Technical Memo

80 MCLARIN ROAD, GLENBROOK - REZONING

Response to Auckland Council RFI
HD Project 2 Ltd

TO:	HD Project 2 Ltd	**HG PROJECT NO :**	A2010091.01
FROM:	Ahlia Hicks & Jonathan Chambers	**DATE:**	17 October 2022

1.0 SUMMARY OF AMMENDMANTS TO SMP

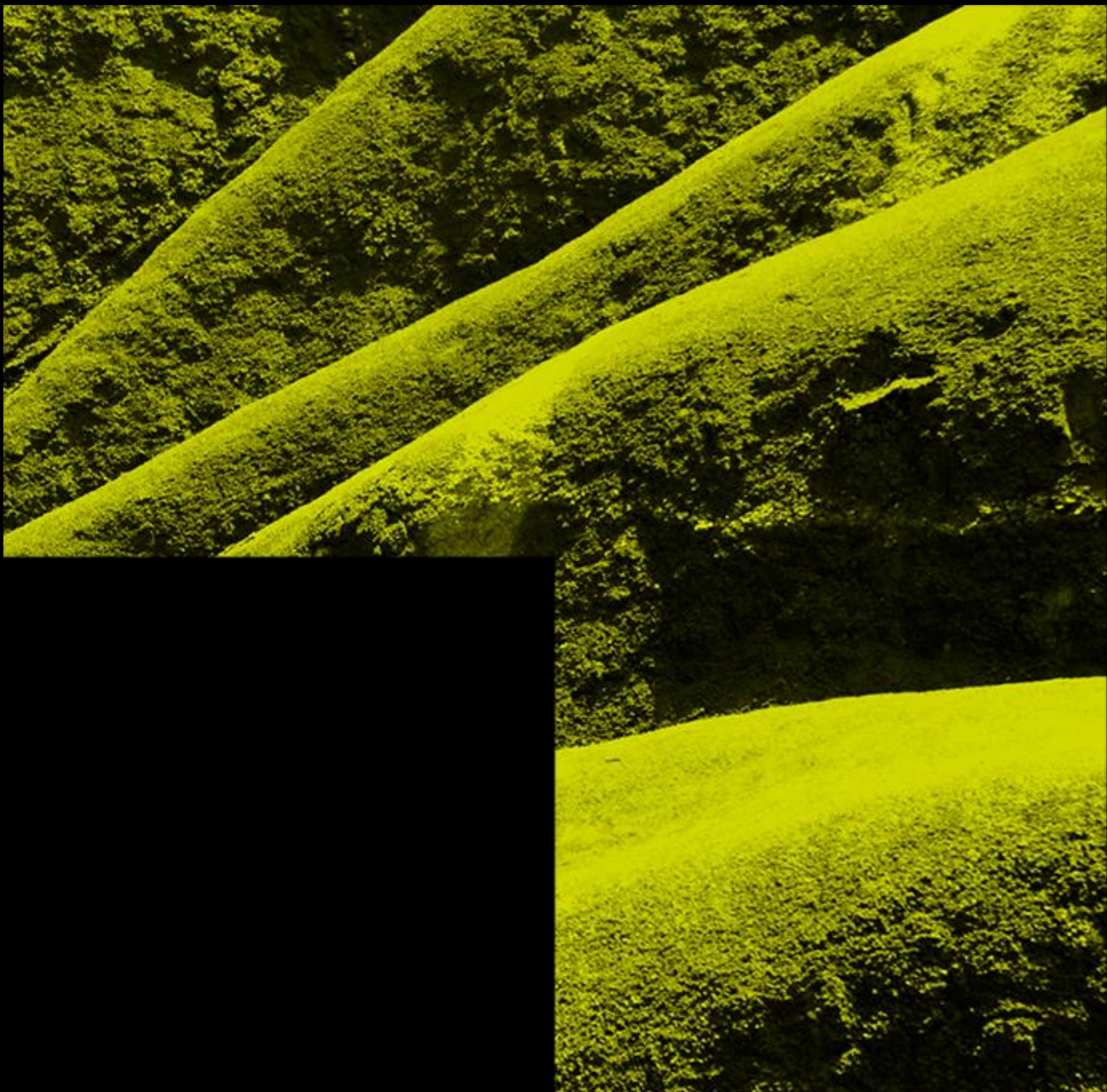
Amendments were made to the Stormwater Management Plan (SMP) for the 80 McLarin Road, Glenbrook – Rezoning project in response to Auckland Council's feedback on the first submission. Below summarises the changes made to the report.

- The ICM model was re-run with an imperviousness of 60% over the entire development site to ignore roading and small green spaces in the post-development scenario. This allows for more flexibility in the masterplan layout.
- The scenarios modelled were updated to:
  - Existing Development (ED)
  - Maximum Probable Development (MPD)
  - ED + MPD on site
- The sea-level rise (SLR) values modelled were reduced to 'no SLR' (2 m tidal level) and '1 m SLR' (3 m tidal level.
- A preliminary stormwater management device layout was drafted and presented based on the current masterplan layout. The attenuation footprints were calculate based on the MPD minus ED scenarios flood modelling results with a 1 m depth.

80 MCLARIN ROAD, GLENBROOK - REZONING

Stormwater Management Plan

HD Project 2 Ltd



DOCUMENT CONTROL RECORD

CLIENT	HD Project 2 Ltd
PROJECT	80 McLarin Road, Glenbrook - Rezoning
HG PROJECT NO.	A2010091.01
HG DOCUMENT NO.	R001-A2010091-SMP-ALH-JMSC
DOCUMENT	Stormwater Management Plan

ISSUE AND REVISION RECORD

DATE OF ISSUE	13 December 2022
STATUS	Final
ORIGINATOR	Ahlia Hicks - Graduate Engineer Fatemeh Mohammadi - Graduate Engineer
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EXECUTIVE SUMMARY

Harrison Grierson (HG) has been engaged to advance a private plan change to rezone 80 McLarin Road from 'Future Urban' to an urban residential land use zoning under the Auckland Unitary Plan 2016 – Operative in Part (AUP(OP)).

80 McLarin Road is one of three properties within the coastal Waitangi Stream catchment, on the Manukau Harbour, identified as 'Glenbrook Beach 2' in the Future Urban Land Supply Strategy 2017 (FULSS) and is earmarked as being 'Development Ready' from 2023.

High-level feasibility investigations undertaken by HG indicate that once urbanised and developed, 80 McLarin Road could yield around 100 household units. Final yield numbers will depend largely on housing typologies and the effective integration of stormwater management, ecology, civil engineering, and urban design.

This Stormwater Management Plan assesses existing information about the subject site including ecological, cultural, and natural hazards data. It presents the results of a detailed rain-on-grid hydraulic modelling exercise which identifies adverse flood impacts associated with a potential future development of the subject site. It proposes a stormwater management approach that is consistent with the aspirations of the Cultural Impact Assessment, complies with the requirements of the Auckland Council Regionwide Network Discharge Consent, and addresses the adverse effects identified in the flooding assessment.

1.0
EXISTING SITE APPRAISAL

1.1 SUMMARY OF DATA SOURCES AND DATES

TABLE 1: DATA SUMMARY

EXISTING SITE APPRAISAL ITEM	SOURCE AND DATE OF DATA USED
Topography	GeoMaps, Auckland Council (2021)
Geotechnical / soil conditions	Detailed Ecological Assessments, Pattle Delamore Partners (December 2021) Additional Wetland Investigations, Pattle Delamore Partners (April 2022) Preliminary Geotechnical Assessment Report, Lander Geotechnical (September 2021)
Existing stormwater network	GeoMaps, Auckland Council (2021)
Existing hydrological features	Concept Master Plan, Harrison Grierson (2020)
Stream, river, coastal erosion	Detailed Ecological Assessments, PDP (December 2021)
Flooding and flow paths	Detailed Ecological Assessment, PDP (December 2021)
Coastal Inundation	GeoMaps, Auckland Council (2021)
Ecological / environmental areas	Detailed Ecological Assessments, PDP (2021)
Cultural and heritage sites	Cultural Impacts Assessment, Ngati Te Ata Waiohua (November 2021) Archaeological Assessment, CFG Heritage (August 2021)
Contaminated land	Preliminary Environmental Site Investigation, ENGEO (November 2021)

1.2 LOCATION AND GENERAL INFORMATION

The proposed Private Plan Change consists of approximately 8.0 ha of land at 80 McLarin Road, Glenbrook. The site is shown in FIGURE 1 and Figure 2 below with respect to the wider Auckland Region.

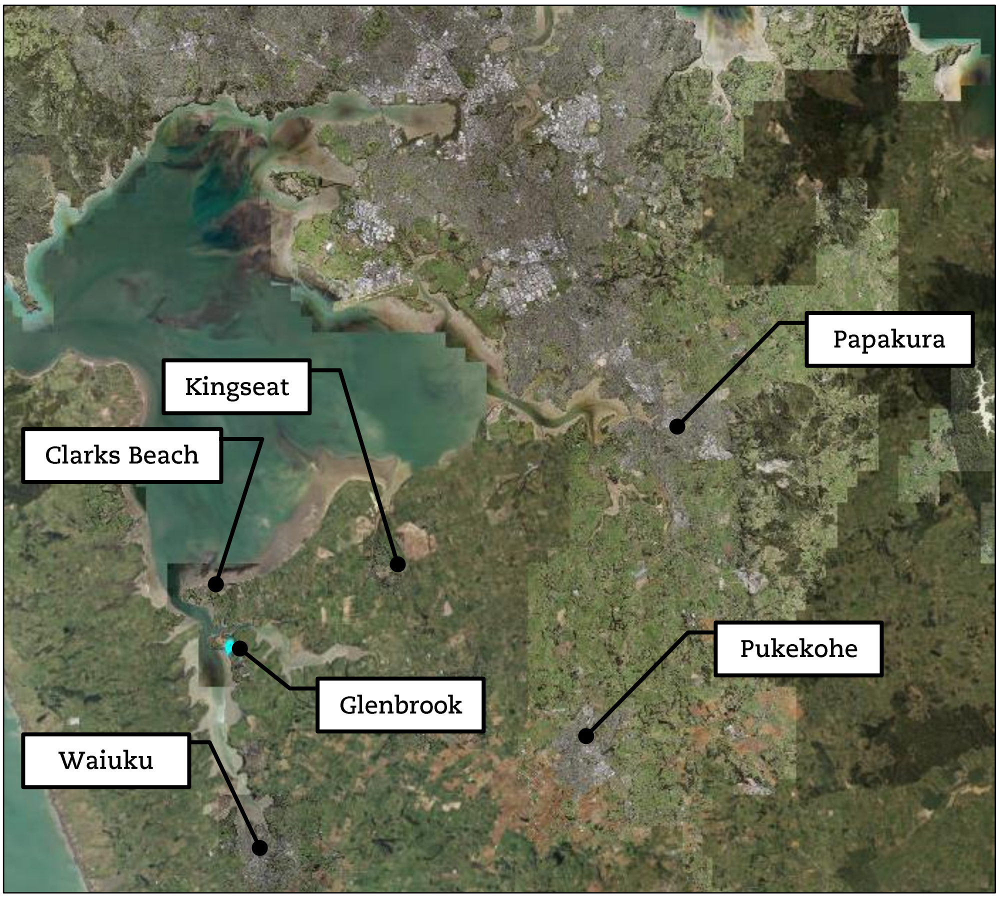

FIGURE 1: Regional site context (Auckland Council, 2022).

FIGURE 2: Local site context (Auckland Council, 2022).

The property information is outlined in the following table.

TABLE 2: PROPERTY INFORMATION

FEATURE	ATTRIBUTE
Site address	80 McLarin Road, Glenbrook, Auckland
Legal description	Lot 2 DP 204733
Current Land Use	Rural - Pastoral
Current building coverage	None
Historical Land Use	Rural - Pastoral

1.3 TOPOGRAPHY

The site is characterised by rolling topography, shelter belt vegetation, three small natural wetlands, and a network of modified watercourses. It has a 19-metre change in elevation from the northeast (approx. 22.5 m RL) to the southwest (approx. 3.5 m RL). A ridgeline runs from west to east across the centre of the site, separating the elevated plateau in the northern portion of the site from the sloping land to the south (HG, 2020). The southwestern corner is low-lying (3.5 m RL) and located around 150 m from the coast.

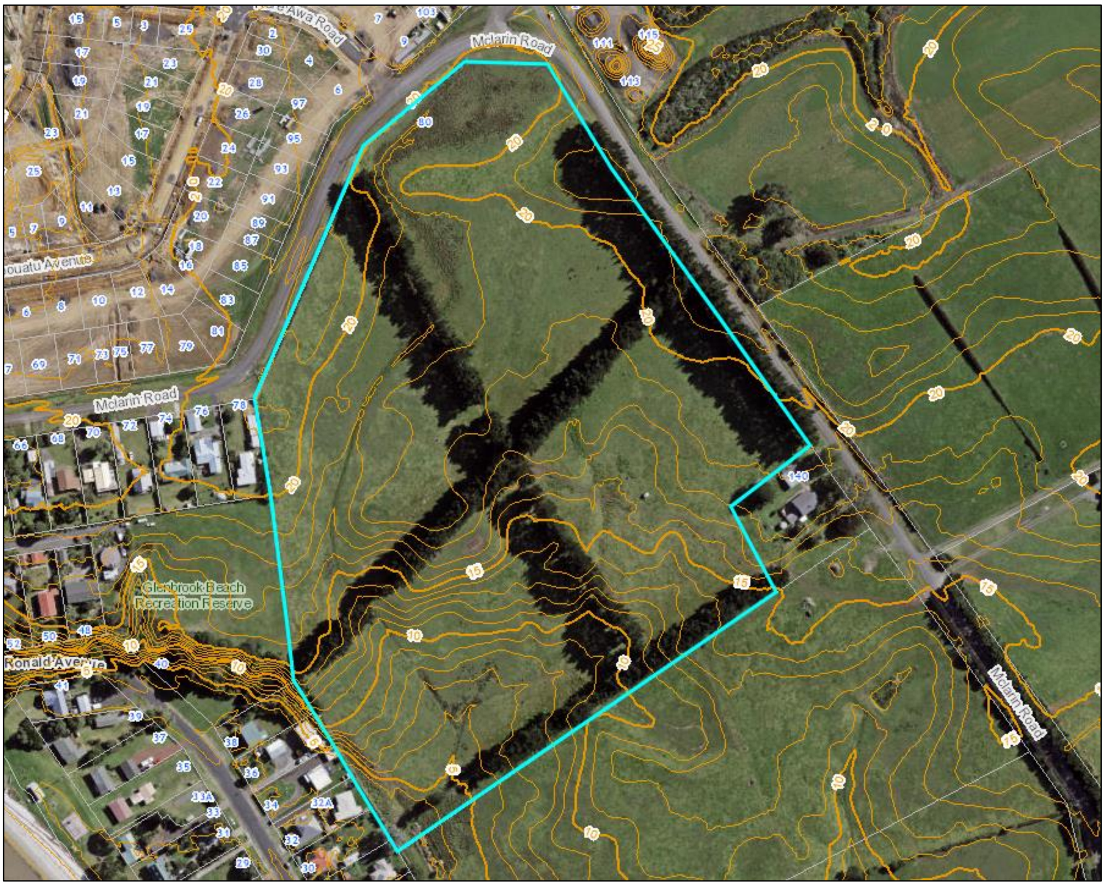

FIGURE 3: Existing site topography (Auckland Council, 2022).

1.4 ECOLOGICAL

1.4.1 WETLAND ECOLOGY

PDP (2021) undertook a Detailed Ecological Assessment of the site to assess the ecological values of the watercourses and the condition of wetlands on the site. This assessment relies on field investigations undertaken in October 2021. Three small natural inland marsh wetlands were identified, with areas of 0.025 ha (W1), 0.02 ha (W2) and 0.1 ha (W3). All three wetlands are in a moderate condition and have some natural vegetation remaining after moderate changes in ecosystem processes and growth of exotic vegetation. These wetlands are shown on Figure 4.

Further investigations and assessments were then undertaken in 2022 using the Wetland Delineation Hydrology Tool for Aotearoa New Zealand (MFE, 2021) after additional hydrophytic vegetation was identified within the site.

