



**Neil Construction Ltd
Whenuapai Business Park Private Plan Change,
Whenuapai, Auckland**

Stormwater Management Plan

PLANNERS | SURVEYORS | ENGINEERS | ARCHITECTS | ENVIRONMENTAL

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Executive Summary

This Stormwater Management Plan has been prepared in support of a private plan change request by Neil Construction Limited (the Applicant) to the Auckland Unitary Plan Operative in Part (AUP). The plan change seeks to rezone approximately 47.57 hectares of land from Future Urban to Business – Light Industry. The plan change further seeks to apply precinct provisions to facilitate the transition from semi-rural land uses to the development of a light industrial business area in an integrated and comprehensive manner.

The Whenuapai 3 Precinct Stormwater Management Plan (W3PSMP) - prepared by 4Sight Consulting in 2017 in support of the Whenuapai Structure Plan - was used as the basis for this Stormwater management Plan (SMP). The principles of stormwater management from the W3PSMP were modified where required, based on site specific requirements and to align with the more stringent requirements of the regionwide Network Discharge Consent (NDC) Schedule 4.

Diversions and discharges of stormwater through the public network are permitted by the NDC provided that the discharges and network are authorised by a Stormwater Management Plan (SMP). For greenfield development, it is a requirement of the NDC that a SMP is notified with the plan change documents and meets the NDC requirements. The SMP is consistent with NDC Schedule 2 (which set out the NDC’s strategic objectives, outcomes, and targets) and Schedule 4 (the performance requirements). This SMP has been prepared to support the private plan change and the plan change is consistent with the SMP. The proposed precinct provisions implement the management and mitigation measures set out on the SMP.

Flood modelling assessments were completed in support of this SMP. The assessments concluded that the development of the Plan Change Area (PCA) into a Business – Light Industry zone will not result in significant increases in stream erosion or flooding risks. The stormwater management treatment train recommended for the PCA is shown in Figure 1. Full details of the proposed stormwater management for the PCA are outlined in Section 6 of this report.

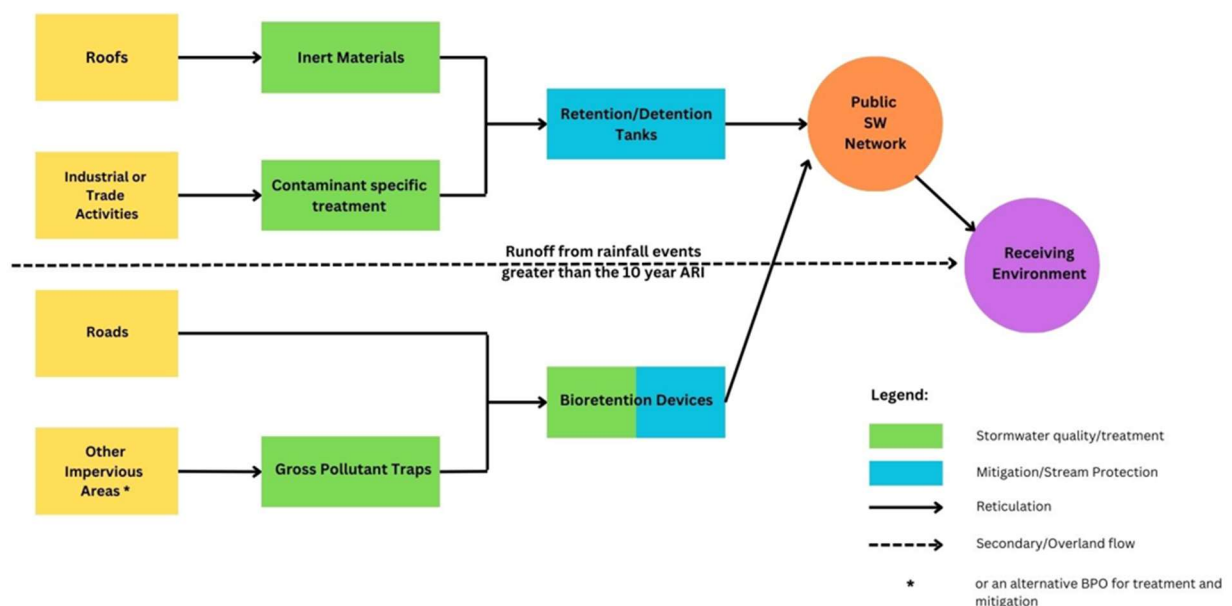


Figure 1: Proposed Stormwater Management Treatment Train

1.0 Existing Site Appraisal

The PCA is split into two catchments being PCA1 and PCA2. PCA1 is located to the east of Trig Road and enclosed by Trig Road to the west, Brigham Creek Road to the north and the Waiarohia Stream with an existing box culvert under Brigham Creek Road to the east. The box culvert conveys the flow from Waiarohia Stream to Waiarohia Inlet. One of the Waiarohia Stream tributaries (unnamed stream) crosses the PCA1 and flows from the south-western side of the site to the north-eastern side before discharging to the box culvert inlet. The PCA2 is located to the west of Trig Road and falls within the Whenuapai Catchment. The PCA2 discharges to Sinton Stream.

There is no existing public stormwater network in the area except for several circular culverts and the existing box culvert under Brigham Creek Road. Stormwater management measures are required to collect, treat, and convey the stormwater from the PCA to the receiving environment.

Investigations on the PCA was carried out and the data sources are summarised in the table below.

1.1 Summary of data sources and dates

Existing Site Appraisal Item	Source and date of data used
Topography	Topographic Survey by Neil Construction
Geotechnical / soil conditions	Geotechnical Investigation Report 2023 by CMW
Existing stormwater network	Survey by Neil Construction Ltd 2019-2023 Auckland Council GeoMaps data 2023
Existing hydrological features	Auckland Council GeoMaps data 2023
Stream, river, coastal erosion	Auckland Council GeoMaps Rivers and Streams layer 2023, Whenuapai Business Park Private Change Ecological Impact Assessment by Viridis Whenuapai Business Park Stream Assessment by Viridis Ltd dated 11 April 2024 Stream Erosion Risk Assessment by Cato Bolam Consultants Ltd dated 30 August 2024
Flooding and flow paths	Auckland Council GeoMaps overland flow path layer 2023 (but modified by recent Consented earthworks) Auckland Council GeoMaps floodplain layer 2023 Flooding and Flood Hazard Risk Report by Cato Bolam Consultants Ltd dated 2 August 2024
Coastal Inundation	Auckland Council GeoMaps Coastal Inundation Layer, 2023
Ecological / environmental areas	Auckland Council GeoMaps Significant Ecological Area Layer, 2023, Whenuapai Business Park Private Change Ecological Impact Assessment by Viridis
Cultural and heritage sites	Archaeological Assessment, by Clough & Associates Ltd September 2023
Contaminated land	Detailed Site Investigation by Geoscience Ltd 2020 and 2021. Preliminary Site Investigation for the PCA 2023.

1.2 Location and General Information

Existing site element	
Site Address	141 &145 Brigham Creek Road, 151-159 Brigham Creek Road and 69-73 Trig Road, 94 Trig Road, 96 & 96a Trig Road
Legal description	Lot 1 DP590594, Lot 2 DP590594, Sec 2 SO 528987, Lot 1 DP169384, Lot 1 DP114117, Lot 1 DP334953, Lot 1 DP167537 Lot 2 DP 334953, Lot 2 DP 101583, Lot 3 DP 101583, Lot 4 DP 101583, Lot 5 DP 101583, Lot 2 DP 117365
Current Land Use	Rural land (Future Urban Zone on Geomaps)
Current building coverage	Residential dwelling and sheds in 141,145, 151 BCR, Spark building in 153 BCR, houses at 96 and 96A Trig Rd
Historical Land Use	1950 -1963 Pastoral Land use 1972-1980 Pastoral Land Use with Dairy shed 1988-2017 Horticulture 2020-2023 Bulk earthworks completed on 94 Trig Road and parts of PCA1.

