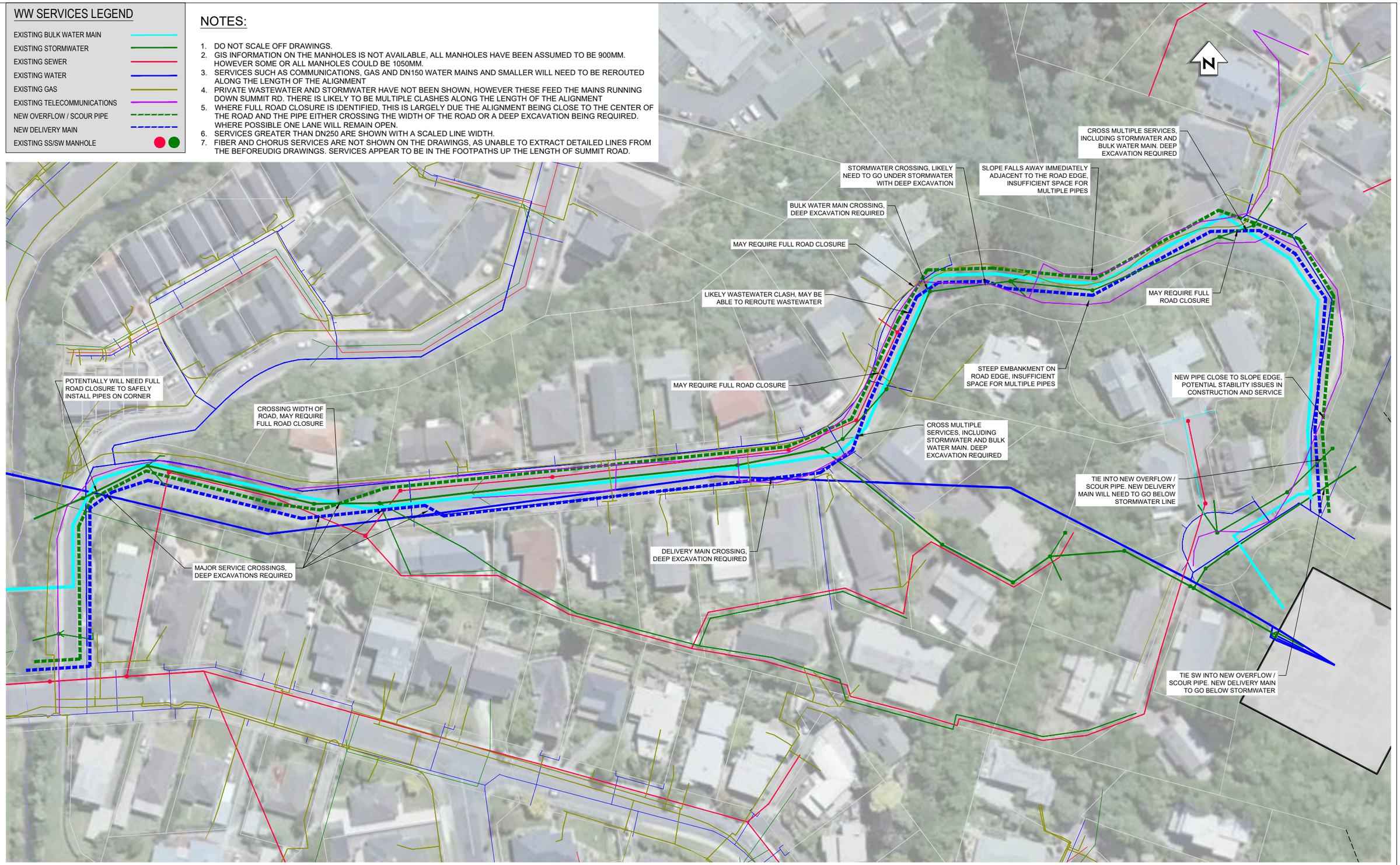
Appendix C
Summit Road Alignment Map

WW SERVICES LEGEND

- EXISTING BULK WATER MAIN
- EXISTING STORMWATER
- EXISTING SEWER
- EXISTING WATER
- EXISTING GAS
- EXISTING TELECOMMUNICATIONS
- NEW OVERFLOW / SCOUR PIPE
- NEW DELIVERY MAIN
- EXISTING SS/SW MANHOLE

NOTES:

1. DO NOT SCALE OFF DRAWINGS.
2. GIS INFORMATION ON THE MANHOLES IS NOT AVAILABLE, ALL MANHOLES HAVE BEEN ASSUMED TO BE 900MM. HOWEVER SOME OR ALL MANHOLES COULD BE 1050MM.
3. SERVICES SUCH AS COMMUNICATIONS, GAS AND DN150 WATER MAINS AND SMALLER WILL NEED TO BE REROUTED ALONG THE LENGTH OF THE ALIGNMENT
4. PRIVATE WASTEWATER AND STORMWATER HAVE NOT BEEN SHOWN, HOWEVER THESE FEED THE MAINS RUNNING DOWN SUMMIT RD. THERE IS LIKELY TO BE MULTIPLE CLASHES ALONG THE LENGTH OF THE ALIGNMENT
5. WHERE FULL ROAD CLOSURE IS IDENTIFIED, THIS IS LARGELY DUE THE ALIGNMENT BEING CLOSE TO THE CENTER OF THE ROAD AND THE PIPE EITHER CROSSING THE WIDTH OF THE ROAD OR A DEEP EXCAVATION BEING REQUIRED. WHERE POSSIBLE ONE LANE WILL REMAIN OPEN.
6. SERVICES GREATER THAN DN250 ARE SHOWN WITH A SCALED LINE WIDTH.
7. FIBER AND CHORUS SERVICES ARE NOT SHOWN ON THE DRAWINGS, AS UNABLE TO EXTRACT DETAILED LINES FROM THE BEFOREUDIG DRAWINGS. SERVICES APPEAR TO BE IN THE FOOTPATHS UP THE LENGTH OF SUMMIT ROAD.



A1 REPRODUCTION SCALE
100 80 60 40 20 0mm

A3 REPRODUCTION SCALE
50 40 30 20 10 0mm

0 5 10 15 20 25
SCALE 1:500 AT ORIGINAL SIZE

FOR INFORMATION
NOT FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
0	ISSUED FOR INFORMATION	G.H.	J.L.	J.L.	20/10/23

Drawing Originator
Connect Water
c/- WSP
PO Box 12-003 Thorndon
Wellington 6144
T 64 4 471 7000

Original Scale (A1) 1:750
Reduced Scale (A3) 1:1500

Design	L.H.	20/10/23	Approved For Construction* - Date-
Drawn	G.H.	20/10/23	
Dsg Verifier	G.B.	20/10/23	
Dwg Check	J.L.	20/10/23	

* Refer to Revision 1 for Original Signature

Client: Wellington Water

Project: WELLINGTON WATER
EASTERN HILLS RESERVIOR

Title: RESERVOIR AND SITE PIPELINES
EXISTING SERVICES

Discipline: CIVIL

Drawing No.: 3-WW021.02_SK013

Rev.: 0

DOCUMENT PATH: \\CORP.ANZ\PROJECTS\NZ\3W3\WW021.02 NAENAE NO 2 RESERVOIR\HOME\700 DRAWINGS

DOCUMENT NO: 3-WW021.02_SK013 SERVICES.DWG

DO NOT SCALE - IF IN DOUBT ASK

PLOTTED BY: PIETERSEN, RIAAN

DRAWING PLOTTED: 27-Jul-23

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