Seven 2 x 2 m vegetation plots were investigated across the site for wetland delineation. Of these, plots 1-3 meet the definition of natural inland wetlands, however, they are considered to be induced wetlands created through unintentional human disturbance (PDP Ltd., 2021). Plots 4-7 do not meet the definition of natural inland wetlands. These plots are also shown on Figure 4.

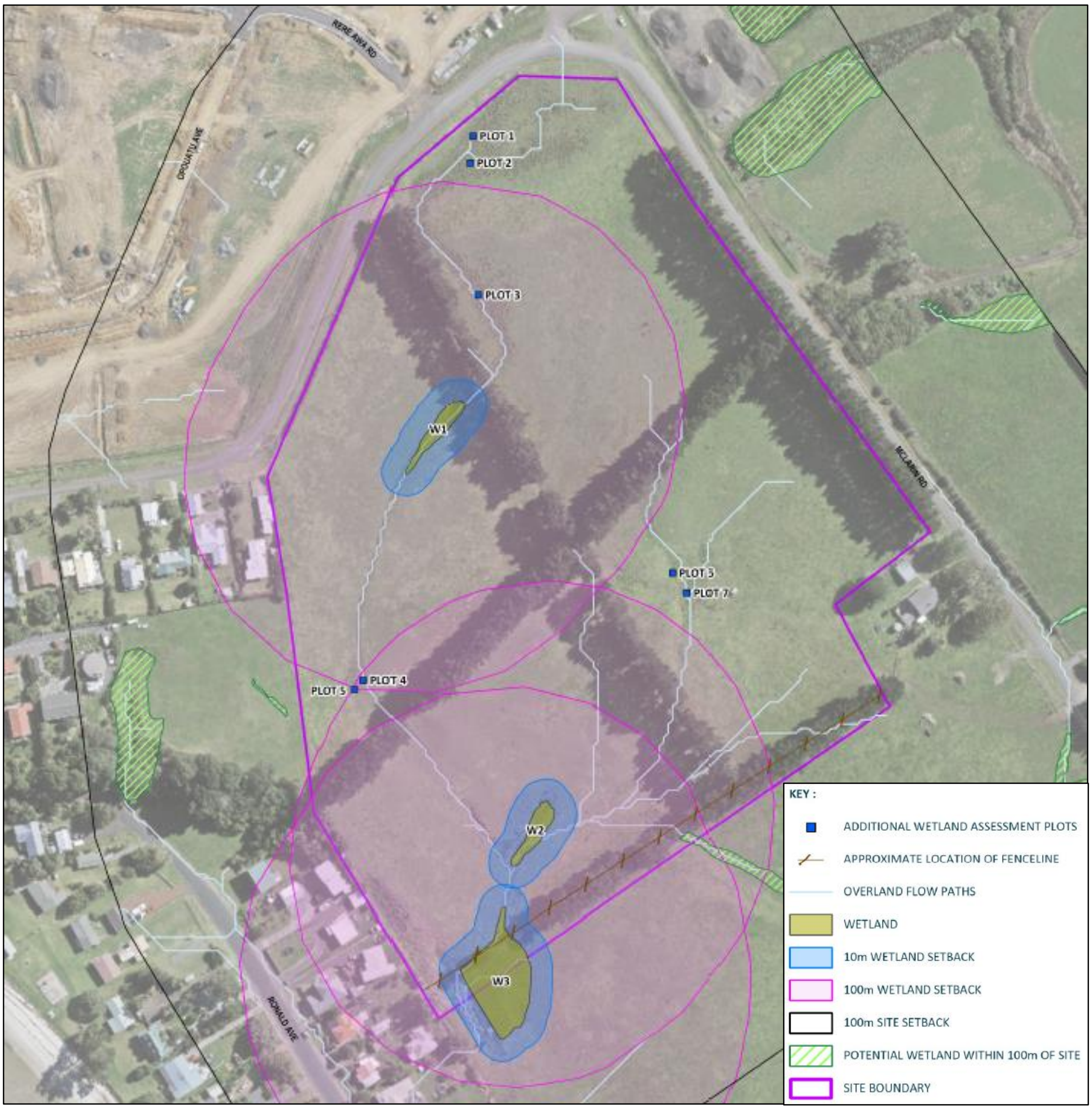

FIGURE 4: Wetland extents, setbacks, and plot locations.

1.4.2 STREAM ECOLOGY

The drainage pattern across the site generally flows northeast to southwest. The two major overland flow path (OLFP) catchments are shown in Table 3 and Figure 5.

TABLE 3: OVERLAND FLOWPATH CATCHMENTS

CATCHMENT	AREA
Western	3.65 ha
Eastern	5.02 ha
Southern	1.32 ha
Combined	9.98 ha

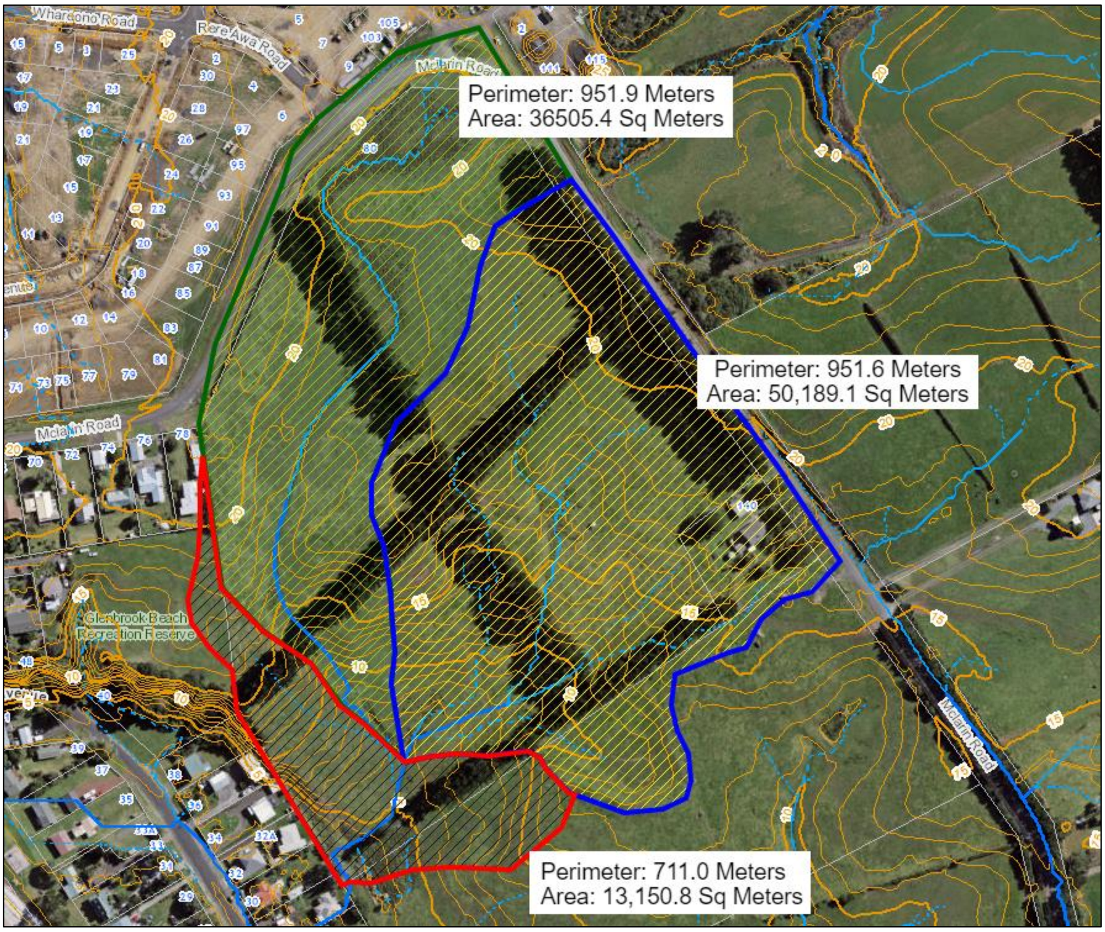

FIGURE 5: Sub-catchments within the subject site (Auckland Council, 2022).

PDP assessed these stream reaches using the Auckland Council River/Stream Classification Guidance Note method (Auckland Council, 2021). The on-site stream reaches were identified as ephemeral and intermittent streams, as shown on Table 4 and Figure 6. These watercourses have been heavily modified through historical farming activities and are degraded by a lack of riparian cover and stock access. All streams have no riparian cover and have very low ecological value.

TABLE 4: SUMMARY OF WATERCOURSES

STREAM NAME	APPROXIMATE LENGTH	CLASSIFICATION	OVERALL ECOLOGICAL VALUE
A1	65 m	Ephemeral	Very low
A2	69 m	Ephemeral	Very low
A3	100 m	Intermittent	Very low
A4	401 m	Intermittent	Very low

FIGURE 6: Classification of streams within the subject site.

undertook a semi-quantitative and qualitative stream habitat assessment of stream A3. The assessment covered an approximately 50 m reach of the intermittent watercourse and found it to have low ecological value. The stream bed was found to be entirely soft sediment with limited organic material and woody debris. A lack of riparian vegetation has resulted in limited habitat for aquatic and terrestrial organisms. The banks were generally stable; however, some evidence of erosion was found (PDP Ltd., 2021).

1.5 EXISTING DRAINAGE FEATURES AND STORMWATER INFRASTRUCTURE

A dry detention pond is located at the southwestern corner of the site, spanning the boundary with the neighbouring site (Lot 3 DP 160963). GeoMaps indicates the dry detention pond is 144 m^2 , installed in 2003 and is privately owned and maintained by Auckland Council. The northern boundary of the pond is aligned with the southern boundary of W3 (Figure 4). The purpose of this pond is likely to collect OLFPs and sheet flows running off the subject site and neighbouring property and discharge them into the pipe network before spilling into neighbouring residential sites. The dry detention pond is shown in Figure 7 and FIGURE 8.

The dry detention pond will be left in place and continue to provide water quantity control for the proposed development. The pond aims to provide peak flow control and stream channel protection. However, dry detention ponds are generally not designed to provide water quality treatment or reduce runoff volumes through infiltration.

FIGURE 7: Dry detention pond outlet.

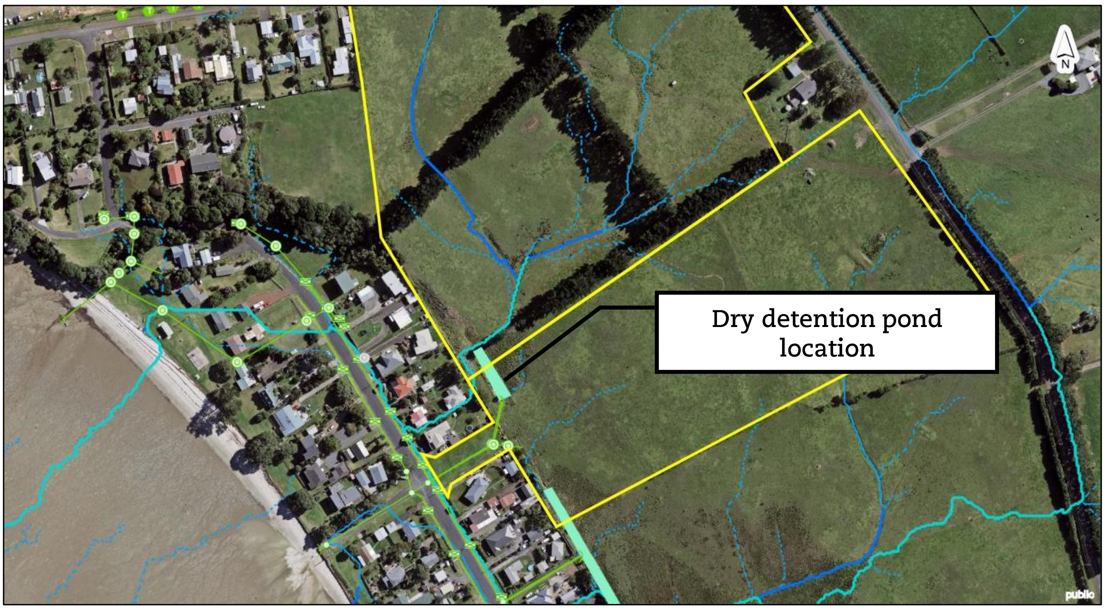

FIGURE 8: Dry detention pond and outlet into the network (Auckland Council, 2022).

1.6 RECEIVING ENVIRONMENT

The watercourses that converge in the southwestern corner of the site are piped through the Glenbrook township and drain into the Waiuku River inlet of the Manukau Harbour a short distance downstream (to the west) of the site. The dual DN450 line draining the pond runs for around 75 m length, then runs into a single DN450 line for around 78 m along Fleet Street, which discharges to the coast via a 6 m length of DN600 line. The network and outlet are shown on Figure 9 and Figure 10.

The coastal receiving environment is considered a Significant Ecological Area Marine 2 (SEA-M2) by the AUP. These areas are defined by the AUP are areas of significant indigenous vegetation or habitats of indigenous fauna located in the coastal marine area. Management of stormwater effects caused by the proposed development must not adversely affect the values associated with the SEA-M2 area in accordance with the AUP. Section 6.2 details the stormwater management approach proposed to mitigate any adverse effects.

FIGURE 9: Underground discharge pipe network to the beach outlet (Auckland Council, 2022).

FIGURE 10: Stormwater outfall at Glenbrook beach.

1.7 STORMWATER DISCHARGE AND PIPE CAPACITY

By inferring pipe grades from GeoMaps the dual DN450 line likely does not have capacity greater than 800 L/s. This capacity will likely be further restricted to around 400 L/s where the network flows into a single DN450 line. For comparison, the un-attenuated peak flow discharged from the site in the 10% AEP event is likely around 1500 L/s based on a possible future development scenario characterised by medium density housing. The existing network is likely at or near capacity servicing the existing township. The capacity of the network may be reduced further in future sea-level rise and storm surge events given its low elevation and proximity to the harbour. It is unlikely that the existing network capacity will be sufficient to service the subject site and attenuation of the 10% AEP site runoff may be required to address this.

Figure 11 and Figure 12 show the hydraulic model result for the existing scenario and no sea-level rise with 1% and 10% AEP events, respectively.

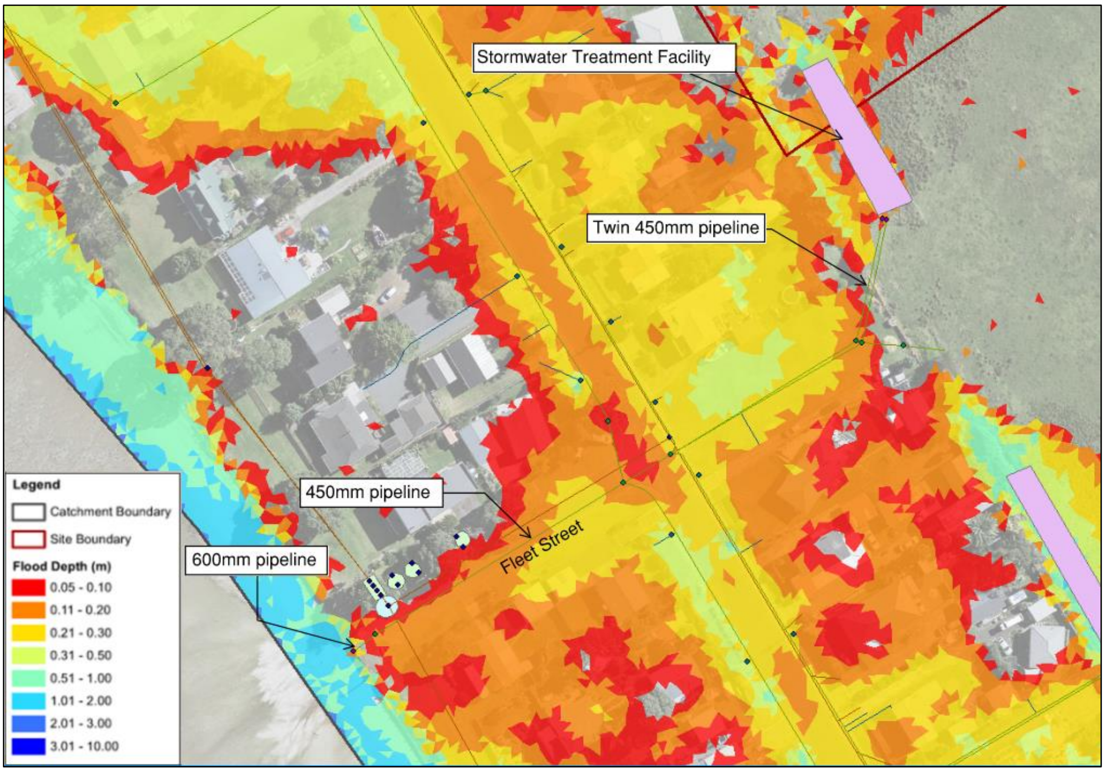

FIGURE 11: Fleet Street Existing Scenario, 1% AEP hydraulic model results for 0 m SLR model results.