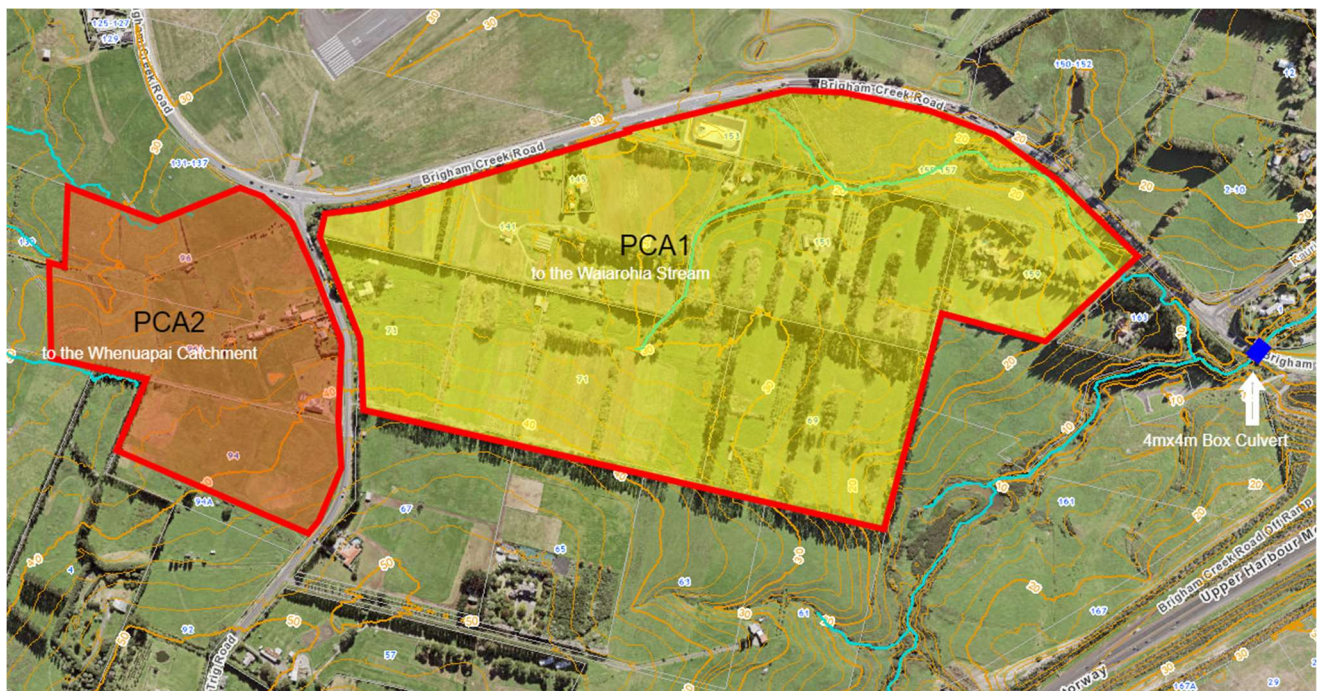


Figure 2: PCA Features

1.3 Topography

The existing landscape has a moderate slope with a ground slope that varies between 2% to 10% across the PCA. There are steeper areas that form the streambanks adjacent to the watercourses.

An unnamed stream within the PCA1 flows to the north-east and discharges to Waiarohia Stream. Sinton Stream originates within the north-west of the PCA2.

Bulk earthworks consents were approved and works carried out across more than half of PCA1, as well as 94 Trig Road in PCA2.

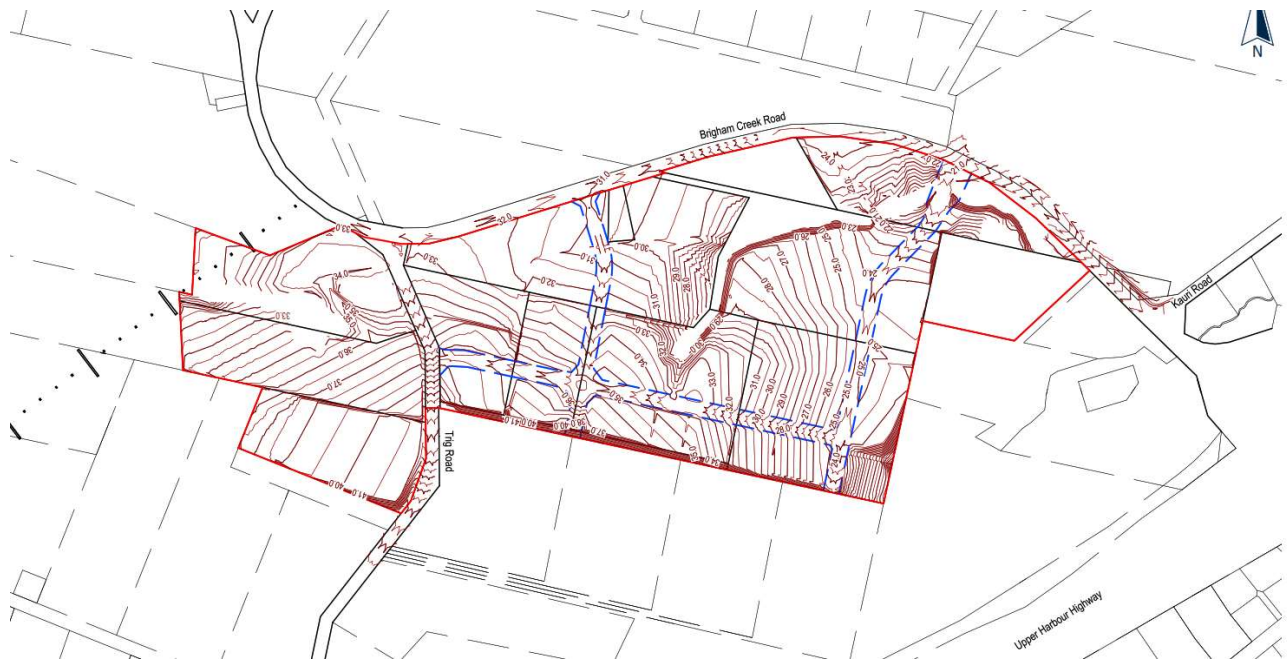


Figure 3 Preliminary Proposed Contours

1.4 Geotechnical

CMW Geosciences Ltd (CMW) was engaged to carry out a geotechnical investigation on the subject site and concluded that based on their hazard assessment, they consider that the land is generally suitable for creating stable building platforms and infrastructure, having acceptable levels of post-development residual risk from natural hazards.

Consideration of the key geotechnical hazards for each zone should be incorporated into Master Planning. Due to the presence of soft soils within 141 Brigham Creek Road this area is considered highly likely to be subject to load induced settlements. Therefore, it will require ground improvement beneath building platforms and/or specific foundation design.

During the site investigations, and recent earthworks undertaken within 94 Trig Road and 155 Brigham Creek Road, high groundwater levels have been recorded in some locations. Based on observations during the earthworks, it is likely that the higher levels encountered during the investigations are in fact sitting within a siltier/sandier layer perched on top of an impermeable clay lens. The lower groundwater depths measured elsewhere are more likely to be regional groundwater levels.

Shallow groundwater can potentially be mitigated by the installation of subsoil drainage, dependent on earthworks required for site development. Additional groundwater monitoring may be required to assess the need for take and diversion consents, again dependent on future proposed earthworks.

Development may require earthworks and drainage to provide adequate stability around the stream which runs through the site. This is achievable given appropriate design, and construction. Any proposed earthworks are to be undertaken in accordance with all relevant standards and documents. The engineering controls required to control existing, latent risks are commonplace works in this terrain that are consistent with those being adopted on adjacent land. Further site investigation and design will need to be undertaken to quantify the geotechnical controls prior to resource consent application and the commencement of any works.



Figure 4: Geotechnical test locations

1.5 Existing Drainage Features and Stormwater Infrastructure

There is no existing public stormwater infrastructure within the PCA or adjacent properties. The PCA and surrounding properties are naturally draining to the existing gullies and the streams. However, there are a few existing culverts under Brigham Creek Road that discharge to the PCA1.

1.6 Receiving Environment

Watercourses were classified in Whenuapai Business Park Private Plan Change Ecological Impact Assessment and Stream Condition Assessments prepared by Viridis Environment Consultants, shown as Figure 5.

The report found that the condition of the waterways within the PCA was good and that there was largely no evidence of erosion, scour or other bank damage. This includes a “before and after” comparison of the main stream using dated photos to assess any damage caused overtime and in particular by the early 2023 significant rain events.

1.6.1 PCA1 (Waiarohia Stream Catchment)

The runoff from the PCA1 discharges to Waiarohia Stream, which is fed by several tributaries.