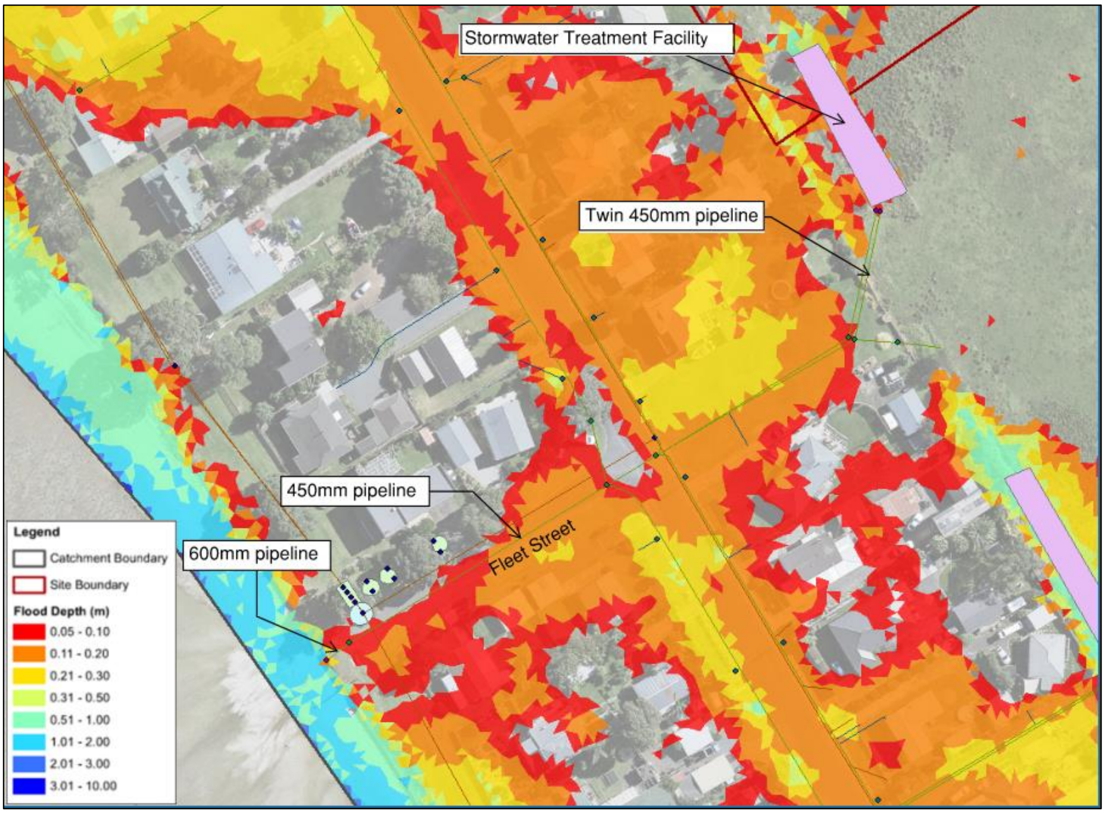

FIGURE 12: Fleet Street Existing Scenario, 10% AEP hydraulic model results for 0 m SLR model results.

1.8 EXISTING HYDROLOGICAL FEATURES

Sections 1.4.1 and 1.4.2 discuss the existing natural wetland and stream network on site.

In accordance with the NES-F (2020) and NPS-FM (2020) policies to protect natural wetlands, the proposed Plan Change should acknowledge the existing natural wetlands (W1, W2, W3) on the site as illustrated in Figure 4 and support their protection and enhancement.

1.9 FLOODING AND OVERLAND FLOW PATHS

Several isolated and confined floodplain areas are identified within the subject site. These floodplains are associated with flat land in the northern portion of the site and associated with the ephemeral and intermittent watercourse in the western site catchment. Another floodplain area in the southwestern catchment is connected to a significant floodplain system in the Glenbrook Beach township, associated with the low-lying, flat land fronting the beach. These floodplains were produced by a Rapid Flood Hazard Assessment in 2009 and do not include climate change factors nor probable future levels of development permitted by planning rules.

The extents of on-site overland flow paths (OLFPs) and floodplains are shown in Figure 13 below.

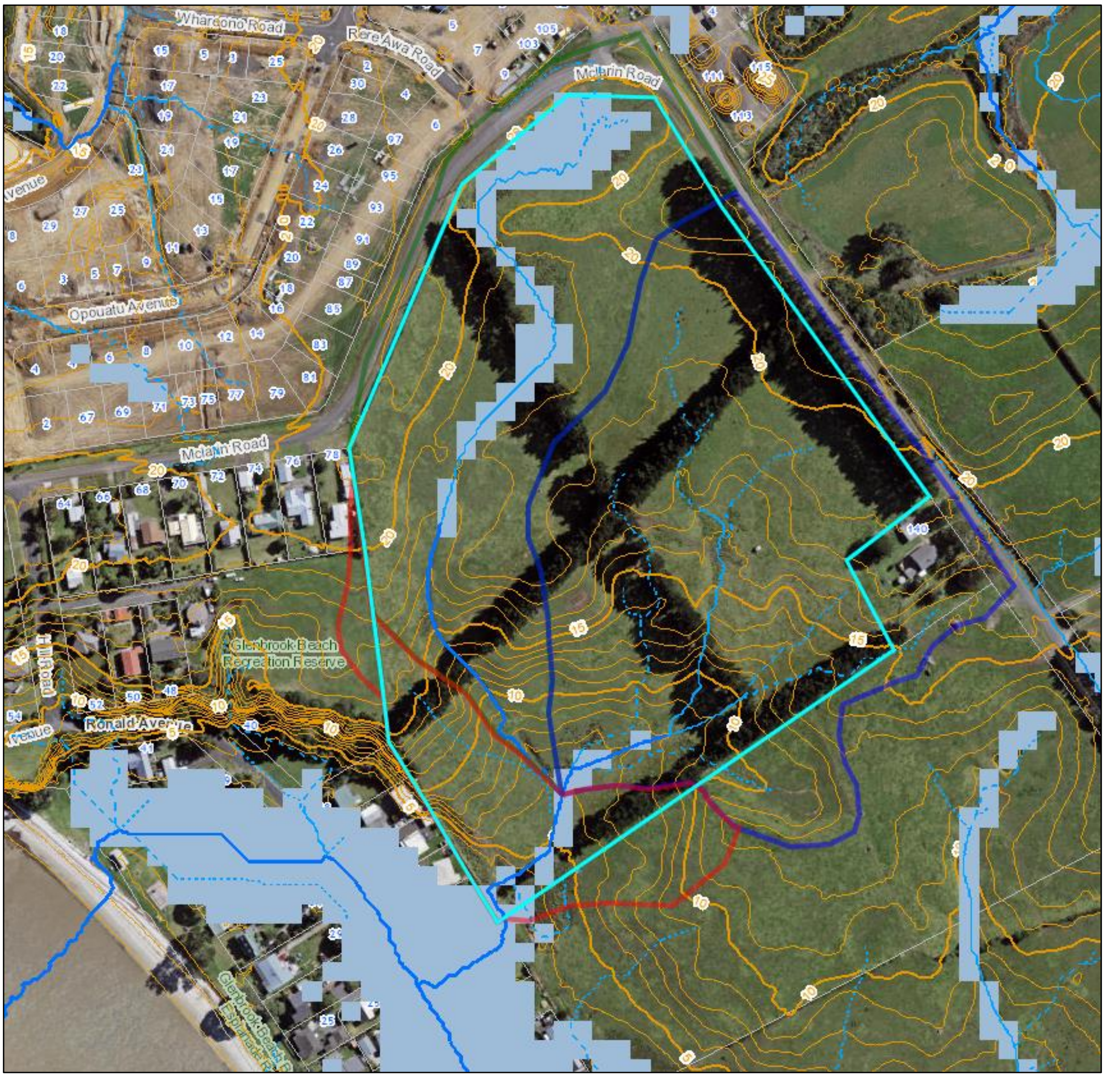

FIGURE 13: Floodplains and OLFPs within the subject site.

1.10 COASTAL INUNDATION

Coastal boundaries and inundation hazards are identified on GeoMaps in terms of the 1% AEP storm surge event as set out in the policy framework of Part E36, Natural Hazards and Flooding, of the AUP(OP).

Storm surge is the rise in sea-level due to meteorological effects. The 1% AEP coastal-storm inundation is at a level that has a 1% chance of being equalled or exceeded per year.

Sea-level rise (SLR) values are based on the projections by the Intergovernmental Panel on Climate Change fifth assessment report (2015). A one metre SLR is representative of the upper-bound climate change scenario to 2115. A two metre SLR is representative of potential, longer term SLR conditions (2120 to approximately 2200).

Figure 14 shows the indicative coastline and extent of coastal inundation anticipated in a 1% AEP event (Auckland Council, 2022). The following datasets are presented:

- 1% AEP (to demonstrate present day risk in alignment with the Auckland Unitary Plan activity controls), correlating to around 3.1 m RL in Glenbrook.

- 1% AEP + 1 m SLR (in alignment with Auckland Unitary Plan activity controls), correlating to around 4.1 m RL in Glenbrook.
- 1% AEP + 2 m SLR (to demonstrate longer term risk with ongoing sea-level rise), correlating to around 5.1 m RL in Glenbrook.

Figure 14 shows that around 930 m^2 of the site may be inundated by a 1% AEP storm surge event in a future +1 m SLR scenario, and a further approx. 670 m^2 may be inundated by the same event with +2 m SLR. The main risks to the site posed by coastal inundation are likely reduced performance of the stormwater collection and drainage network in the future.

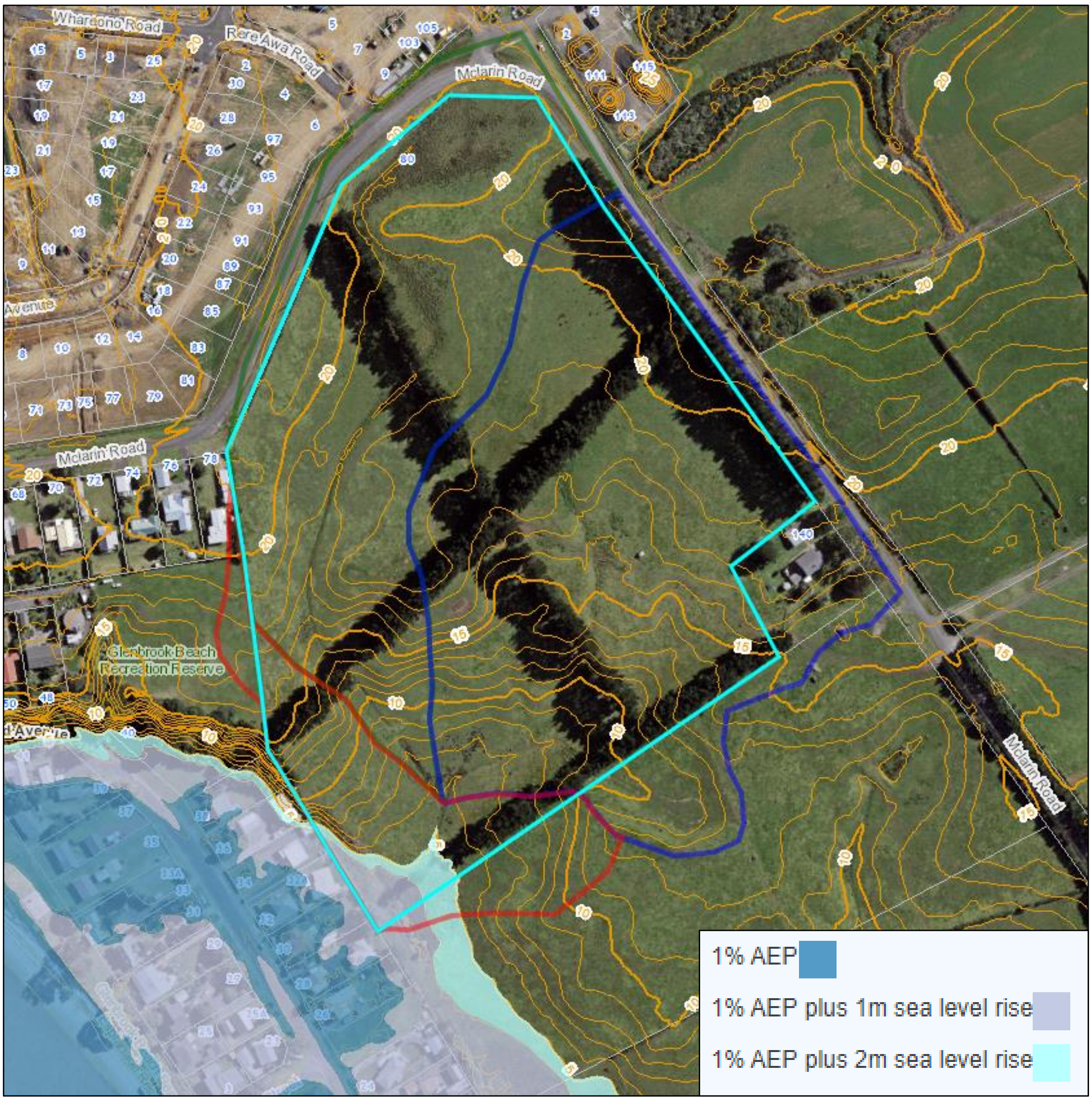

FIGURE 14: Coastal inundation extents (Auckland Council, 2022).

1.11 BIODIVERSITY

PDP (2021) have undertaken a Detailed Ecological Assessment of the site in support of the proposed Plan Change. Key findings of this assessment, relevant to stormwater management, are summarised below.

The lack of riparian vegetation has resulted in limited habitat available for both aquatic and terrestrial organisms. PDP (2021) have provided some detail on the semi-quantitative and qualitative stream habitat assessment that covered an approximately

50 m reach of the intermittent watercourse located in the south-western corner of the site.

Biotic indices were indicative of poor water quality at the site, thus only pollution tolerant taxa were identified. The dominant taxa comprised of midges, seed shrimp, and ribbon worms. The ecological value of this site was assessed as very low.

1.12 CULTURAL AND HERITAGE SITES

CFG Heritage undertook an Archaeological Assessment on the site. The following summarises the key findings of this assessment.

A small section of remaining forest to the west of the site has been identified as pōhutukawa, pūriri, broadleaved forest with an IUCN threat status of Endangered. The potential or historical extent of indigenous vegetation for this area has been identified as pūriri forest with a treat status of critically endangered.

CFG Heritage (2021) concluded that no archaeological and heritage constraints on the proposed Plan Change have been identified. It is recommended as a precautionary measure that any earthworks and ground disturbance undertaken should be under a HNZPT archaeological authority, and further research into the locations of John Kent and Te Wherewhero's children's graves should be taken. Archaeological survey cannot always detect sites of traditional significance by Māori, or wahi tapu, so the appropriate tangata whenua authorities should be consulted regarding the possible existence of such sites, and the recommendations in this report.

Ngati te Ata supports the recommendations made in the CFG Heritage Archaeological Assessment (Ngati te Ata Waiohua, 2021).

1.13 CONTAMINATED LAND

ENGEO Ltd undertook a PSI of the subject site to support the plan change process. The report found the site may have been impacted by two activities listed on the HAIL (ENGEO, 2021).

1. HAIL ID H: Any land that has been subject to the migration of hazardous substances from adjacent land in sufficient quantity that it could be a risk to human health or the environment.
    - The sites adjacent to the northern end of the property were historically used for horticultural purposes, therefore the site may have been subject to spray drift during pesticide application on this neighbouring property.
2. HAIL ID I: Any other land that has been subject to the intentional or accidental release of a hazardous substance in sufficient quantity that it could be a risk to human health or the environment.
    - Agrichemicals, in particular superphosphate fertiliser, are likely to have been applied to the site to support use as grazing land. Cadmium is often co-located with the source of superphosphate fertiliser, resulting in a build-up of cadmium in soils where superphosphate fertiliser is regularly applied.

The report does not make any recommendations specifically relating to stormwater management. The author notes that it is unlikely for either or both of the above HAIL activities to apply to the site however recommends topsoil contamination testing should be undertaken.

2.0
DEVELOPMENT SUMMARY AND PLANNING CONTEXT

2.1 REGULATORY AND DESIGN REQUIREMENTS

Table 5 summarises the relevant regulatory and design requirements for the proposed stormwater management.

TABLE 5: RELEVANT REGULATORY AND DESIGN REQUIREMENTS

FEATURE	ATTRIBUTE
Auckland Council Regionwide Network Discharge Consent	Greenfield Development under Schedule 4 of the Auckland Council Network Discharge Consent
Auckland Unitary Plan Precinct	N/A
Existing Catchment Management Plan	No
Natural Hazards	Coastal inundation 1% AEP + 1 m SLR Flood plains
High Contaminant Generating Areas	No
Unitary Plan – SMAF hydrology mitigation	No

3.0
MANA WHENUA: TE AO MĀORI AND MĀTAURANGA

Incorporating te ao Māori and mātauranga Māori to our work encourages meaningful community engagement and builds the relationship between people and the environment.

A Cultural Impact Assessment (CIA) (2021) has been prepared by Ngati Te Ata Waiohua in respect to the proposed Plan Change. The CIA identifies the cultural considerations and aspirations of the site at 80 McLarin Road, Glenbrook. The cultural and historical associations of Ngati Te Ata Waiohua with Glenbrook have been researched and the conclusions from the CIA (2021) are summarised below.

The CIA notes that the proposed Plan change could provide significant economic development opportunities for Ngati Te Ata Waiohua including housing, employment, social enterprise, skills development and driving a development framed around the Te Aranga principles. It also acknowledges the cultural dimension of the plan change and the importance to Ngati Te Ata Waiohua of having a say in how ancestral land is used and developed.

3.1 IDENTIFICATION AND INCORPORATION OF MANA WHENUA VALUES

The main goals of Ngati Te Ata Waiohua include the protection, preservation, and appropriate management of natural and cultural resources in a manner that recognises and provides for their interests and values, and enables positive environmental, social, and economic outcomes.

Ngati Te Ata Waiohua supports engagement that respects and provides for their cultural and traditional relationships with Glenbrook, its unique cultural identity, and have input into shaping the physical, cultural, social and economic regeneration of these areas.

Ngati Te Ata Waiohua is committed to protecting the mauri of natural waterways and advocates for the highest level of treatment of stormwater before being discharged into waterways. It is important that 'clean' and 'contaminated' waters are not mixed, i.e., no direct disposal of waste into waterways, including wetlands. Natural wetlands should only be used to filter stormwater after passing through at least two forms of treatment to promote the regeneration of any wetland.

The CIA (2021) identifies that the improvement of stormwater quality is an essential element towards protecting aquatic receiving environments. Ngati Te Ata Waiohua notes that the proposed development activity has the potential to adversely impact cultural values, including:

i) The relationship of Ngati Te Ata Waiohua to wai (water) and thus the mauri (lifeforce) and oranga (livelihood) of wetlands, streams, the Taihiki Awa and Manukau Harbour.

ii) The harm to fish particularly Kahawai to which the area is traditionally renowned for, and the young kanae (mullet) and patiki (flounder) to which the Taihiki Awa is considered a nursery for.

iii) The harm to shell fish and thus the adverse impact upon kutai (mussel) and tio (oyster), and subsequently the adverse impact upon mahinga mataitai, (customary shellfish gathering sites) in the Taihiki Awa and Manukau Harbour.

iv) The harm to wildlife populations, killing native vegetation, fouling drinking water supplies, eroding and destabilising mana whenua sites of significance and the Taihiki Riverbank and make traditional recreational areas (e.g., waka ama) unsafe and unpleasant.

To minimise the contaminants in stormwater runoff from streets, car parks, access-ways, roofing, spouting, external wall cladding and architectural features adversely affecting cultural values, a water sensitive design approach is requested by Ngati Te Ata Waiohua. The CIA seeks a treatment train approach for future urban development of the site, e.g. with roof tanks for reuse and groundwater recharge discharging to swales and dry basins/wetlands prior to discharge to the receiving environment. Specific outcomes sought by Ngati Te Ata Waiohua include the following.

- **Rain barrels and cisterns** for harvesting rainwater for reuse, which can be implemented without the use of pumping devices, are recommended for every home building covenant or public building.

- **Permeable pavements** as an alternative to asphalt or concrete surfaces are recommended for every home driveway, footpath, public pathway and carpark.

- **Tree pits** coupled with permeable pavements are recommended along streets to filter runoff from small carpark areas and roads.

- **Planted vegetated swales** are culturally pleasing and supported for the retention and treatment they provide as well as mitigating the harsh urban appearance of developments. At least one swale should feature in the proposed development of the site.

- **Rain gardens** are recognised as best practice along with swales contributing options for contaminated road runoff and reducing pressure on detention basins.

The use of native plants for these devices as well as tree pits adds to best practice stormwater management.

- **Wetlands** are recognised as being among the most effective stormwater practices for pollutant removal and aesthetic and habitat value for their filtration of contaminants and dissolved particulates, incorporation of contaminants in soils, adsorption, plant uptake, and biological microbial decomposition. They offer safety benefits to alternatives like wet ponds and are important cultural features to Ngati Te Ata Waiohua. The potential adverse impacts on natural wetland features should also be managed through the development process to avoid cumulative effects and maintain and stabilise the water levels and ecological condition of significant wetlands.

4.0 STAKEHOLDER ENGAGEMENT AND CONSULTATION

Informal meetings have been held with Auckland Council Healthy Waters specialist, Danny Curtis leading towards the preparation of this Stormwater Management Plan (SMP). The proposed stormwater management approach has been amended in line with the initial feedback received from Healthy Waters and the SMP updated accordingly.

Feedback from Mark Iszard of Auckland Council indicated the management of natural wetlands within the subject site being a key matter for the Council. Additional feedback provided indicated the potential adverse effects of development on flooding of neighbouring sites. A flood modelling exercise was undertaken to support the plan change application as a result of this feedback.

5.0 PROPOSED REZONING APPROACH

This Stormwater Management Plan (SMP) has been prepared to anticipate future urban residential development of the subject site.

This SMP anticipates that rezoning of the land will facilitate a range of residential dwelling typologies to establish on the land, including high intensity typologies in appropriate locations. This SMP also anticipates that future site development will incorporate a stormwater management design and approach that works with the natural stormwater characteristics of the land and that achieves integration of best-practice stormwater, roading and urban design principles and outcomes.

6.0 STORMWATER MANAGEMENT

6.1 PRINICIPLES OF STORMWATER MANAGEMENT

The proposed stormwater management is intended to comply with the requirements of Auckland's regionwide stormwater network discharge consent. The strategy has been developed to demonstrate the overarching principles of how stormwater will be managed for the site proposed to be live zoned, as required by the regional NDC, AUP, and Auckland Council Stormwater Code of Practice version 3 (SW CoP).

6.1.1 NETWORK DISCHARGE CONSENT

The regionwide stormwater Network Discharge Consent (NDC) is a tool for managing and integrating land use, stormwater discharge and the region's natural water assets to mitigate the impacts of climate change and flooding (Auckland Council, 2021). It allows multiple community and environmental outcomes to be realised. Schedule 4 of the regionwide NDC outlines development requirements for Greenfields developments within Auckland.

Below summarises how the future development of the site will meet the requirements of the Greenfields section of the regionwide NDC.

TABLE 6: NDC REQUIREMENTS FOR GREENFIELDS DEVELOPMENT

STORMWATER MANAGEMENT REQUIREMENTS	DESIGN APPROACH
Water Quality Treatment	Water Quality Treatment to GD01 standard or equivalent for all new impervious areas, and areas with High Contaminant Generating Activities. Gross Pollutant Traps for waste storage areas.
Stream Hydrology (discharge to streams via the public stormwater network outside of AUP SMAF 1)	Hydrological mitigation to SMAF 1 standard for all new impervious areas to GD01 standard or equivalent. This will be managed using a SMAF 1 overlay applying to the total extent of the Plan Change area.
Flooding 10% AEP - Pipe Network Capacity	Attenuate stormwater runoff generated within northern stream catchments 1 & 2 in the 10% AEP rainfall event as required to avoid adverse effects and comply with AC SW CoP requirements and AT SW CoP requirements for all existing public stormwater infrastructure draining runoff from the site. Alternatively, upgrade the existing public stormwater infrastructure draining runoff generated within the site to achieve the same level of performance.
Flooding 1% AEP – Buildings	Attenuate stormwater runoff generated within northern stream catchments 1 & 2 in the 1% AEP rainfall event as required to avoid adverse effects and comply with AC SW CoP requirements and AT SW CoP requirements for all existing public stormwater infrastructure draining runoff from the site. Manage OLFPs safely within engineered OLFP channels and drainage reserves and establish minimum finished floor levels for new buildings as per AC SWCoP and NZBC.
Assets	All new public stormwater infrastructure will be designed and constructed in accordance with AC SW CoP and AT SW CoP requirements.

6.1.2 GD04 PRINCIPLES

GD04 outlines a Water Sensitive Design (WSD) approach for stormwater management to provide guidance for land use planning and development (Lewis, et al., 2015). It provides an innovative and resilient three waters strategy to ensure long-term benefit to the development, the wider community and surrounding natural environment. The approach aims to reduce, mitigate, or eliminate environmental degradation, maintain and enhance the quality of the existing stream network, and contribute to healthy soils and enhance the quality of the receiving environment by reducing the amount of nitrogen and contaminants flowing into the sea.

WSD principles from GD04 are provided below with an explanation of how these can be applied to the subject site.

TABLE 7: WSD PRINCIPLES AND THE APPLICATION TO THE SUBJECT SITE

WSP PRINCIPLE	POTENTIAL APPLICATION OPTIONS TO THE SUBJECT SITE
Promote inter-disciplinary planning and design	• Providing a robust options assessment of stormwater management devices that includes all devices supported by Ngati Te Ata Waiohua and Healthy Waters. • Meeting early with Auckland Council Healthy Waters specialists to discuss the site, its constraints, and an early draft concept. • Collaborating with urban designers, ecologists, and planners to develop a stormwater management concept that is integrated with natural site features and existing infrastructure.
Protect and enhance the values and functions of natural ecosystems	• Identifying at an early stage the sensitive nature of the existing wetlands. • Delineating the contributing catchments of existing wetland features to understand their surface hydrology in the undeveloped site. • Designing the developed site contours and stormwater networks to achieve primary and secondary catchment extents that preserve the surface hydrology of existing headwater wetlands within a small error margin, relative to their current function. • Protecting and enhancing the tributary streams within the site, including new riparian planting and in-stream features. • Prioritising bioretention stormwater devices over non-bioretention devices to improve treatment and greening outcomes.
Address stormwater effects as close to the source as possible	• Adopting at-source management of stormwater runoff across the whole site. • Mitigating frequent storm runoff prior to discharging into the on-site tributary stream reaches and headwater wetlands. • Providing erosion protection for discharges to the headwater wetlands by way of diffuse surface spills from stormwater devices.
Mimic natural systems and processes for stormwater management	• Adopting bioretention swales, raingardens and wetlands as the Best Practicable Option (BPO) for most of the site, reflecting the drainage of the site in its present form. • Preserving baseflows by discharging runoff to ground via infiltration wherever possible; however, recognising the limited soakage capacity across much

TABLE 7: WSD PRINCIPLES AND THE APPLICATION TO THE SUBJECT SITE	
WSP PRINCIPLE	POTENTIAL APPLICATION OPTIONS TO THE SUBJECT SITE
	of the site referenced in the geotechnical investigation report prepared for the site. • Providing physical treatment pathways for particulate contaminants within stormwater runoff via sediment forebays, check-dams, and live ponding areas. • Providing biological treatment pathways for soluble contaminants within stormwater runoff via filtration through soil media, nutrient uptake in the rhizosphere, and adsorption to particulate matter settling out of the flow.

6.1.3 PLAN CHANGE PRINCIPLES

The GD04 principles for stormwater management are sound and should be adopted for the purposes of this plan change.

6.2 PROPOSED STORMWATER MANAGEMENT

6.2.1 SUMMARY

The proposed stormwater management complies with the requirements for Greenfields development outlined in TABLE 6 under Schedule 4 of the Auckland Council Regionwide stormwater network discharge consent. The Best Practical Option (BPO) approach was considered to determine the proposed stormwater management devices. The CIA outlines the specific devices Ngati Te Ata Waiohua wishes to be implemented in accordance with the WSD approach. The device options that are proposed to be applied across the site are in accordance with the CIA, Schedule 4 of the NDC, GD04 and E10 AUP.

Section 6.2.2 of this report provides a brief discussion on the merits and constraints of the devices considered in the BPO assessment. The devices selected to manage water quantity and quality impacts are summarised in TABLE 8.

A range of stormwater management devices are supported for mitigating runoff and providing treatment from the subject site. The devices will be used in a treatment train to create a resilient stormwater system with a pre-treatment stage. The proposed BPO treatment train approach will ensure any adverse effects on the indigenous biological values of the receiving SEA-M2 area caused by the development are mitigated.

Natural streams and wetlands will be managed in a way that reflects the expectations of the Ngati te Ata Waiohua Cultural Impact Assessment (CIA), aspirations of the NPS:FM 2020 and NES-FW 2020. Section 3.1 discusses the specific outcomes of Ngati te Ata Waiohua that have been included in the stormwater management device selection summarised below.

6.2.2 BPO DEVICE SELECTION

EXISTING NATURAL WETLANDS

There are existing natural wetlands on site that can provide both water quantity and quality control for large scale catchments. They are complex natural water environments with low lying vegetation.

Wetlands are preferred over open wet ponds are they provide better contaminant removal due to the density of vegetation allowing better absorption, plant uptake and biological microbial decomposition. Wetlands manage temperature increases well due to vegetation providing shade which allows the water to hold more oxygen. Increases in temperature can also cause extra stress on aquatic species and make nutrients in the sediment more susceptible to algae growth.

Wetlands have lower maintenance requirements and costs, are aesthetically pleasing and are better habitat for wildlife compared to other treatment devices. They are also reasonably safe with shallow water levels. However, natural wetlands must be protected, and runoff will require pre-treatment before discharging into the wetlands. The existing wetlands are appropriate as a second stage of treatment in line with the specific outcomes desired by the local iwi (Ngati te Ata Waiohua, 2021) before discharging into the ultimate receiving environment.

The local iwi has indicated their preference for the use of wetlands as the second stage of treatment (Ngati te Ata Waiohua, 2021) over other devices for these reasons along with incorporating WSD practices and utilising the natural environment, which makes wetlands a BPO for the stormwater management of this project.

ATTENUATION BASINS

Attenuation basins are a storage device that provide extended detention, water quality treatment, and protect downstream channels from peak flows.

Attenuation ponds are typically deeper than wetlands but have a smaller footprint area as a result. Maintenance access tracks are required around the ponds for ongoing safety and maintenance. This must be considered when designing and sizing the ponds.

Attenuation ponds are considered a BPO for this project as they provide pre-treatment of runoff before entering the natural wetlands and will help protect the existing stream network from peak flows.

Preliminary layouts of the proposed attenuation basins can be found in Appendix 1. It should be noted that this is a preliminary layout based on the hydraulic modelling results and the indicative plans provided from the client. This layout and the attenuation volumes are subject to change as the masterplan is finalised.

SWALES

Bioretention swales are effective at providing SMAF retention and detention requirements and treating runoff.

They can be used in conjunction with other devices to provide pre-treatment of runoff before discharging to wetlands and other sensitive areas. This provides a 'treatment train' approach that is supported by the local iwi (Ngati te Ata Waiohua, 2021).