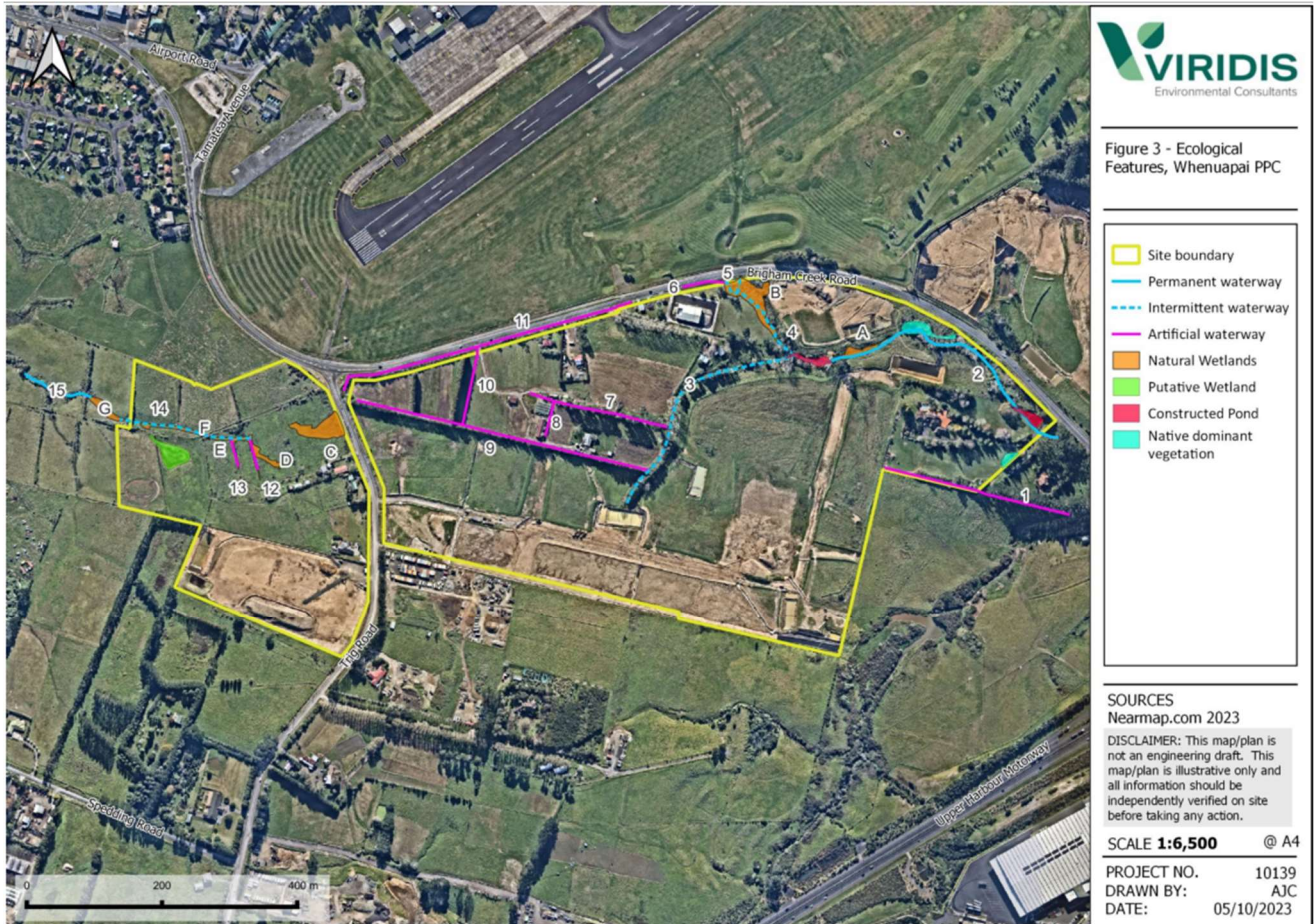


Figure 5: PCA Receiving Environment

The combined flow is conveyed through an existing 4m by 4m box culvert under Brigham Creek Road before discharging to Waiarohia Inlet and Upper Waitemata Harbour.

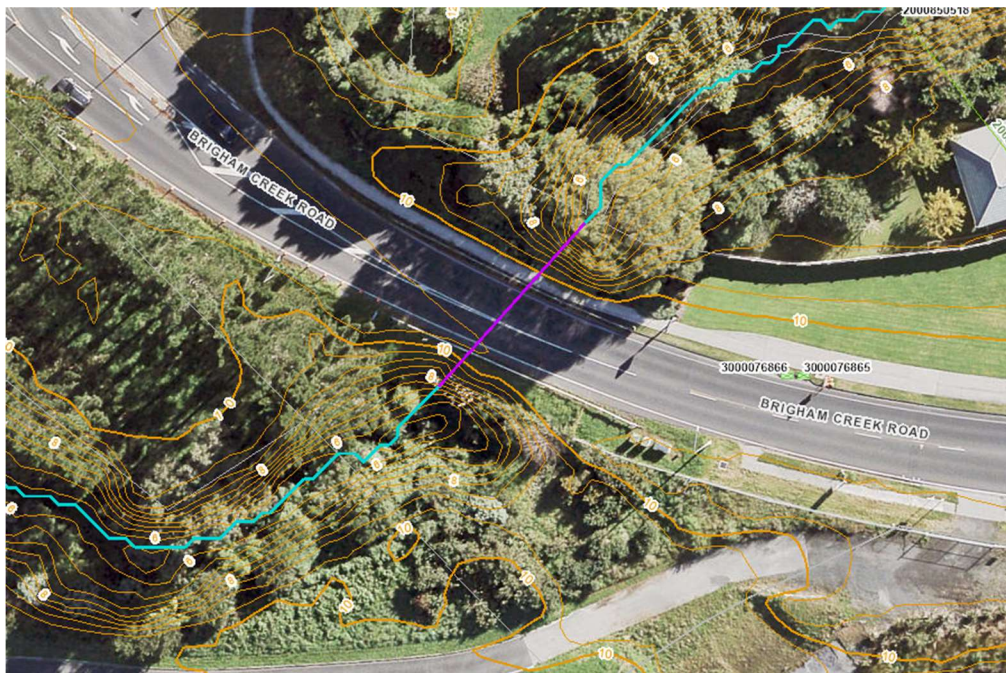


Figure 6: Downstream 4m Box Culvert (shown in purple)

1.6.2 PCA2 (Whenuapai Catchment)

The PCA2 to the west of Trig Road, is defined by several overland flow paths that discharge to Sinton Stream. Natural wetlands are identified in 96 Trig Road as shown in the Ecological Impact Assessment Report.

1.7 Existing Hydrological Features

The Ecological Impact Assessment undertaken by Viridis Environmental Consultants indicated that the extent of intermittent and permanent streams within the PCA is generally less than that identified by the Auckland Council GeoMaps overland flow path layer (>4000 catchments). Many of the minor overland flow paths appear to have been heavily modified/reclaimed. The waterways in PCA are described below.

PCA1:

Waterway 2 in the north-west of PCA1 is classified as permanent stream, which is an unnamed tributary of Waiarohia Stream.

Intermittent waterways 3, 4 and 5 are the upper reaches of waterway 2. Waterway 3 is fed by flows from a greater portion of PCA1 while the waterways 4 and 5 are partially fed by runoff from Brigham Creek Road and a stormwater management dry pond device in the RNZAF Base Whenuapai, through a natural wetland (wetland B) within the PCA1.

Another wetland (Wetland A) was identified within the flood plain of Waterway 2.

PCA2:

Intermittent Waterway 14 flows in the western direction from 96 Trig Road and discharges to another wetland (G) downstream of the western boundary of PCA2, before becoming a permanent stream.

Wetland C (which appears was caused by blocked road drainage) was found adjacent to the western side of Trig Road. Wetland D, E and F are all connected to each other.

There are also several artificial drains which are identified in both PCA1 and PCA2.

1.8 Flooding and Overland Flow paths

Auckland Council GeoMaps show the existing flood hazards and overland flow paths (OLFP) within and in the vicinity of PCA as shown in Figure 7.

A moderate overland flow path within the PCA1 dominates the middle and north-eastern sections, in the unnamed Stream. Minor overland flow paths are mainly present in the south-west and south-east of the PCA1. Flood prone areas are present to the north and east within 141 Brigham Creek Road, 155-157 Brigham Creek Road and 159 Brigham Creek Road. These shallow areas of flooding are caused by flat gradients in the existing agricultural fields. Development of these areas will resolve the shallow areas of flooding and secondary flow paths will be formed (in roads and channels as necessary) to control the flow and discharge them to the adjacent water course. No habitable floors are anticipated

in these areas. The flows from these minor OLFPs discharge into the unnamed stream and directly into Waiarohia Stream, respectively.

The unnamed stream merges with Waiarohia Stream at the inlet of the existing 4m box culvert under Brigham Creek Road. No flooding within PCA1 is an impediment to development.

PCA2 is characterised by minor flood plains to the south-west of the property at 96 Trig Road, with minor overland flow paths through three properties forming the PCA2. The Auckland Council GeoMaps show no flood prone areas within the PCA2. The flows from this area discharge into Sinton Stream within adjoining properties downstream. Potential Wetland C exists in the eastern section of 96 Trig Road, according to ecological assessment by others. This wetland appears to collect a portion of the runoff from Trig Road and discharge to Sinton Stream further downstream.

Flood modelling for the existing situation shows similar overland flow paths and flood plains pattern as those presented on Auckland Council GeoMaps. Any discrepancy can be attributed the use of more accurate survey information (which includes recent bulk earthworks) instead of the Geomaps data.



Figure 7: Flood Plain and Overland Flow Paths (from Geomaps)

1.9 Coastal Inundation

This is not applicable within this SMP as the coastal inundation extent with 2m Sea Level Rise (SLR) is further away from the subject site. A combination of coastal inundation with 2m SLR and the catchment rainfall was assessed. The results show that the subject site will not be affected, nor was the relevant section of the downstream environment (as far down as adjacent to the existing box culvert and 162 Brigham Creek Road).