Bioretention swales are considered to be part of the BPO for this site to provide SMAF retention and detention and pre-treatment of runoff in areas where attenuation ponds are not suitable.

FILTER STRIPS

Grass filter strips are uniformly graded and densely vegetated strips that provide water quality treatment by infiltration, filtration, absorption, and biological uptake. Sheet flows are conveyed across the filter strips and distributed along the length of the strip. TSS concentration is effectively reduced through filter strips, and they are aesthetically pleasing. Grassed filter strip are accepted by the local iwi as they meet WSD principles.

Filter strips do not provide water quantity control and they require a large footprint immediately adjacent to the pavement source. They are not suitable for areas with moderate to steep slopes. The development site has areas of steep topography and is anticipated to have spacing constrains due to the density of future development.

For these reasons grassed filter strips are not considered part of the BPO for this site.

RAIN GARDENS

Rain gardens provide water quality treatment through infiltration, filtration, absorption and biological uptake. Runoff is passed through an organic filter medium of soil and a vegetative strip. Sheet flows are collected in the device, and infiltrated to the subsurface drainage layer.

Rain gardens can be useful in residential zones where there are small local catchments and space available for them to be placed adjacent to paved areas. Rain gardens are accepted by the local iwi and an acceptable device for SMAF retention and detention and water quality treatment as they uphold WSD principles.

For these reasons, rain gardens are considered part of the BPO for this site.

TREE PITS

Tree pits provide water quality treatment by directing runoff through soil layers and root pores. Trees are an important green infrastructure in urban environments as they provide oxygen, passive heating and cooling and intercept dust. They are aesthetically pleasing and help define landscape corridors and establish recreational spaces. Tree pits require good quality soil, root management to protect utilities and paved surfaces from root growth and space for projected tree growth.

The local iwi have accepted tree pits as a preferred stormwater management device (Ngati te Ata Waiohua, 2021) as it provides ecological value to the site and is in line with WSP principles.

Tree pits are considered part of the BPO for this site for the above reasons.

RAINWATER TANKS

Rainwater tanks can provide SMAF detention and retention with the intention of re-using the collected water on private lots. They contribute to reducing stormwater runoff flows and the negative effects to the environment. Detention capabilities can be added to retention tanks to make them dual-purpose systems. Rainwater tanks can be above ground or below ground systems and come in a range of shapes and sizes to easily fit into private lots.

The local iwi has outlined rainwater tanks on private lots as a specific outcome in the CIA due to the ability to re-use water for other purposes (Ngati te Ata Waiohua, 2021).

For these reasons rainwater tanks are considered part of the BPO for this site.

GROSS POLLUTANT TRAPS

Gross pollutant traps are structures that trap solid waste using physical processes. They are commonly used as primary treatment to remove large, non-biodegradable pollutants. Gross pollutant traps generally have a small footprint area and are discrete. However, they do not provide adequate treatment for fines or dissolved contaminants, can have high costs to construct and are complex to build and maintain.

Gross pollutant traps are considered a BPO for waste storage areas only. This will be dependent on the final masterplan and land uses.

TABLE 8: PROPOSED STORMWATER MANAGEMENT DIVICE OPTIONS

MITIGATIVE OUTCOME	PROPOSED STORMWATER MANAGEMENT DEVICE OPTIONS
Water Quality Treatment	• Treatment Swales

TABLE 8: PROPOSED STORMWATER MANAGEMENT DIVICE OPTIONS	
MITIGATIVE OUTCOME	**PROPOSED STORMWATER MANAGEMENT DEVICE OPTIONS**
	• Treatment Rain Gardens • Wetlands • Gross Pollutant Traps (for Waste Storage Areas)
SMAF Retention (5 mm minimum retention for all impervious areas)	• Bioretention Swales • Bioretention Rain Gardens • Bioretention Tree Pits • Rainwater Tanks/Barrels infiltrating to ground or providing a non-potable water supply
SMAF Detention (95th percentile, 24 hr rainfall event minus retention volume for all impervious areas).	• Bioretention Swales • Bioretention Rain Gardens • Bioretention Tree Pits • Rainwater Tanks/Barrels with restricted outlets • Wetlands
Peak Flow Attenuation	• Wetlands • Attenuation Basins

6.2.3 ASSET OWNERSHIP & MAINTENANCE

Assets will be established and vested to Council or held in private ownership in accordance with the SW CoP. Devices located on private lots including rainwater tanks will be owned and maintained by the future owners of those lots.

Devices located in public roads and public reserves will become vested in the Auckland Council's ownership in accordance with the SW COP criteria in section 4.3.6.2.

Following the completion of the sites works, the existing dry pond and new attenuation basins will become vested in Council at a date to be agreed on between the developer and the Council. The developer is responsible for construction of the basins and ensuring they are operational including vegetation growth prior to handing over ownership to the Council.

6.2.4 MANAGING RUNOFF FROM PRIVATE LOTS

There is a wide range of devices available for managing runoff from private lots. Rainwater tanks, permeable pavements, and small scale bioretention devices are suitable for meeting treatment and hydrological mitigation requirements. WSD involves managing stormwater effects as close to the source as possible. In accordance with GDO4 and the specific outcomes of Ngati te Ata Waiohua, the preferred solution for managing stormwater runoff from private lots is providing small-scale rainwater tanks for each home, which can be privately owned and operated.

These will be dual-purpose devices to provide SMAF retention and detention of runoff prior to discharge into the public stormwater network. These devices will be connected to the private drainage within the site which will then discharge to the new public networks constructed to enable future developments.

Rainwater tanks are preferred as they can be installed above or below ground to be compatible with a range of building typologies. This approach can offer reduced mains water consumption, protection and enhancement of natural streams, and improving the resilience of the public stormwater network.

6.2.5 MANAGING RUNOFF FROM ROADS AND PUBLIC SPACES

Bioretention swales and rain gardens are proposed to provide pre-treatment and hydrological mitigation for runoff generated by roads and public spaces within the site. These devices will provide SMAF retention and detention requirements to convey the 'first flush' of runoff. This will ensure the protection of the natural wetlands from contaminants in the runoff from developed areas in accordance with the expectations set by Ngati Te Ata Waiohua, WSD principles and the NPS-FM. It will also prioritise surface spills from bioretention features into the wetlands (rather than piped point-source stormwater discharges) to avoid scouring of the natural wetlands. These devices will be discharged to the attenuation basins which will help preserve a baseflow within the attenuation ponds to continue feeding the natural stream network during drier seasons.

Natural wetlands will then be utilised to provide a second stage of treatment that the cultural impacts assessment identified as a key outcome to provide the highest level of treatment before discharging stormwater to the receiving stream network. This secondary treatment stage will not be counted towards fulfilling the treatment requirements for future development of the site.

Vegetated bioretention swales are the preferred stormwater management devices for road runoff, with good performance in removing total suspended solids, oils, and heavy metals as well as preserving stream baseflows by infiltrating runoff into the ground. These versatile devices can reduce the extents of stormwater networks required to service a site and can also form part of the overland flow path management system.

Bioretention rain gardens and tree pits are also proposed for use throughout the site. These devices serve the same purpose as bioretention swales but are designed for smaller, localised road catchments. They are suitable in service-rich environments where swales cannot be constructed at public road construction phase with certainty that clashes can be avoided in future super-lot development phases.

Groundwater testing is recommended to be undertaken throughout the site to confirm the suitability of infiltration devices to meet the SMAF retention requirements. This will determine in which areas of the site retention volumes can be achieved by infiltrating runoff to ground, and where it may need to be provided as a non-potable water supply or as part of the detention volume (i.e., where groundwater levels are too high). Retention is not suitable in areas with high groundwater however detention can be used in these areas to provide hydrological mitigation.

Stormwater assets proposed to be located within public road reserves will require consultation with and approval from Auckland Transport.

6.2.6 PIPED STORMWATER NETWORKS

Piped networks will be constructed within the site to convey the 10% AEP runoff from roads, other public areas, and private lot connections. The network will be discharged via the southwestern corner of the development site into the existing stormwater network, which runs through the Glenbrook township and drains into the Waiuku River inlet of the Manukau Harbour a short distance downstream. The networks will be designed and constructed in accordance with SW CoP and NDC. This will be done at a later stage of design once a masterplan has been produced.

6.2.7 COMMUNAL STORMWATER MANAGEMENT

Communal devices are proposed to meet the peak flow attenuation requirements generated by the increase in impervious surface on the site from development and the loss of depression storage prior to discharging runoff into the stream network. The preferred devices to provide peak flow attenuation are the existing natural wetlands and new attenuation basins.

Upgrading the existing network on site was initially considered, however providing attenuation basins on site is more feasible for this site. This approach means that all new stormwater devices and networks are within the site boundary, thereby reducing further disruption to the surrounding properties.

The cultural values assessment stated that a water sensitive design (WSD) approach is requested by Ngati Te Ata Waiohua. WSD involves a treatment train approach to stormwater management. Attenuation basins designed as treatment wetlands and/or with a sediment forebay can provide a second stage of treatment for runoff generated from the road surfaces and hydrological mitigation that Ngati Te Ata Waiohua identified as a specific outcome. Furthermore, with planned landscaping, the ecological and amenity values of the development can be enhanced in line with the main goals of the cultural impact assessment to protect and preserve natural resources.

Locations of the existing wetlands and preliminary layouts of the proposed attenuation basins can be found in Appendix 1.

6.2.8 WETLAND MANAGEMENT

There are three existing wetlands within the proposed development site. The locations of the wetlands (W1, W2 and W3) are shown in Appendix 1.

PDP Ltd. (2021) found that wetlands W1 and W2 are primarily sustained by surface water inflows such as overland flow and stream flow. W3 may be primarily fed by groundwater, and it is also likely that there is some subsurface flow/groundwater component feeding the northern portion of W2. Due to the likelihood of high groundwater levels around W3 and W2 and seasonal variability in groundwater levels, a groundwater assessment should be completed at a later stage in design. This will determine where retention or detention devices will be required and ensure our stormwater management goals are met.

To protect and enhance the natural wetlands overland flows should be directed and retained into the stream network for longevity, through the consideration of best practice Low Impact Design principles (PDP Ltd., 2021). It is envisioned that the wetlands and streams will be connected with the greenspace of the development. Bio-retention or attenuation devices should be placed suitably to capture the 'first flush' of surface runoff before discharging to the northern wetlands.

PDP Ltd. (2021) have outlined the relevant freshwater NES and NPS implications. The NPS-FM (2020) includes policies to avoid the loss and extent of natural inland wetlands and rivers, and to protect their values and promote their restoration.

Important considerations in terms of the NPS-FM (2020) for future site development include:

- The 'hierarchy of obligations' to prioritise the health and wellbeing of waterbodies, the essential needs of people, and any other uses.
- National bottom lines defined with all water bodies to be at least maintained, and degraded water bodies required to be improved.
- Adverse effects on wetland or river extent or values to be managed by the effects management hierarchy.
- The NPS-FM (2020) does not support any loss in potential ecosystem values (e.g., loss of streams through reclamation or piping).

The NES-F (2020) regulations require strict measures, including resource consents, for activities that can result in the loss of extent and value of natural inland wetlands. Table 9 outlines the relevant activities.

TABLE 9: REGULATORY AND DESIGN REQUIREMENTS UNDER THE NES-F 2020 (PDP LTD., 2021).

ACTIVITY	NON-COMPLYING	PROHIBITED
Vegetation clearance	Vegetation clearance within 10 m setback from a natural wetland if they do not have another status (for example restoration, scientific research, maintenance, natural hazards).	N/A
Earthworks or land disturbance	Earthworks within, or within a 10 m setback from, a natural wetland. Earthworks outside, but within a 100 m setback from a natural wetland if it results, or is likely to result, in the complete or partial drainage of all or part of a natural wetland; and does not have another status under any regulations 38 to 51. Earthworks within, or within a 10 m setback from, a natural wetland if they do not have another status.	Earthworks within a natural wetland if it results, or is likely to result, in the complete or partial drainage of all or part of a natural wetland; and does not have another status under any regulations 38 to 51.
The taking, use, damming, diversion, or discharge or water.	The taking, use, damming, diversion, or discharge or water within, or within a 100 m setback from, a natural wetland if it results or is likely to result, in the complete or partial drainage of all or part of a natural wetland; and does not have another status under any regulations 38 to 51. The taking, use, damming, diversion, or discharge or water within, or within a 100 m setback from, a natural wetland if they do not have another status.	The taking, use, damming, diversion, or discharge or water within a natural wetland if it results or is likely to result, in the complete or partial drainage of all or part of a natural wetland; and does not have another status under any regulations 38 to 51.

6.2.9 ATTENUATION BASIN SIZING

Attenuation of extreme event runoff from the site will be required to avoid exceeding the capacity of the receiving stormwater networks and the increase of surface flooding to property. A concept design of peak flow attenuation basins is provided, using the hydraulic flood modelling results in Section 6.3 of this report. This design proposes 4 new attenuation basins in addition to the existing wetlands, shown in Appendix 1.

The hydraulic flood model results indicate the potential future development of the site to MPD levels will increase the peak flow rates and volumes of runoff discharged from the site in the 10% and 1% AEP storm events.

Results from the hydraulic modelling were used to estimate the attenuation volumes required on site. TP108 calculations were not deemed necessary on top of the hydraulic model results to calculate the attenuation volumes. The hydrology in the ICM model uses the SCS method to produce a net rainfall input to the model, which then translates to increased runoff from the site. The flow hydrographs from the boundary of the catchment provide the difference in net rainfall between the pre- and post-development scenarios, effectively providing the same information as a TP108 calculation.

The results summarised in Table 11 indicate that the peak flow attenuation for the 10% AEP event runoff required on site is 3,600 m^3 (as the difference between the ED and MPD scenario events).

However, the results in Table 11 indicate that the post development scenario has caused an increase of the runoff generated in the 1% AEP event. Therefore, peak flow attenuation is required to attenuate 1% AEP runoff to the same standard with a volume of 4,800 m^3.

As hydraulic modelling results have been used for the attenuation basin sizing, space for maintenance tracks have not been considered. To ensure there is sufficient space on site for maintenance tracks, a 20% allowance was added to the footprint area of the attenuation basins. Therefore, a total attenuation volume of **4,800 m^3** is required for the 1% AEP runoff with an estimated surface area of **3,840m^2**.

The site is limited for space to construct the required attenuation basins in conjunction with treatment and detention functions due to the existing topography, natural wetlands, and streams. Locations for the attenuation basins have been proposed based on the existing site contours and watercourses. The locations are displayed in Appendix 1 with the basin footprints sized using the following parameters.

- 4,800 m^3 live storage volume
- 3,840 m^2 estimated footprint area
- 1.5 m average live storage depth

The sizing and layout proposed will be updated following the submission of the masterplan from the developer.

6.2.10 WATER QUALITY DEVICE SIZING

Water quality treatment will be provided in accordance with Chapter E9 of the Auckland Unitary Plan and the proposed development precinct conditions.

Devices will be selected and sized following the submission of a proposed masterplan and indicative impervious areas.

Per Table 8 this can be achieved using treatment swales, rain gardens, wetlands, and Gross Pollutant Traps.

6.2.11 STREAM HYDROLOGY

PDP's assessment found that modifications in the catchment have altered the surface hydrology (PDP Ltd., 2021). To mitigate adverse effects on the wetlands, overland flow paths should be retained and not diverted, and directed into the streams without scouring the wetland features. Monitoring of groundwater levels at W3, and of the surface flows at W1 and W2, is also recommended by PDP.

7.0 HYDRAULIC MODELLING

Hydraulic models were developed using InfoWorks ICM v11 software to support Plan Change application. These models are primarily 2D models using topographical survey data presented in this report to identify flood hazards within the existing site and downstream of the site through the future development process.

A total of twelve hydraulic model simulations were completed for three land-use scenarios with 1% and 10% AEP rainfall and 0- and 1-metres sea level rise, (SLR) correlating to tidal boundary levels of 2 m and 3 m respectively. The completed model simulations are shown on Table 10.

The three scenarios based on the following assumptions are:

- **Pre-development Scenario (ED)**

  An 'Existing Scenario' (ED) model representing the present land-use throughout the subject site. This provides a baseline scenario that will be used to assess the impacts of the proposed development.

- **Post-development Scenario (MPD)**

  A 'Maximum Probable Development' (MPD) model representing a possible future development scenario of the subject site and wider catchment based on AUP OP zoning. Impervious coverage of 60% was used across the entire the subject site based on a conceptual residential future development scenario to ignore roading and greenspace layouts. This is a conservative estimate of the impervious coverage of the site which will enable future changes to the proposed layout to be made without causing significant changes to hydraulic modelling results.

- **Interim Scenario (ED + MPD on site)**

  An 'Existing Wider Catchment + On-site Maximum Probable Development (ED + MPD on-site) model representing the existing scenario throughout the catchment, but with the subject site modelled using its MPD coverage. This scenario enables us to quantify the downstream impacts in the wider catchment of the proposed development on the downstream network.

TABLE 10: HYDRAULIC MODEL SIMULATIONS

MODEL SCENARIO	TIDAL BOUNDARY LEVEL	RAINFALL EVENT	DESIGN RAINFALL DEPTH	CLIMATE CHANGE FACTORS?	STORM PROFILE
ED	2 m	1% AEP	178	Yes – per AC SW CoP	24-hour TP108 SCS
		10% AEP	118		
	3 m	1% AEP	178		
		10% AEP	118		
MPD	2 m	1% AEP	178		
		10% AEP	118		
	3 m	1% AEP	178		

TABLE 10: HYDRAULIC MODEL SIMULATIONS					
MODEL SCENARIO	**TIDAL BOUNDARY LEVEL**	**RAINFALL EVENT**	**DESIGN RAINFALL DEPTH**	**CLIMATE CHANGE FACTORS?**	**STORM PROFILE**
		10% AEP	118		
ED + MPD on site	2 m	1% AEP	178		
		10% AEP	118		
	3 m	1% AEP	178		
		10% AEP	118		

Full details of the model build process including assumptions and exclusions can be found in Appendix 2.

7.2 DOWNSTREAM IMPACTS

The results of the 1% AEP ED scenario flood model simulations are presented below. These results indicate the significant hazard posed to the Glenbrook township and the southern corner of the subject site by local sea-level rise.

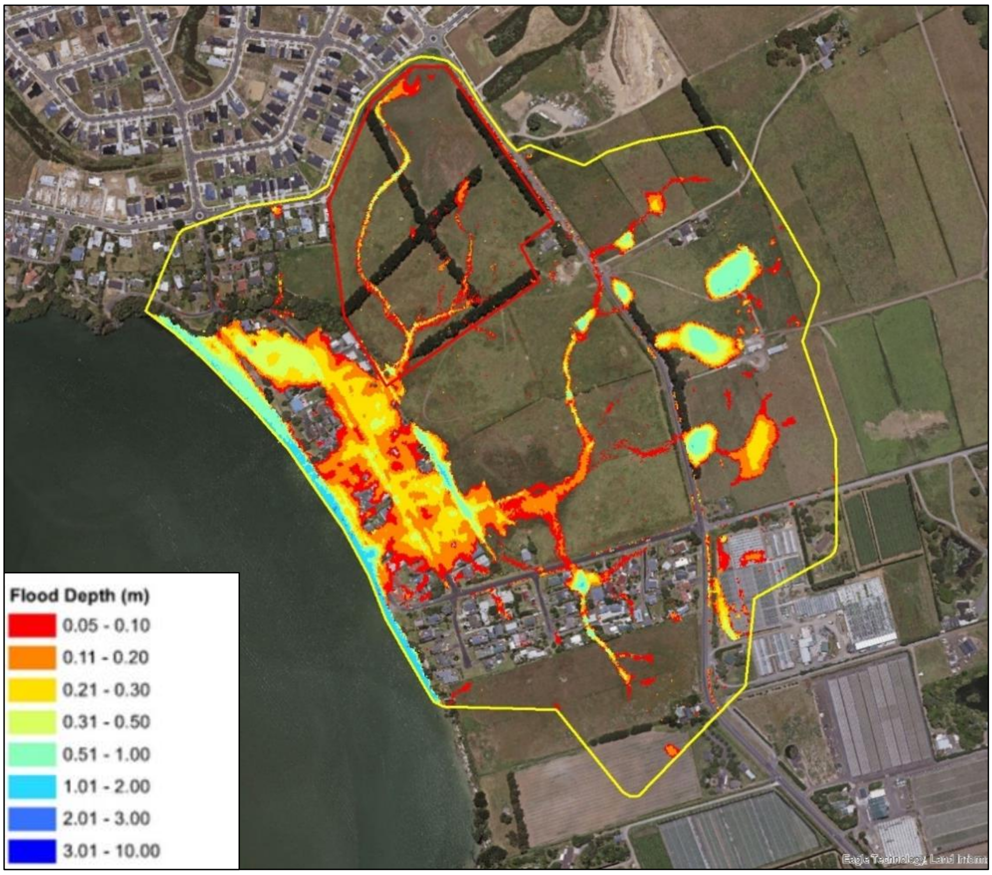

FIGURE 15: Existing Development scenario, 1% AEP hydraulic model results (no SLR).

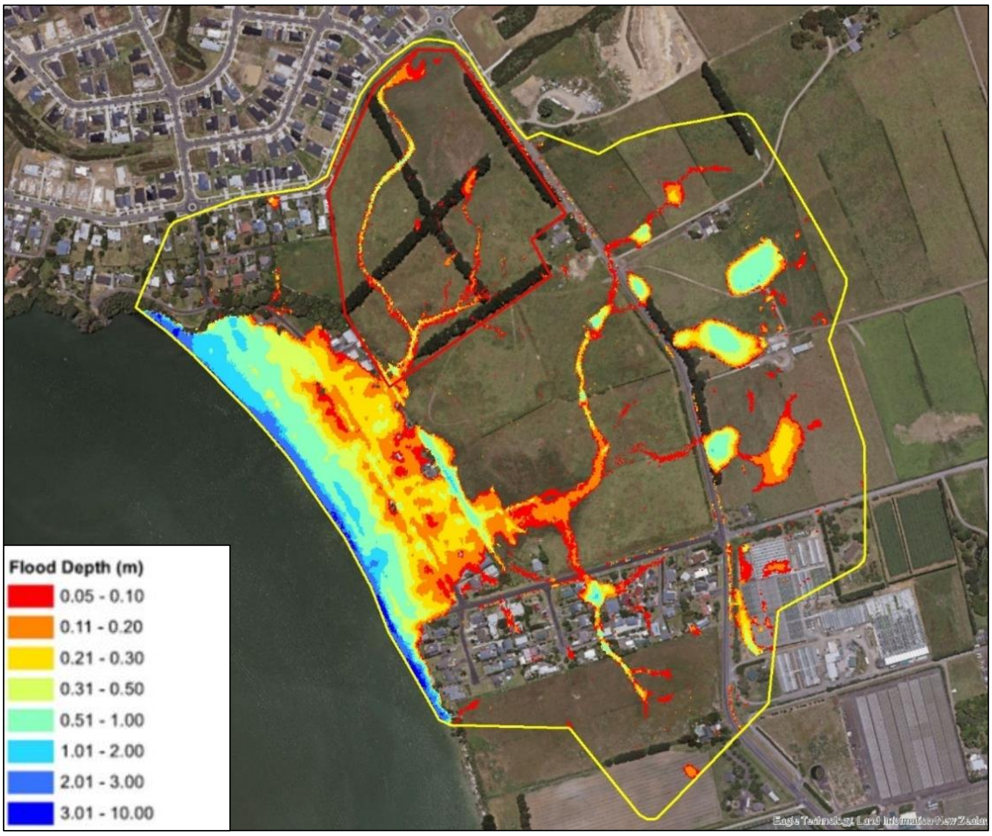

FIGURE 16: Existing Development scenario, 1% AEP hydraulic model results (1 m SLR).

Table 11 shows peak flow rates and volumes discharged from the subject site for the 1% and 10% AEP rainfall event with 1 m SLR (3m tide level). Flood maps indicating changes in the extents and severity of flooding experienced across the site and downstream receiving environment in the 1% and 10% AEP with 1 m sea level rise scenario are provided in Figure 17 to Figure 22.

The difference in flooding between the Interim (ED + MPD on-site) and Pre-development (ED) scenarios displays the impacts of the proposed development on the existing surrounding catchment. The difference in flood extents between the Post-development (MPD) and Pre-development (ED) scenarios show the impacts of the proposed development on a possible future development scenario of the subject site and wider catchment as a worst-case scenario.

TABLE 11: MODEL SCENARIO RESULTS (1 M SLR)

MODEL SCENARIO	RAINFALL EVENT	PEAK FLOW RATE (M3/S)	24HR FLOW VOLUME (M3)
ED	1% AEP	1.9	10,500
	10% AEP	0.8	5,200
MPD	1% AEP	2.6	15,300
	10% AEP	1.4	8,800
ED+MPD	1% AEP	2.4	14,200
	10% AEP	1.3	7,950

FIGURE 17: 1% AEP catchment wide depth difference, ED + MPD minus ED flood model scenarios (1 m SLR).

FIGURE 18: 1% AEP on site depth difference, ED + MPD minus ED flood model scenario (1 m SLR).

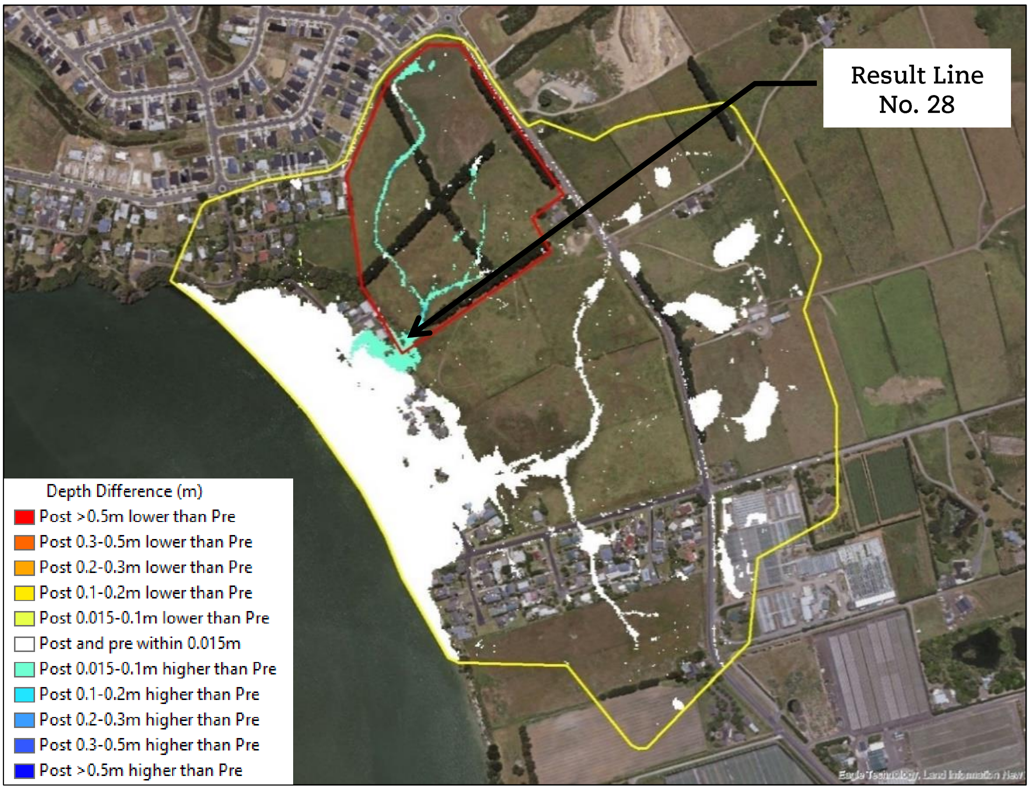

FIGURE 19: 10% AEP catchment wide depth difference, ED + MPD minus ED flood model scenarios (1 m SLR).

FIGURE 20: 10% AEP on site depth difference, ED + MPD minus ED flood model scenarios (1 m SLR).

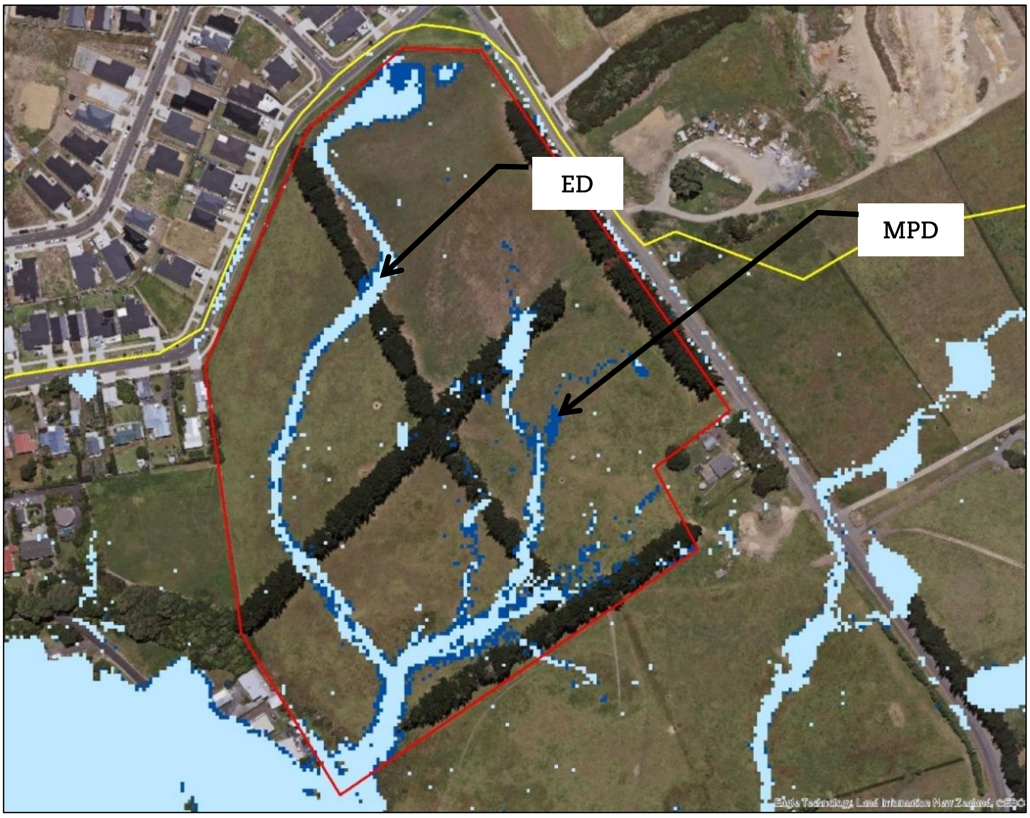

FIGURE 21: 1% AEP ED and MPD scenario flood extents (1 m SLR).

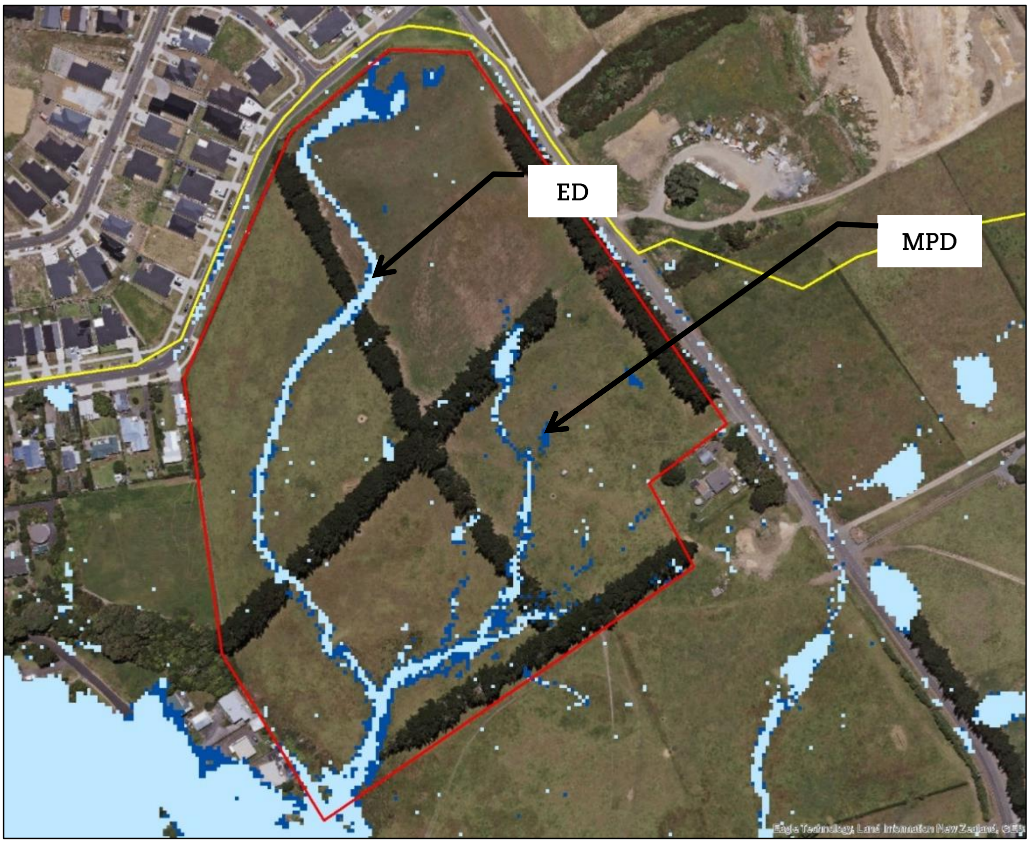

FIGURE 22: 10% AEP ED and MPD scenario flood extents (1 m SLR).