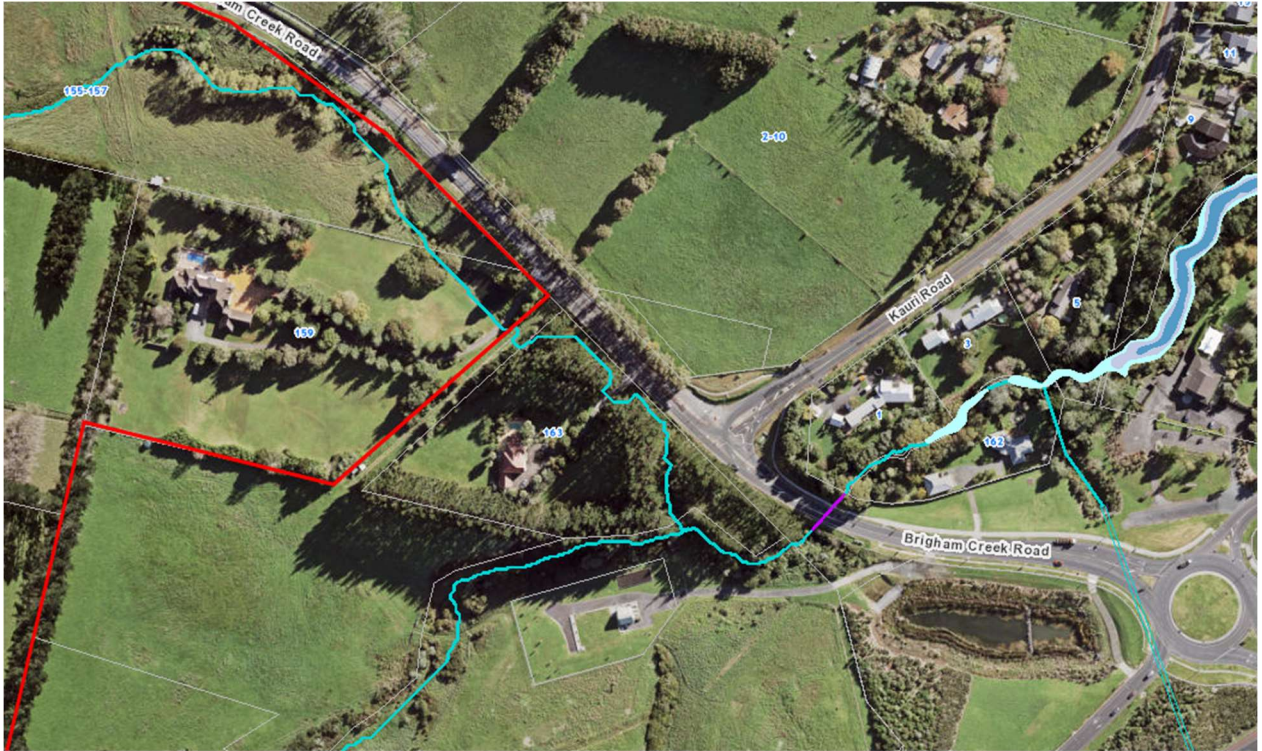


Figure 8: 1% AEP plus 2m sea level rise (light blue)

1.10 Biodiversity

There is no significant ecological area (SEA) shown on Auckland Council’s GeoMaps for the subject site or the surrounding area.

As stated in the Ecological Impact Assessment by Viridis, the ecological value of the permanent and intermittent waterways is moderate, and the ecological value of the wetlands are low except that wetland B was conservatively assessed as moderate due to the diversity of structure and presence of native species.

1.11 Cultural and Heritage Sites

Cultural and Heritage layer on Auckland Council GeoMaps and the archaeological assessments provided by Clough & Associates Ltd in 2019, 2020, and 2023 show that there are no cultural or heritage sites within the subject site.

1.12 Contaminated Land

The construction of bulk earthworks has been progressed at 69 Trig Road with 151 Brigham Creek Road, and 71 Trig Road under resource consent LUC60350837, LUC60376543 respectively. Geosciences Ltd (GSL) have completed the site validation report. Bulk earthworks are also progressing at 94 Trig Road under resource consent BUN60395603.

Geosciences Ltd (GSL) has undertaken detailed site investigation for the remaining properties within PCA. To date, earthworks have been carried out over an area greater than 20 hectares with only minor contamination having been identified and disposed of at an appropriate disposal facility.

2.0 Development Summary and Planning Context

2.1 Regulatory and Design Requirements

The Auckland Council Regional Stormwater Network Discharge Consent (NDC) is a key tool for managing and integrating land uses, stormwater discharges and the region’s natural water assets to mitigate impacts from climate change and flooding and allow multiple community and environmental outcomes to be realised. The NDC provides a pathway for “greenfield developments” such as this one to be included under it, subject to a Stormwater Management Plan (SMP) being prepared and approved by Council in accordance with Schedule 4 of the NDC, which addresses the requirements set out in Figure 9 relating to:

- Water Quality
- Stream Hydrology
- Flooding: 10% AEP property/pipe capacity
- Flooding: 1% AEP – building

These requirements are addressed in this report.

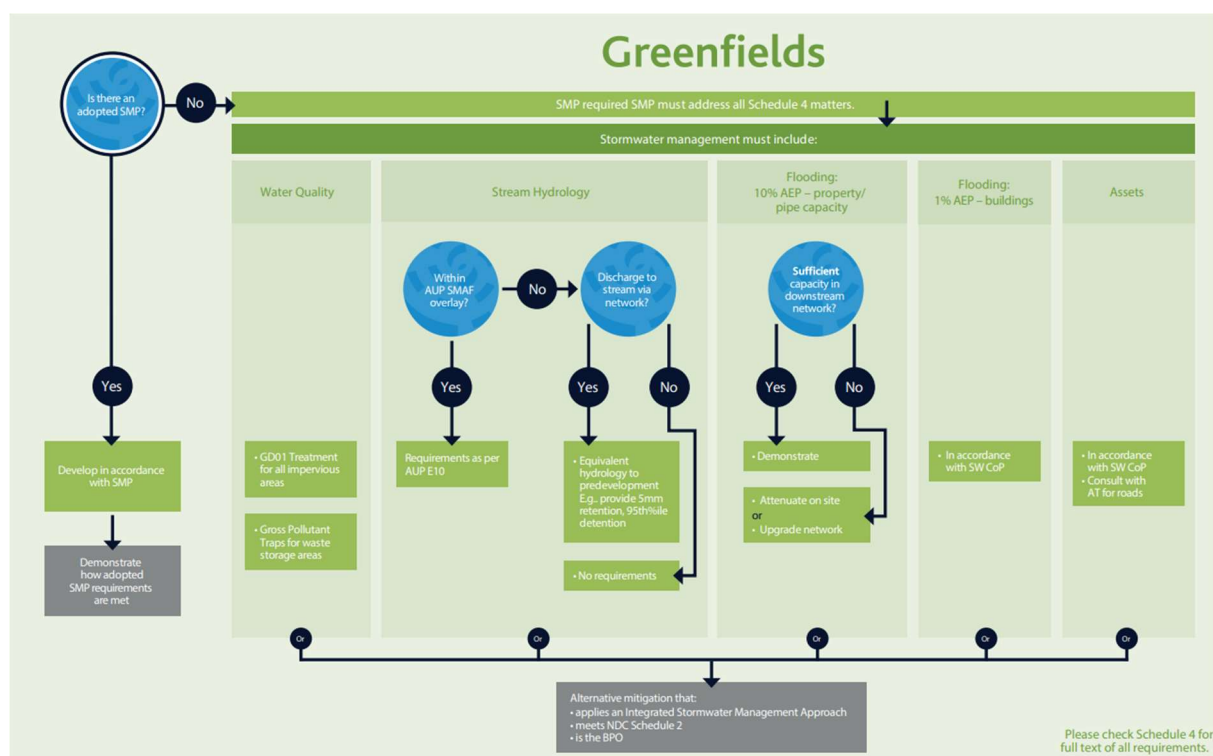


Figure 9 NDC Schedule 4 Requirements for Greenfields

This SMP has been prepared in accordance with the Auckland Council Regional Stormwater Network Discharge Consent. However, if this approach is not accepted by Council, the alternative approach would be to apply for a private stormwater discharge consent instead. Similar stormwater management requirements would apply to this situation as for the NDC SMP approach. Hence, the design principles adopted here apply to both situations. The stormwater management requirements are listed in section 6.2.

3.0 Mana Whenua Matters

3.1 Identification and Incorporation of Mana Whenua Values

A cultural impact assessment (CIA) for part of the proposed development in PCA1 was prepared by Te Kawerau ā Maki. The CIA indicates that the stream is the key cultural feature of the site requiring protection. Site walkovers and consultation were conducted with Te Kawerau ā Maki as part of a previous Fast Track Consent Application, and a Bulk Earthworks Consent granted for 94 Trig Road.

The proposed design is formulated in compliance with the recommendations in Auckland Council's Guidance Document GD01 and GD04 to incorporate Mana Whenua values.

- Provide hydrologic mitigation to reduce run off from extensive impervious areas.
- A riparian margin will be created with a 10m set back from the top bank of the stream and restored with native riparian planting 10m wide either side of stream.
- Provide treatment to the runoff from the roads.

4.0 Stakeholder Engagement and Consultation

Stakeholders	What is the reason for interest	What engagement has been completed	Feedback and response
Auckland Council including AT, Parks	All matters related to the Land-use and Private Plan Change Application	Meetings, Email correspondence	Stream to be protected/enhanced. Align the PCA with the NDC-SMAF1 requirements
Auckland Council – Healthy Waters	Guidance regarding requirements for stormwater treatment and detention requirements for the Private Plan Change Application	Meetings	A site-specific stormwater management plan to be consistent with Whenuapai 3 Precinct Stormwater Management Plan September 2017. Best Practicable options are to be considered. On-site detention and retention are to be provided as per SMAF1 Controls requirement. Raingardens should be used on road reserves. Where applicable treatment device such as stormfilter and GPT system should be used. Provide flood modelling results to demonstrate that there is no increase in flood risk.

<p>Te Kawerau ā Maki</p>	<p>Te Kawerau ā Maki is an iwi with customary interests that extend from Hikurangi (West Auckland), east through the Tāmaki Isthmus, and north through lands around the upper Waitematā Harbour and North Shore (Te Whenua roa o Kahu), and into the south Kaipara and Mahurangi. Te Kawerau ā Maki interests also extend into the Hauraki Gulf including islands such as Tiritiri Matangi.</p> <p>Te Kawerau ā Maki hold mana whenua or customary rights in particular over Hikurangi and the upper Waitematā which is the heartland of the iwi and where it asserts lead cultural interests. Te Kawerau ā Maki have shared whakapapa with many other hapū and iwi who also have overlapping customary interests in these areas, though our take whenua (specific land rights) and take moana (specific water rights) may differ in nature and location.</p>	<p>Te Kawerau ā Maki was consulted in regard to a Whenuapai Business Park FTCA application for an industrial development on part (22ha) of the plan change area. Engagement included a Site walk over, completion of a Cultural Impact Assessment and consultation on the location and design of a wastewater pumping station.</p>	<p>The recommendations within the Te Kawerau ā Maki Cultural Impact Assessment from September 2021 (covering 22ha of the PPC area) were considered in the design of the proposed stormwater management system. Key recommendations relating to stormwater included:</p> <p>The adoption of a combination of on-site detention/retention tanks, tree pits/rain gardens, vegetated swales, proprietary devices or other methods such as to develop a secondary or tertiary (three-step) stormwater treatment process for the development.</p> <p>A summary of impacts listed within the CIA and proposed mitigation is provided below:</p> <p>Te Wai te matā o Kahu</p> <p>Summary of impact:</p> <ul style="list-style-type: none"> • Direct, indirect, and cumulative temporary and permanent adverse from stormwater discharge carrying sediments and contaminants • Potential combined neutral-beneficial impact if stream and ecological
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			<p>enhancement works undertaken and robust stormwater systems in place</p> <ul style="list-style-type: none"> Proposed mitigation: Undertaking stream and wetland protection and restoration works within the property footprint, employ a 100% native vegetation palette for all street planting/public spaces, and will install a mixture of tree pits, vegetated swales, proprietary devices, and retention/detention tanks for stormwater treatment <p>Te Waiarohia o Ngariki (and tributaries)</p> <p>Summary of impact:</p> <ul style="list-style-type: none"> Direct, indirect, and cumulative temporary and permanent adverse from installation of drainage pipes/infrastructure, discharge of stormwater, and domestic contaminant discharges <p>Proposed mitigation:</p> <ul style="list-style-type: none"> Stormwater management and sediment controls during construction phase, use a combination of raingardens grassed swales proprietary devices and detention/retention tanks to treat stormwater/allow infiltration, use riprap at the stormwater outfalls to prevent
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			<p>scouring, and 10m riparian yard establishment with weed management and native enhancement planting</p> <p>Aquatic Fauna Summary of Impact:</p> <ul style="list-style-type: none"> • Direct, indirect and cumulative temporary and permanent adverse from loss of small areas of riparian vegetation to accommodate outfalls, construction disturbance to instream features while installing outfalls/infrastructure, sediment discharge during construction, stormwater and contaminant discharge from roading and private activities (e.g. washing vehicles, spraying round-up). <p>Proposed mitigation:</p> <ul style="list-style-type: none"> • Stormwater management and sediment controls during construction phase, use a combination of raingardens grassed swales proprietary devices and detention/retention tanks to treat stormwater/allow infiltration, use riprap at any stormwater outfalls to prevent scouring, and 10m riparian yard establishment with weed management and native enhancement planting
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5.0 Proposed Development

The plan change seeks to rezone approximately 47.57 hectares of land from Future Urban to Business – Light Industry. The plan change further seeks to apply precinct provisions to facilitate the transition from semi-rural land uses to the development of a light industrial business area in an integrated and comprehensive manner.

Details about the PCA's proposed development are currently focused on proposed road layouts and upgrades to existing roads. Finalised versions of conceptual lot arrangements and earthwork designs have yet to be established and are anticipated to undergo changes at resource consent stage. Consequently, these plans are not included in this report. This SMP has been developed in support of the plan change application. Information presented in this section will, therefore, be generalised at best and have a limited impact on the proposed stormwater management at this stage. Detailed design must be based on the principles outlined in this SMP.

Three new roads are proposed and generally positioned as previously discussed with AT, which includes three new intersections with existing roads. Upgrades to Brigham Creek Road and Trig Road are also proposed, including an upgrade/repositioning of the Trig Road/Brigham Creek Road intersection.

5.1 Location and Area

The PCA includes the following properties in Whenuapai:

- 141 Brigham Creek Road
- 145 Brigham Creek Road
- 151 Brigham Creek Road
- 153 Brigham Creek Road
- 155-157 Brigham Creek Road
- 159 Brigham Creek Road
- 69 Trig Road
- 71 Trig Road
- 94 Trig Road
- 96 Trig Road
- 96A Trig Road

The total developable area is approximately 36 hectares of the 47.6 hectares of total area. There is a potential Gross Floor Area of 15.1 hectares.

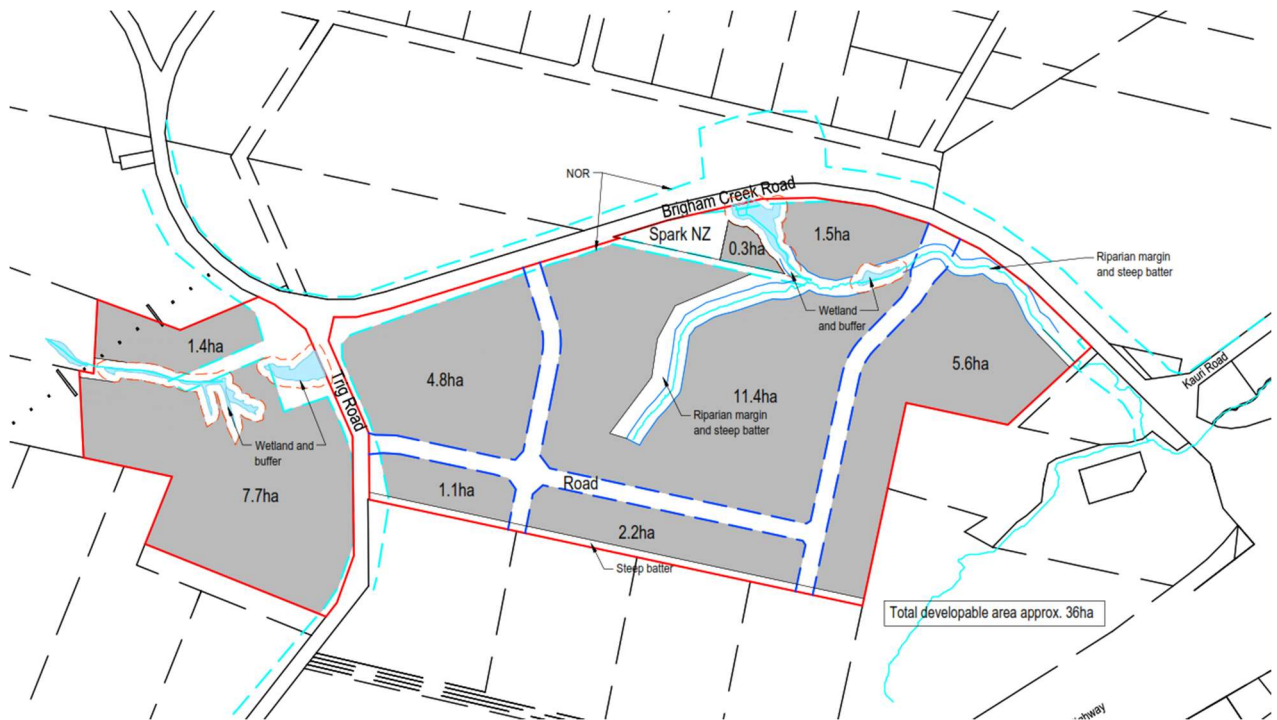


Figure 10: Plan Change Developable Area

5.2 Purpose of the Development

The proposed development is planned for Business – Light Industry. This SMP is prepared in support of a plan change application, not a specific development. As such, no accurate information is currently available on lot specific development plans. It is estimated that about 15ha of gross floor area could be accommodated. New roads and road upgrades, wetland protection and riparian margins/ecological enhancement are included in the proposed PCA. This SMP sets out requirements for stormwater management which are suitable for Business – Light Industry and for public road networks in accordance with Schedule 4 of the NDC.

5.3 Site Layout and Urban Form

Further information will be provided on the urban form at a later stage during the consenting process for subdivision and/or individual developments.

5.4 Earthworks

Further information will be provided on the remaining earthworks during the resource consenting process for individual lot developments. Approximately 20 ha of land has been modified under existing earthworks consents.

6.0 Stormwater Management

6.1 Principles of Stormwater Management

6.1.1 Original Principles

The stormwater design principles adopted for the subject site are consistent with regulatory guidelines, and Guideline Document 2015/004 Water Sensitive Design for Stormwater, and with reference to AUP chapter E1. More specifically, they include:

- Inter-disciplinary planning and design – Engineering design and planning were undertaken simultaneously, including specialised input from land surveyors, ecologists, geotechnical and contamination specialist so that one may inform the other, and to identify risks at the earliest opportunity.
- Protect and enhance the values and functions of natural ecosystems. The PCA was identified as being appropriate for the area from an ecological perspective. Riparian margins are proposed to be created with 10m set back from the top of bank of the stream and wetlands.
- Address stormwater effects as close to source as possible – The runoff from impervious areas shall be treated and mitigated prior to discharging to the receiving environment.
- Mimic natural Systems and processes for stormwater management – The restoration of the existing stream integrated with the proposed treatment of impervious surfaces and roads will promote the ecological values.