The flood-prone and low-lying nature of the receiving environment to the west of the site does not allow for an objective assessment of the impacts of the proposed development on downstream flood hazards. Therefore, further model simulations were undertaken to isolate the effects associated with sea-level rise and development of adjacent properties.

Table 12 shows peak flow rates and volumes discharged from the subject site for the 1% and 10% AEP rainfall event with no SLR (2m tide level). Flood maps indicating changes in the extents and severity of flooding experienced across the site and downstream receiving environment in the 1% and 10% AEP with no sea level rise scenario are provided in Figure 23 to Figure 28.

TABLE 12: MODEL SCENARIOS RESULTS (NO SLR)

MODEL SCENARIO	RAINFALL EVENT	PEAK FLOW RATE (M3/S)	24HR FLOW VOLUME (M3)
ED	1% AEP	1.9	10,500
	10% AEP	0.8	5,200
MPD	1% AEP	2.64	15,300
	10% AEP	1.4	8,800
ED+MPD	1% AEP	2.5	14,200
	10% AEP	1.3	7,950

FIGURE 23: 1% AEP catchment wide depth difference, ED + MPD on-site minus ED flood model scenarios (no SLR).

FIGURE 24: 1% AEP on site depth difference, ED + MPD on-site minus ED flood model scenarios (no SLR).

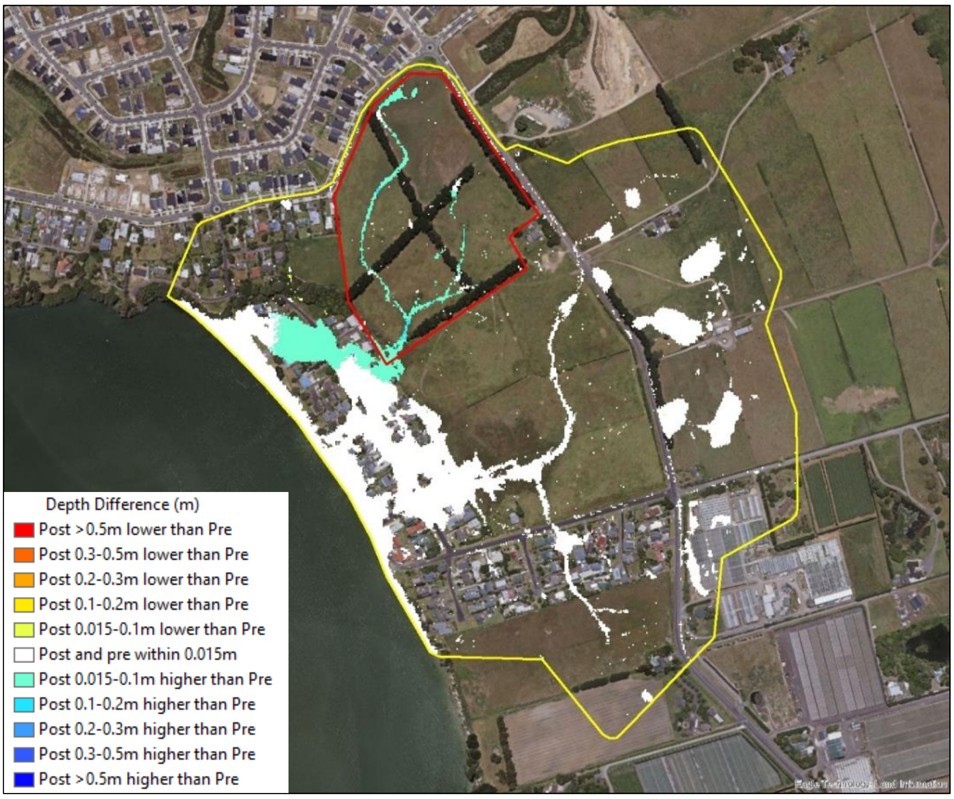

FIGURE 25: 10% AEP catchment wide depth difference, ED + MPD on-site minus ED flood model scenarios (no SLR).

FIGURE 26: 10% AEP on site depth difference, ED + MPD on-site minus ED flood model scenarios (no SLR).

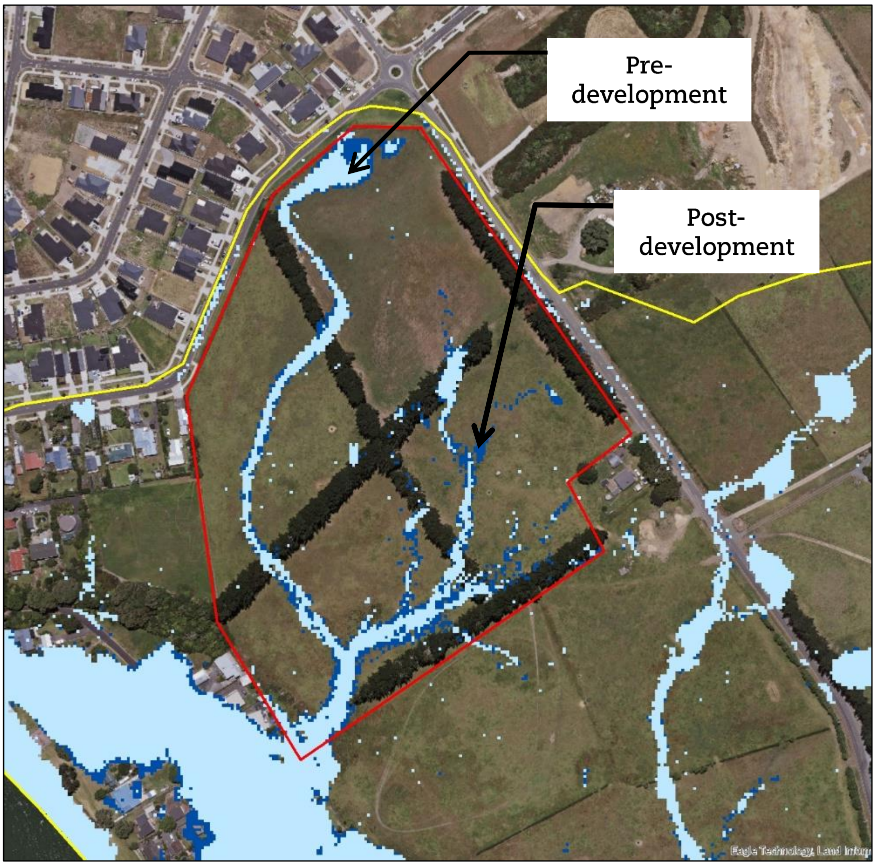

FIGURE 27: 1% AEP ED and MPD scenario flood extents (no SLR).

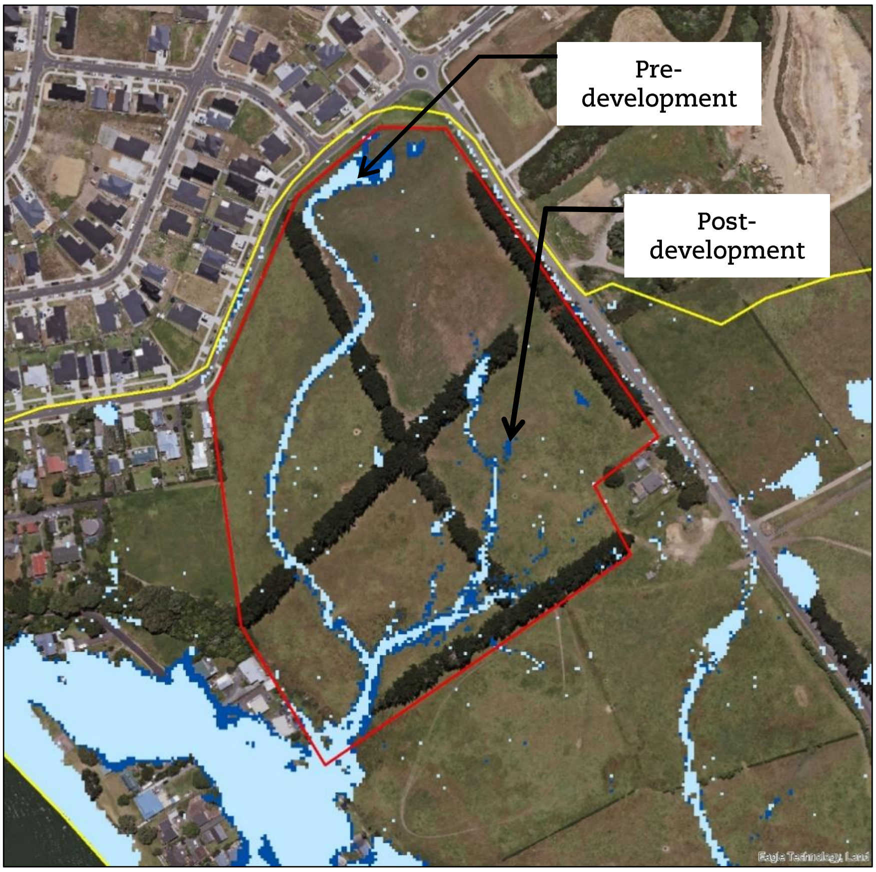

FIGURE 28: 10% AEP ED and MPD scenario flood extents (no SLR).

7.3 FLOOD MODELLING SUMMARY

The influence of SLR partially obscures the impacts of the potential future development of the site on flood hazards in the receiving environment. Despite the additional 0.7 m^3/s peak flow and 4,800 m^3 total runoff from the subject site from the 1% AEP (1 m SLR) MPD scenario compared to the ED scenario, there is no noticeable increase in flood hazards to downstream properties. This result is replicated in the 10% AEP (1 m SLR) event.

The results are similar in the 'no SLR' scenario. The results in Figure 23 to Figure 25 indicate a small number of properties neighbouring the subject site experience an increased flood depth of between 2 and 10 mm resulting from the development of the subject site.

It should be noted that the model likely over-estimates flood hazards in the 'no SLR' simulations since the stormwater pipe network is not included in the model. It may be possible to mitigate this increased flood hazard using peak flow attenuation devices within the subject site. The current model has also assumed the entire developable site to have an impervious coverage of 60% to produce a conservative estimate of the flooding impacts. This allows for flexibility in the final masterplan layout.

Further hydraulic modelling is recommended to be undertaken at a later stage in the design process to better quantify the impacts of the proposed development once a proposed layout and design earthworks surface is known. The climate change effects considered in the hydraulic modelling completed may be overestimating the resulting floodplain and mask the potential impacts of the proposed development. Therefore, the pre-development scenario should be modelled with no climate change or SLR effects to ensure the current conditions are understood and the actual impacts of the development on the existing catchment can be assessed.

Further refinements to the flood models could be made throughout future plan change, consenting, and development processes to progressively confirm that the adverse effects of development on flood hazards can be adequately mitigated. These model refinements may include adding topographical survey data, design earthworks surfaces, existing and proposed stormwater pipe networks, building footprints, and any attenuation devices proposed under future applications. It is recommended that further hydraulic modelling is carried out when the master plan is confirmed.

8.0 DEPARTURES FROM REGULATORY OR DESIGN CODES

Any departures will be identified during design phase as detailed design progresses.

9.0 CONCLUSIONS AND RECOMMENDATIONS

9.1 CONCLUSIONS

This SMP demonstrates that stormwater within the subject site area will be managed in accordance with the relevant standards and requirements. No major concerns are anticipated relating to stormwater management across the site. Based on the investigations that have been completed, it is expected that stormwater effects from the subject site can be appropriately and adequately managed in accordance with the requirements of the AUP and NDC. This SMP will act as a live document that will continue to be updated as the project progresses, and further investigations are carried out.

The 80 McLarin Road Plan Change proposes to significantly expand the Glenbrook Beach area. This report provides insights into the existing site features and the interventions that may be required to mitigate the potential adverse effects of future urban intensification of the subject site on the receiving environment. These interventions include stormwater management controls of water quality treatment, SMAF 1 retention & detention, and peak flow attenuation of the 10% and 1% AEP rainfall events.

The current AUP provisions are sufficient for stormwater management of the site relating to SMAF 1, water quality treatment, and peak flow attenuation.

This proposal seeks to preserve the ecological value of existing natural features within the site, including wetlands and stream reaches, and will create new valuable areas by creating treatment and bioretention assets within the site. This proposal provides a range of stormwater management controls that could be used to provide several stormwater quality and quantity management outcomes, which are proposed to mitigate impacts on existing watercourses within the site, existing flood-prone properties downstream of the site, and the sensitive estuarine environment of the Waikopua Creek.

Ngati Te Ata Waiohua provided a detailed Cultural Impact Assessment report to support the Plan Change application. This assessment identified iwi values in the subject site and proposed stormwater management concepts and devices that have been adopted under this SMP.

Hydraulic modelling was used to understand existing floodplain extents, infrastructure constraints, and downstream hazards, and how these might change as a result of the future development of the subject site. Increases in downstream flood hazards and capacity restrictions in the receiving pipe network identified through the hydraulic modelling can be mitigated using suitable peak flow attenuation devices discussed in this report. The hydraulic modelling completed so far is a 'rain on grid' model, not including any piped network. The piped network can be added to the model at a later date when the masterplan is at detailed design phase if necessary.

Stormwater management devices proposed in the SMP have been chosen to align with the mana whenua values of this project and the principles of Water Sensitive Design. They are in accordance with WSD guidelines for the Auckland Region and Schedule 4 of the Regionwide NDC. These devices include rain water tanks, wetlands, bioretention swales, rain gardens, tree pits, and attenuation basins to achieve the retention, detention, water quality, and peak flow attenuation requirements set out in this report. Detailed sizing and layouts of the proposed stormwater devices will be provided following the submission of a masterplan layout.

The findings of this report support that the implementation of these devices will help protect the area from stormwater quality and quantity risks and enhance the cultural and ecological value of the area.

9.2 RECOMMENDATIONS

The following actions are recommended to confirm the conclusions and support the proposed management plan:

- Topsoil contamination testing should be undertaken to confirm if the site may have been impacted by activities listed on the HAIL.
- Groundwater level investigations to determine the suitability of retention and detention devices.
- Further hydraulic modelling to assess the downstream impacts of the development one the proposed masterplan is received that includes a pre-development scenario with no climate change or SLR effects to quantify the impacts of the proposed development on the existing wider catchment area.

Much of the assessment in this report is based on 'rain on grid' hydraulic modelling undertaken using a concept design surface of a potential future development within the subject site. There is significant scope for change within the layout. The stormwater modelling and design tasks presented in this report should be progressively refined in line with specific future development proposals and as any future changes to engineering codes, particularly and changes to climate change impacts on rainfall or stormwater device design requirements.

Ongoing consultation with mana whenua and the local community is necessary for successful project implementation. The findings of this assessment should be validated against the observations and expectations of iwi/hapū groups and local community members.

The recommendations outlined in this SMP were based on the present NDC and AUP conditions. The recommendations will be re-assessed and the SMP updated accordingly with any future changes to the NDC or AUD conditions.