6.1.2 Updated Principles

Not applicable within this SMP.

6.2 Proposed Stormwater Management

6.2.1 General

The proposed stormwater management is generally consistent with the requirements of the Auckland Council Regional Stormwater Network Discharge Consent. The approach comprises:

- The primary stormwater networks shall accommodate the runoff from the 10% AEP storm event for the Maximum Probable Development (MPD) scenario with climate change accounted for. The MPD allows for the maximum impervious surface limits of the current zone or, if the land is zoned future urban in the AUP, the probable level of development arising from zone changes. The maximum impervious area is not limited in the light industrial zone but in practice, areas of green space will be required for stormwater treatment and detention as well as mandatory landscaping on buffer areas, front yards and unbuildable land near riparian margins.
- The stormwater mitigation requires to provide retention for 5mm runoff depth from the impervious areas and provide detention for the difference between the pre-development and post-development runoff volumes from the 95th percentile 24 hours rainfall event minus the retention volume.

- Treatment systems shall be provided to treat the runoff from impervious surfaces (excluding inert roofing) in accordance with GD01/TP10 for the relevant contaminants.
- The existing and proposed overland flow paths shall be managed or re-routed to avoid any detrimental effects to the neighbouring properties and downstream environment. The locations of the overland flow path entry and exit points from the PCA shall not be altered without resource consent.
- Removal of existing culverts and reinstating the stream bed to restore the waterways are proposed to promote ecological and biodiversity values. Future development will be set back at least 10m from the top of bank of the stream. Riparian planting is to be established 10m either side of the stream and wetland. Green outfalls will be incorporated where practicable and shall be considered carefully during the detailed design of the future stormwater network in the Resource Consent and Engineering Approval stages. Works in the stream will be required to remove existing culverts, to remove an artificial area of ponding, to construct one or more bridges and to complete the planting in the stream and riparian margins.
- The following diagram describes the proposed treatment train:

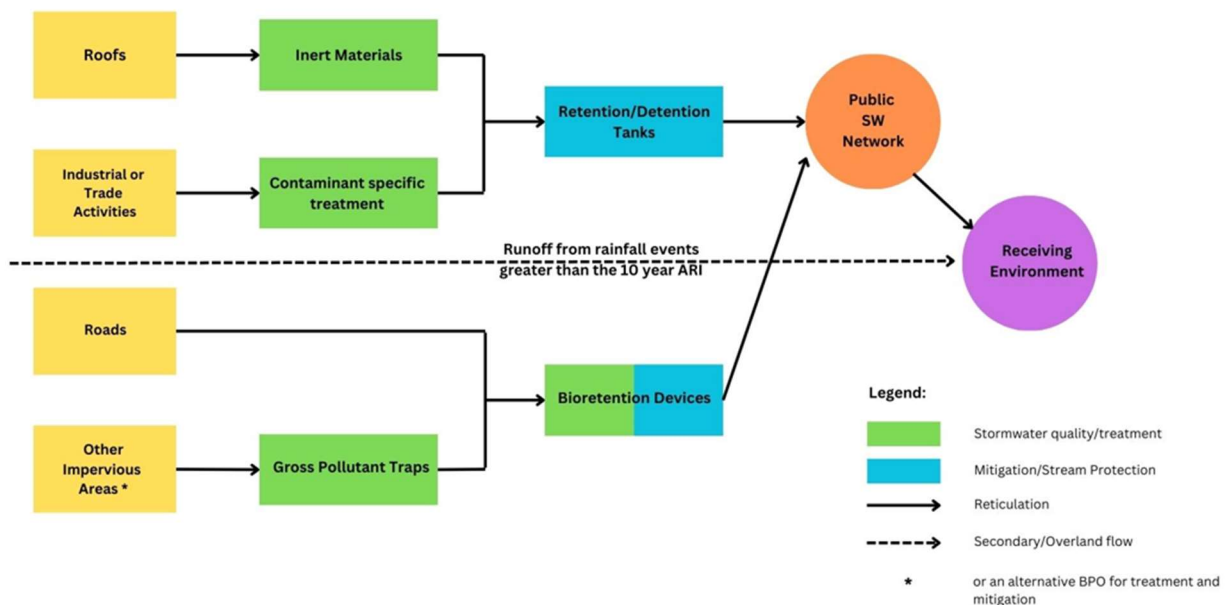


Figure 11: Proposed Stormwater Management Treatment Train

6.2.2 Stormwater Quality Management Device Selection

A variety of water quality treatment options were considered for the development. The suitability of devices was considered as shown in Figure 12 below:

	Light Industry/Commercial		
	Roofs	Impervious Surfaces/Parking	Roads
Bioretention	Not Needed	Very Suitable	Very Suitable
Re-use Tanks	Very Suitable	Not Suitable	Not Suitable
Detention Tanks	Very Suitable	Very Suitable	Not Suitable
Swales	Somewhat Suitable	Very Suitable	Very Suitable
Dry Detention Basin	Somewhat Suitable	Somewhat Suitable	Somewhat Suitable

Figure 12: Stormwater Device Suitability

Treatment shall be provided within the future individual lots for all impervious areas (excluding clean roof runoff) by water quality devices designed in accordance with GD01/TP10 for the relevant contaminants.

The poor infiltration rate of the in-situ soil limits the hydrological mitigation functions of bioretention devices to detention only, as the available infiltration is likely to be insufficient to allow for retention through infiltration.

Furthermore, the occupancy level in some of the future Lots may be too limited to make use of re-use tanks. Where re-use tanks are not deemed suitable, the re-use volume shall be allowed for as additional detention volume in the roof tanks.

Created Wetland ponds are not appropriate to provide treatment for the PCA due to the potential of bird-strike issues at the Whenuapai Airbase. Open water or new bird habitats (within stormwater management devices) are to be prohibited to limit an increase in bird life in the area. Large detention/wetland basins, if selected, shall be constructed as “dry basins”.

Due to the varied topography and natural features, a variety of devices are likely to be utilised to provide treatment and mitigation of runoff from road surfaces. Bioretention raingardens and swales are likely to form the bulk of the management devices within the road reserves. A larger dry treatment/detention basin can be used on the south of Brigham Creek Road. Sections of the Brigham Creek Road upgrade may be too constrained to provide treatment and mitigation devices. In such cases, treatment and mitigation of an equivalent existing (and untreated) impervious area within the same catchment (or BPO approach) shall be provided.

Riparian planting 10m either side of the stream will also provide the filtration of surface runoff to assist with the reduction of contaminants and sediment entering waterways.

Green outfalls where practicable shall be incorporated at detailed design during the Resource Consent and Engineering Approval stage/s. Green outfalls comprise a riprap section to reduce the velocity of

discharge, and a planted channel section to provide further treatment before the discharge enters the stream.

The measures discussed above are compatible with the road upgrades proposed by Strategic Growth Alliance (SGA) as represented by their design/Notice of Requirement. The SGA design allows to use a dry pond in the NZ Defence Force to the north of Brigham Creek Road, and another basin to the west of the Trig Road/Brigham Creek Road intersection. It is unlikely that the design envisioned by SGA will be constructed prior to the development of the PCA. As such, devices as discussed above, or dry ponds/basins constructed in the PCA will manage the runoff from road surfaces once fully upgraded, as well as partial upgrades to enable the development of the PCA.

6.2.2.1 Structural Stormwater Management

- Bioretention treatment devices
- Erosion protection at outlets and Green Outfalls
- Gross pollutant traps or screens at inlets

6.2.2.2 Non-Structural Stormwater Management

- Provision of Riparian Margins/planting
- Incorporating Green Outfalls
- Protection and enhancement of existing streams
- Erosion and Sediment controls during construction activities.

6.2.3 Stream Hydrology

The creation of impervious surfaces in a catchment increases the flow rate and volume of stormwater runoff. This change in hydrology, unless managed, can have a significant adverse effect on streams within the catchment, including accelerating river and stream erosion and bank instability, and creating hydrological conditions that do not support healthy aquatic ecosystems.

To mitigate the increased impervious surfaces created by the proposed roads, bioretention (raingardens or swales) are proposed to provide the required detention for the difference between the pre-development and post-development runoff volumes from the 95th percentile 24 hours rainfall. According to the advice provided by CMW Geosciences, the percolation rates from the test are below 2mm/hr. Therefore, the required retention for the impervious area in the road reserve shall be compensated within the proposed detention volume.

Within future lots, retention and detention volumes shall be provided in private stormwater devices such as tanks, bioretention (raingardens), filters or other appropriate devices during the development of individual lots in the future. The detention and retention volumes shall be calculated in accordance with GD01 and the Auckland Council Unitary Plan.

Stormwater outlet structures shall be set back from the stream. Riprap protections shall be provided to minimise the erosion. Multiple stormwater outlets shall be used where feasible to minimise the peak flows at discharge points while maintaining the water balance to streams.

Stream works including removal of the existing culverts and reinstating the stream beds to restore the waterway and riparian planting to mitigate the adverse effects of runoff from the development are proposed.

6.2.4 Flooding 10% AEP event (Network capacity)

There is no existing public stormwater reticulation within the PCA.

New public stormwater networks shall convey the 10% AEP flow from the PCA for the Maximum Probable Development (MPD) scenario. Climate change shall be accounted for in accordance with the Auckland Code of Practice for Land Development and Subdivision.

6.2.5 Flooding 1% AEP event (Habitable Floors)

Flood modelling was undertaken to assess the flooding effects on downstream environment and neighbouring properties in support of the Plan Change application. The post-development flood effects were assessed for the 1% AEP, 10% AEP and 50% AEP storm events, 24 hours using HEC RAS 2D software. These rainfall depths account for future climate change based of 3.8°C and in consultation with Healthy Waters. The 3.8°C climate change allowance exceeds the 2.1°C climate change required to be allowed for in the currently published Code of Practice (SWCoP v3) and is considered conservative. 3.8°C climate change is considered the worst-case scenario that will occur by the year 2100. The rainfall depths are summarised in Table 1.

Table 1: Rainfall Depths and Climate Change Increase at 3.8°C			
Storm Events	Existing TP108 Rainfall Depth (mm)	Climate Change Increase (%)	TP108 Rainfall Depth + CC (mm)
1% AEP	200	32.7	265
10% AEP	135	30.8	177
50% AEP	85	27.4	108

Hydrograph precipitation generated from TP108 using HEC HMS was utilised in HEC RAS rain on grid modelling.

The impervious areas for the proposed plan change are based on the Maximum Probable Development (MPD) being mainly the anticipated future Business Light Industry Zone.

A catchment area of 410ha was considered in the model to assess the effects on the existing 4m box culvert under Brigham Creek Road.

The flood assessment results indicate that the flood extent resulting from future development of the PCA (PCA1 and PCA2), are generally contained within the respective stream channel or riparian margin area. The difference in flood extents within the PCA between the predevelopment and post development with climate change in MPD situation is not significant.

The post-development flooding effects on Brigham Creek Road at the existing 4m box culvert (adjacent to the Kauri Road intersection) were assessed for the 1% AEP storm event allowing for climate change. The culvert is shown to have capacity to convey the 1% AEP storm event including the additional flow resulting from the development of the PCA. The flood extents remain very similar to the pre-development scenario and the effect on adjacent properties is less than minor.

The flood effects on other sections of Brigham Creek Road which will be utilised to convey the 1% AEP flows, will be less than minor. The flood depths within the proposed public roads shall comply with the Auckland Council (Auckland Transport) requirements.

No habitable floor levels are affected by 1% AEP flood due to developing the PCA. The flood depth around the existing building at 162 Brigham Creek Road (adjacent to the culvert inlet) will remain unchanged in the post development scenario at 50% culvert capacity. The building is positioned adjacent to the existing flood plain, however, the floor level (RL9.13) is above the modelled flood level (RL9.08) when the box culvert is 50% blocked in 1% AEP storm event with 3.8°C climate change.

Table 2: Flooding at Existing House at 162 BHC Rd (3.8°C Climate Change)				
Scenarios	House Flood Levels (m)	Garage Flood Levels (m)	House Current FFL (m)	Garage Current FFL (m)
100% Culvert Capacity existing	9.08	8.9	9.13	8.70
50% Culvert Blockage Existing	9.08	9.0	9.13	8.70
100% Culvert Capacity PCA Only Post Developed	9.08	8.9	9.13	8.70
50% Culvert Blockage PCA Only Post Developed	9.08	9.0	9.13	8.70

Due to the PCA being positioned in the lower half of the catchment and having a less than minor impact on the flood risk on Brigham Creek Road, and no impact on downstream habitable floor levels (even when using highly conservative approach), mitigation of additional 1% AEP flow in PCA1 is not recommended.

The flood plain within Sinton Stream, downstream of PCA2, is contained within the stream banks and no habitable floors will be affected by the 1% AEP flow from the site. However, the stormwater network shall be designed in accordance with the stormwater code of practice to convey the 10% AEP flow before discharging to the respective stream.

6.2.6 Flooding outside the PCA

The impact of the proposed change of land use on land and structure downstream of the PCA was assessed for the 2, 10 and 100 year rainfall events with and without climate change. The results demonstrate that no habitable floors are affected outside the PCA in any of the modelled scenarios. The properties considered include:

- 131-137, and 139 Brigham Creek Road
- 161 and 163 Brigham Creek Road
- The Watercare pump station at 161 Brigham Creek Road
- The 4m box culvert at Brigham Creek Road (adjacent to the Kauri Road intersection)

6.2.6.1 131-137, and 139 Brigham Creek Road

The properties at 131-137 and 139 Brigham Creek Road with those within PCA are at the upstream end of the catchment. The flood assessment carried out for the 50% AEP storm, 10% AEP storm and 1% AEP storm demonstrates that the flooding effects over 131-137 Brigham Creek Road will be considerably improved as the post-development flow (0.08m³/s) discharging to this site will be reduced by 0.50m³/s compared to the flow (0.58m³/s) in the pre-development scenario for a 1% AEP storm.

The flow that will discharge to 139 Brigham Creek Road will increase from predevelopment flow of 2.87m³/s to 3.52m³/s. The flow increases by 0.65m³/s compared to the predevelopment. However, the 1% AEP flow increase will be contained within the flow channel. No habitable floor is expected to be affected by the 1% AEP post development flow. The effect on this property is less than minor. Refer to the Flood and Flood Hazard Assessment report prepared by Cato Bolam in support of the plan change.

6.2.6.2 161 and 163 Brigham Creek Road

The results demonstrate that no habitable floors are affected outside the PCA in any of the modelled scenarios and the effect of the proposed development in the PCA on downstream flooding is minor regarding the driveway at 161 and 163 Brigham Creek Road, and less than minor elsewhere.

The modelled flow generally remains in the stream channel or riparian, except for at the vehicle crossings to 61 and 63 Brigham Creek Road where the existing culverts are under capacity and the driveways are overtopped.

The results indicate that the driveways at 161 and 163 Brigham Creek Road will not be accessible for a period of time in both pre-development and post-development scenarios during the 1% AEP storm event. Mitigation options include:

- Flood warning signage could be provided along the driveways to warn traffic and pedestrians of the flood depth if present. Residents and visitors shall avoid accessing this location until the water has receded. It is noted that the affected areas are largely part of land designated for road upgrades and subject to Notice of Requirement.
- The existing culverts are shown to be under capacity in pre-development assessments. Upgrading the culverts (provided property owner approval is provided) to convey the additional flow resulting from development in the PCA would reduce the risk of access being limited due to flood water. Installing 1800mm diameter culverts would convey the additional flow up to the 100year storm which includes an additional 20% capacity to allow for partial blockage.

6.2.6.3 Watercare Pump Station

The pump station is located within an existing flood plain and within an identified flood prone area. The flood levels in the flood prone area appears to be set by Brigham Creek Road if the 4m box culvert is blocked. The development has a less than minor effect on the flood water adjacent to the pump station.

When the existing culvert is fully operational, the 1% AEP water level increases by between 10mm (excluding climate change to assess the impacts of the development itself) and 30mm (allowing for climate change) adjacent to the pump station in the post-development scenario. This effect is considered less than minor.

6.2.6.4 Box Culvert

The post-development flooding effects on Brigham Creek Road at the existing 4m box culvert (adjacent to the Kauri Road intersection) were assessed for the 1% AEP storm event allowing for climate change. The culvert is shown to have capacity to convey the 1% AEP storm event including the additional flow resulting from the development of the PCA. The flood extents remain very similar to the pre-development scenario and the effect on adjacent properties is less than minor. Discharge from the 1% AEP storm appears to be contained within the stream channel and riparian margin downstream of the culvert without affecting any habitable floor levels.

6.2.7 Overland Flow Path and Floodplain Management

Overland flow paths within the entire PCA (PCA1 & PCA2), will depend on the final contours during the future subdivision and building design. The purpose of this flood assessment is to inform the stakeholders and to demonstrate that the flood hazard within the PCA, can be managed efficiently to minimise the flood effects on the surrounding properties and downstream environment in support of the plan change application. The flood assessment was carried out for the pre- and post-development situations for 50% AEP, 10% AEP and 1% AEP storm events with 3.8°C Climate Change as shown in Figure 13 and Figure 14. The existing and future public or private roading with multiple channels within the PCA, should be utilised to convey the overland flow where possible as shown in Figure 14. The proposed overland flow paths and the flood results in the PCA shall be used as guidance to ensure that the effects on future buildings, infrastructure and downstream environment are eliminated or minimised.

The HEC-RAS model results demonstrate that the extent of the 1% AEP floodplains for the post-development situation are contained within the stream banks or riparian margin area, road reserves and the proposed flow path channels. Detrimental effects to the neighbouring properties or downstream environment is minor where flow overtops two driveway crossings due to under capacity culverts, and less than minor elsewhere.

Overland flows from storm events greater than 10% AEP shall be diverted to the proposed overland flow paths. It is also recommended that the earthworks should not be carried out within the riparian margin areas unless it is for public infrastructure and flood hazard mitigation reasons.

Future buildings shall be located outside of the floodplains and be provided with a minimum freeboard above the 1% AEP overland flow levels in accordance with the Auckland Council's Stormwater Code of Practice, NZS4404, and the New Zealand Building Code. The entry points and the exits points of the existing overland flow paths shall not be altered.