10.0 LIMITATIONS

10.1 GENERAL

This report is for the use by HD Project 2 Ltd only and should not be used or relied upon by any other person or entity or for any other project.

This report has been prepared for the particular project described to us and its extent is limited to the scope of work agreed between the client and Harrison Grierson Consultants Limited. No responsibility is accepted by Harrison Grierson Consultants Limited or its directors, servants, agents, staff or employees for the accuracy of information provided by third parties and/or the use of any part of this report in any other context or for any other purposes.

10.2 ESTIMATES

Should this report contain estimates for future works or services, physical or consulting, those estimates can only be considered current and will only reflect the extent to which the detail of the project is known to the consultant (feasibility, concept, preliminary, detailed, tender etc) at the time given.

The client is solely responsible for obtaining updated estimates from the consultant as the detail of the project evolves and/or as time elapses.

10.3 PEER REVIEW

Should this report be a peer review of the work of another consultant ("the designer"), the following limitations apply:

- The review is limited to only those aspects of the designer's work specified in the peer reviewer's scope of engagement.
- The liability for the reviewed work remains at all times solely with the designer.
- If any comments or recommendations by the peer reviewer are adopted by the designer, the responsibility for their adoption is assumed totally by the designer.

APPENDICES

APPENDIX 1
PRELIMINARY STORMWATER MANAGEMENT DEVICE LAYOUT

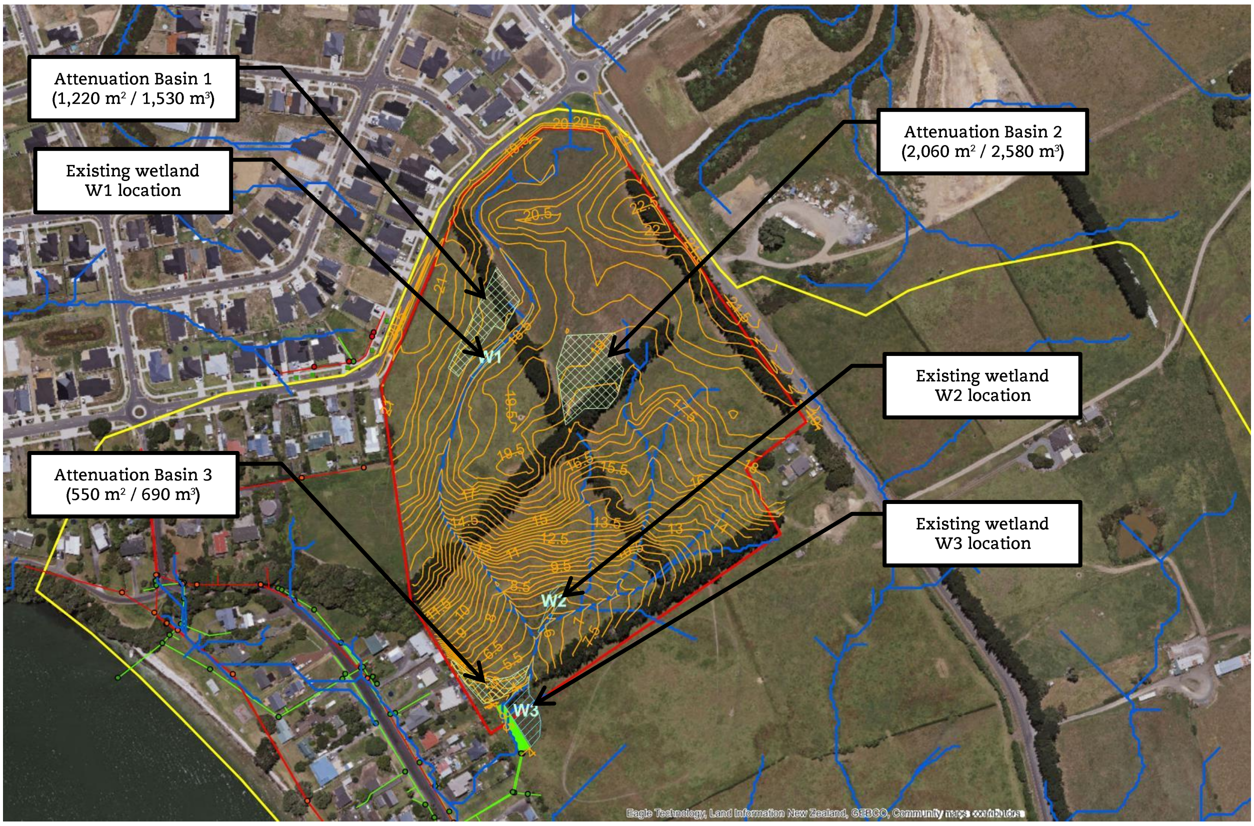

FIGURE 29: Proposed preliminary attenuation basin locations relative to existing wetlands and OLFPs

APPENDIX 2
HYDRAULIC MODEL BUILD

MODEL ASSUMPTIONS & EXCLUSIONS

- New pipe networks associated with potential future development were not included in the model. This exclusion caused ponding in several wetland areas within the site.
- Primary network and secondary network sub-catchments are assumed to have equal extents. This is a typical assumption for rain-on-grid modelling.
- A weighted curve number is calculated for each land-use area.
- The coastal boundary is a static water level set at 2 m and 4 m RL for the 0 m and 2 m SLR scenarios respectively. This corresponds with the indicative coastline extent indicated on Auckland Council GeoMaps.
- A 60% Impervious coverage was used over the entire development site for the post development (MPD) scenario. This allows for more flexibility in the proposed roading and greenspace layout.

DESIGN RAINFALL

All hydraulic model simulations use TP108 SCS method rainfall with climate change factors applied in accordance with the Auckland Council Stormwater Code of Practice v3.

Runoff zones were delineated across the site based on soil types and proposed density. Runoff hydrographs were applied directly to rainfall zones within the model using the 'net rainfall' approach, whereby initial & constant losses are subtracted from the rainfall hyetograph prior to modelling. Design rainfall depths are shown on Table 7.

CATCHMENT IMPERVIOUSNESS

The pre-development (ED) scenario was modelled using weighted curve numbers derived from different land use zones based on percentage impervious coverage as shown on Figure 29.

The post-development (MPD) scenario was modelled using weighted curve numbers derived from a potential future development layout. The impervious coverage zones anticipated in the modelling are shown on Figure 30. The interim (ED + MPD on site) scenario was modelled using the post-development MPD scenario imperviousness values within the proposed development site extent and the pre-development ED imperviousness coverage values within the rest of the catchment as shown on Figure 31**Error! Reference source not found.**.

A constant impervious coverage was used over the development site for the post-development scenarios to provide flexibility in the layout of the masterplan as it has not been finalised. This means further modelling will not be necessary if changes to the road and green space layouts are made.

Weighted curve numbers of CN = 65, 83, 87, and 94 were used to represent reserves, residential areas, laneways, and commercial/road areas respectively.

FIGURE 30: ED scenario model extent and imperviousness.

FIGURE 31: MPD scenario model extent and imperviousness.

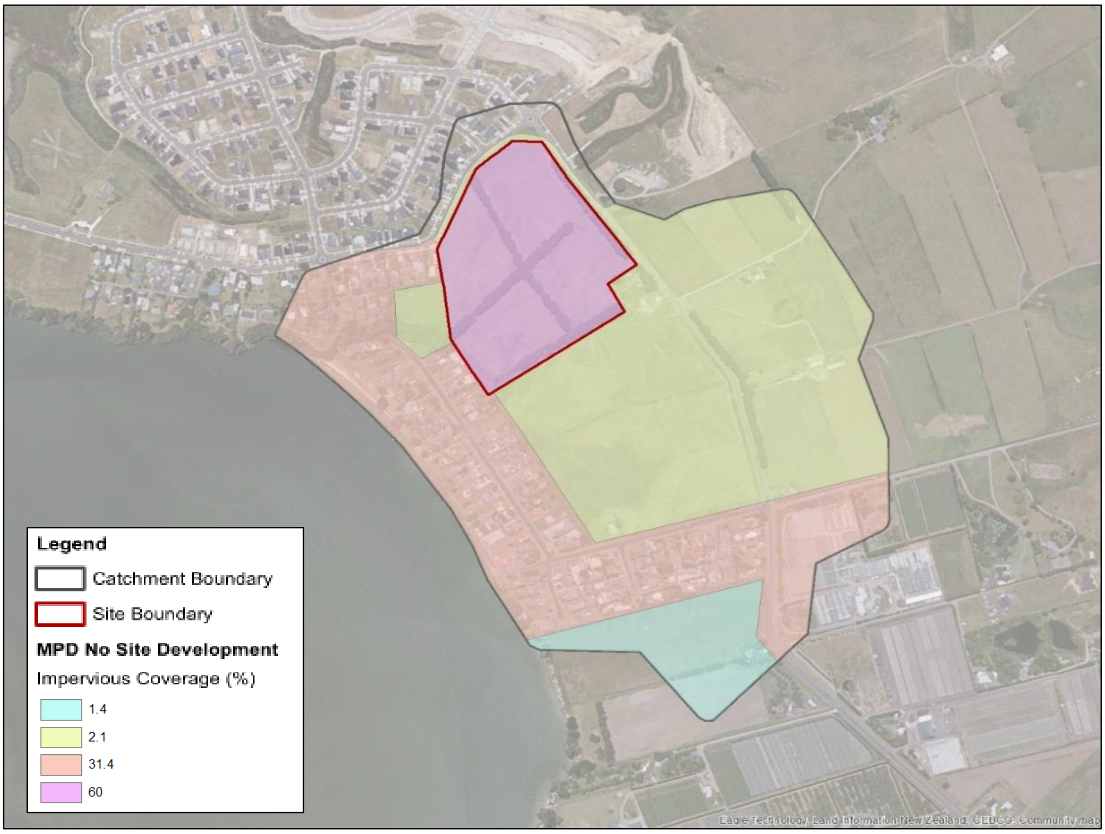

FIGURE 32: ED+MPD site scenario model extent and imperviousness.

SURFACE ROUGHNESS

Surface roughness values for the existing scenario were derived by validating observations from successive site visits against Manning's roughness values put forward in Chow (1959). This is also a valid general assumption for the MPD and ED+MPD site scenarios due to the level of intensity anticipated under a future development concept for the site. The surface roughness used in the hydraulic models are shown on Figures 32 and 33.

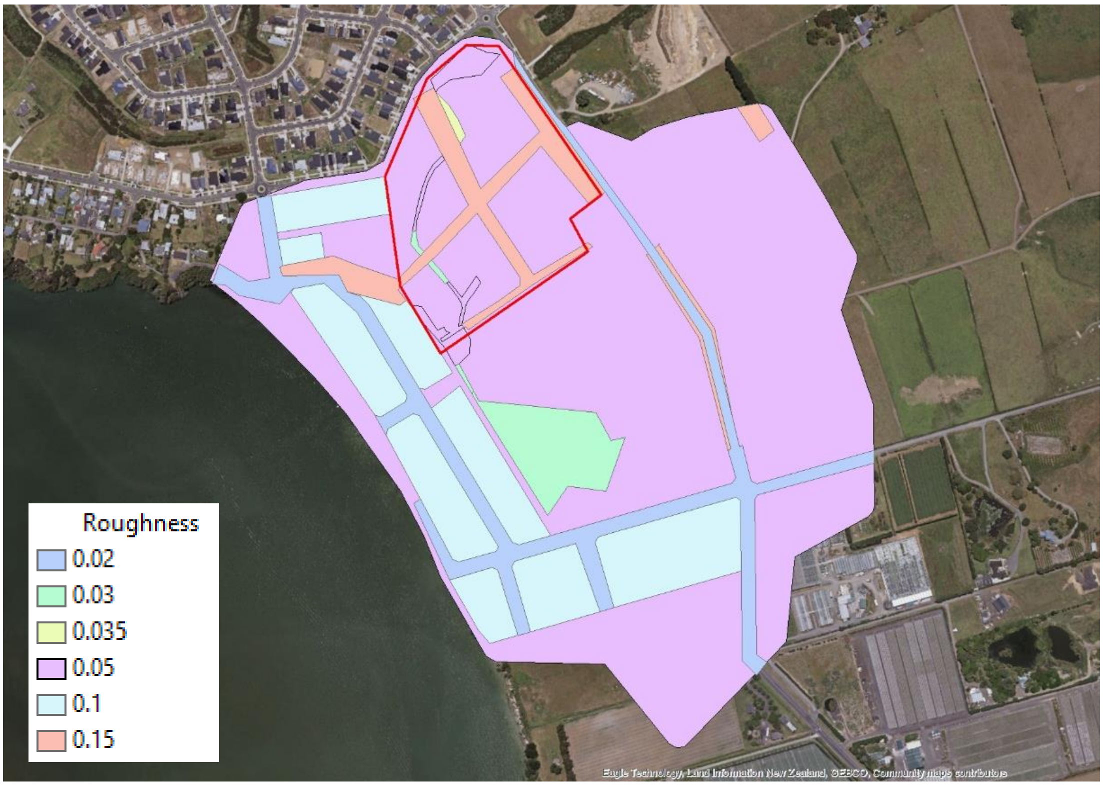

FIGURE 33: Hydraulic model ED scenario surface roughness values (Manning's n values).

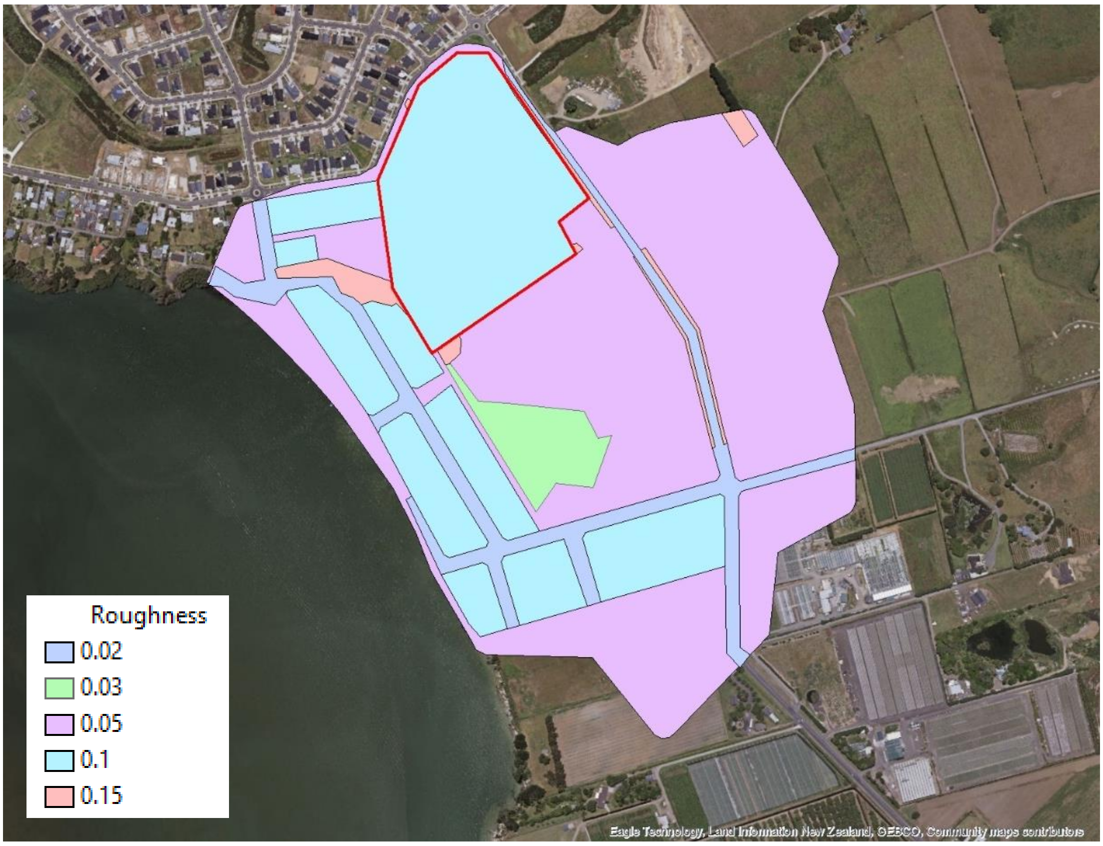

FIGURE 34: Hydraulic model MPD and MPD+ED scenario surface roughness values (manning's n values).