The future bridges over the unnamed stream within PCA1 shall be designed to convey the 1% AEP post development flow at 3.8°C climate change or current code of practice subject to approval by Auckland Council, while allowing the required freeboard.

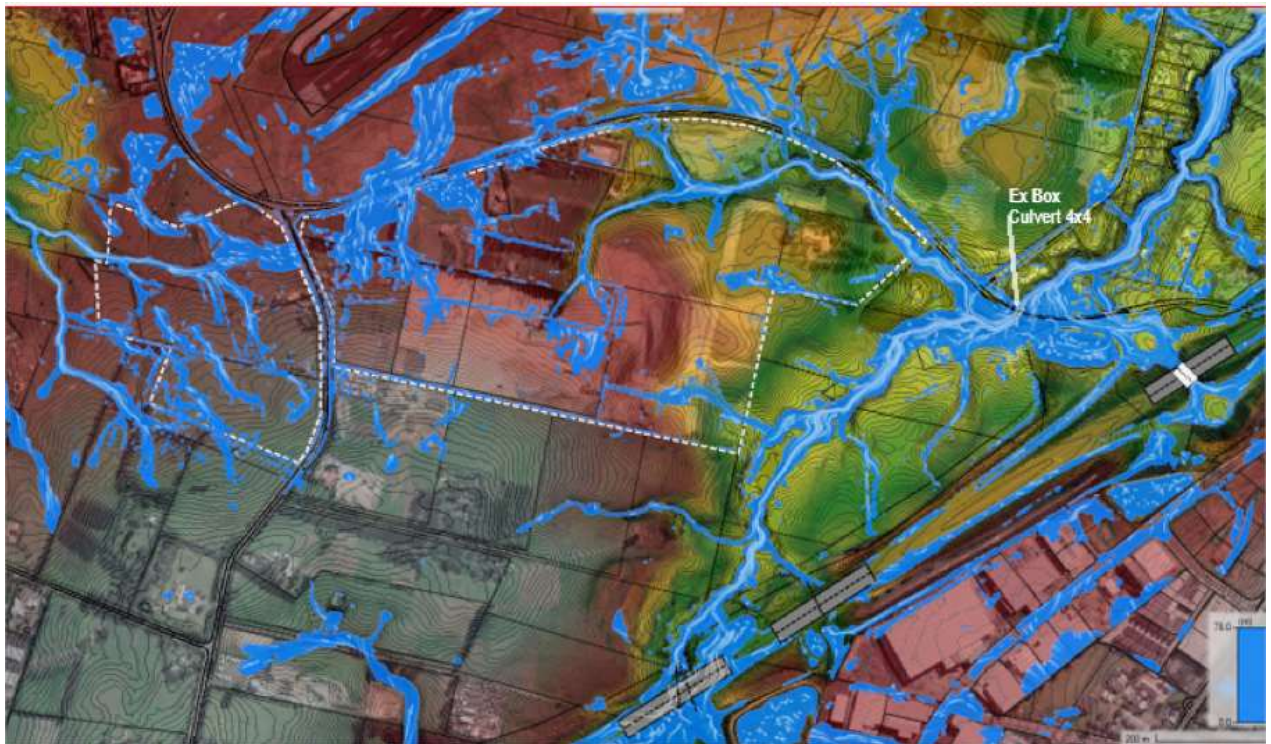


Figure 13: Existing Flooding within PCA with 3.8°C Climate Change



Figure 14: Future Flood Management within PCA with 3.8°C Climate Change

6.2.8 Development Staging

The stormwater reticulation within the PCA shall be designed to cater for the 10% AEP storm event flow from the development for the MPD scenario. Overland flow paths and flooding risk in the 1% AEP storm event are also assessed for MPD scenario. The climate change factor (as specified in section 4.2.10 of the Auckland Code of Practice for Land Development and Subdivision) has been accounted for in the stormwater assessment.

During the future development of the individual lots, private stormwater networks shall be designed to service the Lot.

Private stormwater devices for on-site retention and detention shall be provided during individual lot development. Stormwater devices such as tanks, bioretention (raingardens) or approved similar devices should be used. Retention volume shall be provided for at least 5mm of runoff depth from impervious surfaces with detention volumes being the difference between the pre-development and post-development runoff volumes from impervious surfaces in the 95th percentile, 24 hours rainfall event minus the achieved retention volume. Treatment shall be provided within the individual lots for all impervious areas (excluding inert roof areas) by water quality devices designed in accordance with GD01/TP10 for the relevant contaminants.

6.3 Hydraulic Connectivity

Public stormwater reticulations shall be designed to convey the 10% AEP runoff from the development. The runoff from the impervious areas of proposed roads shall be collected by the cesspits after treatment in raingardens or other selected devices before discharging to the public stormwater network.

6.4 Asset Ownership

- Public stormwater reticulation is to be vested in Auckland Council. This includes stormwater pipes, manholes and outlet structures.
- Cesspits, raingardens, and bioretention treatment devices in road reserves are to be vested in Auckland Transport.
- Devices within the future lots will be privately owned and maintained by the respective owners enforced by consent notices.

6.5 Ongoing Maintenance Requirements

All public stormwater management devices proposed within the plan change area will be designed in accordance with Auckland Council guidelines and standards and vested to the Council on completion. The operation & maintenance required to support the ongoing function of the stormwater devices will be set out in a draft operation & maintenance plan at resource consent stage and progressively updated following commissioning and approval of as built drawings.

6.6 Implementation of Stormwater Network

Sediment and Erosion controls will be installed prior to additional earthworks commencing and will be monitored and maintained during construction.

Further implementation of the stormwater network will be discussed during the resource consent process.

6.7 Dependencies

Not Applicable within this SMP.

6.8 Risks

What is the risk to the proposed stormwater management?	How can this be mitigated/ managed?	What other management/ mitigation could be used?	When does this risk need to be address?	What is the resultant level of risk?
Limited number of infiltration tests	More On-site testing	A conservative assumption is made that the poor infiltration rates are constant throughout the entire PCA	During the design	Low
Flow paths on Geomaps do not match the on-site topography	Complete site-specific topographic survey		During the design phase	Low
Streams and watercourses on the site are different to Geo Maps	Undertake site investigation and watercourses classification assessment		During the plan and design phase	Low
Raingardens are not installed properly	Construction monitoring		During the construction phase	Medium
Groundwater		Subsoil drains		

7.0 Departures from Regulatory or Design Codes

Not Applicable within this SMP.

8.0 Conclusions and Recommendations for Future Work

8.1 Conclusions

An integrated stormwater management approach shall be taken for the PCA to protect the receiving environment.

The proposed stormwater measures satisfy the requirements for “greenfield developments” set out under the Regional Stormwater Network Discharge Consent. The applicable stormwater management requirements and guidance under this SMP are summarised in the following:

Component	Minimum requirements	Recommended approaches	Guidelines
Water quality treatment	<ul style="list-style-type: none"> Treatment of runoff from all new impervious areas (excluding inert roofing material) prior to discharge into the receiving environment. Requiring the use of inert building materials to eliminate or minimise the generation and discharge of contaminants. 	<ul style="list-style-type: none"> Treatment is provided at the source. Treatment train approach Multi-purpose devices are preferred such as bioretention devices. Proprietary treatment devices should only be considered for small catchments, or where there are significant infrastructural constraints in a particular area that mean other options are infeasible. 	<ul style="list-style-type: none"> Auckland Council GD01 Auckland Council GD04 Auckland Council Unitary Plan stormwater management provisions TR2013/35
Stream hydrology	<ul style="list-style-type: none"> Detention for the difference between the predevelopment and post-development runoff volumes from the 95th percentile, 24-hour rainfall. Retention of 5 mm runoff depth from all impervious areas if practicable 	<ul style="list-style-type: none"> Stormwater retention is achieved by rain tanks where practicable. Detention is achieved by bioretention devices where practicable that have additional water quality benefits. Riparian margin enhancement and planting. 	<ul style="list-style-type: none"> Auckland Council GD01 Ecology Assessment Report
Erosion protection	<ul style="list-style-type: none"> Required at all stormwater outlets into the receiving environment 	<ul style="list-style-type: none"> Erosion protection requirements should be addressed in the design of all outlets. 	<ul style="list-style-type: none"> Auckland Council TR2013/018
Stormwater conveyance	<ul style="list-style-type: none"> Conveyance of runoff generated in the 10% AEP rainfall event through the primary stormwater network into the receiving environment. Conveyance of runoff generated in rainfall events greater than the 10% AEP through overland flow paths 	<ul style="list-style-type: none"> Manage overland flow paths 	<ul style="list-style-type: none"> Auckland Council GD01 Auckland Council GD04 Auckland Council Stormwater Code of Practice Auckland Transport Stormwater Code of Practice
Development staging	<ul style="list-style-type: none"> Erosion and sediment control plans required prior to development and construction and in accordance with GD05 requirements. 	<ul style="list-style-type: none"> No impacts on existing stormwater/stream structures 	<ul style="list-style-type: none"> Auckland Council GD05

8.2 Recommendations

Infiltration tests shall be conducted throughout the PCA in consenting stage to confirm the infiltration rate and to determine the retention function of the bioretention devices.

The stormwater modelling and design shall be progressively refined in line with specific future development proposals.