ROTOKAURI NORTH

Green Seed Consultants Limited

Sub-Catchment Integrated Catchment Management Plan

April 2019

DOCUMENT CONTROL RECORD

PROJECT:	Rotokauri North Private Plan Change – Sub-Catchment ICMP
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CONTENTS:

Acronym Table:

Acronym	Definition
ANZECC	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
B6Z	Business 6 Zone
BPOs	Best Practicable Options
DSI	Detailed Site Investigation
FUZ	Future Urban Zone
FWI	Far Western Interceptor
GSCL	Green Seed Consultants Ltd
HAIL	Hazardous Activities and Industries List
HCC	Hamilton City Council
HCDP	Hamilton City District Plan
ICMP	Rotokauri North Sub-Catchment Integrated Catchment Management Plan
RITS	Regional Infrastructure Technical Specifications
LASS	Waikato Local Area Shared Services
LOS	Level of Service
MDRZ	Medium Density Residential Zone
Morphum	Morphum Environmental Ltd
NPS-FM	National Policy Statement for Freshwater Management
OLFP	Overland Flowpath
PPC	Private Plan Change
PSI	Preliminary Site Investigation
RITS	Regional Infrastructure Technical Standards
RMA	Resource Management Act 1991
RNSP	Rotokauri North Structure Plan
Rotokauri ICMP	Rotokauri Integrated Catchment Management Plan
RPS	Waikato Regional Policy Statement
Settlement Act	Waikato-Tainui Raupatu Claims (Waikato River) Settlement Act 2010
SH39	State Highway 39
SNA	Significant Natural Area
THaWK	Te Haa o te whenua o Kirikiriroa
WDC	Waikato District Council
WRC	Waikato Regional Council
WRP	Waikato Regional Plan
WRPS	Waikato Regional Policy Statement
WWTP	Wastewater Treatment Plant

1.0 INTRODUCTION

This Sub-Catchment Integrated Catchment Management Plan ("**ICMP**") report has been prepared to support a request for a Private Plan Change ("**PPC**") to the Hamilton City District Plan ("**HCDP**"), by Green Seed Consultants Ltd ("**GSCL**") for an area of land identified as "Rotokauri North" in the north-west of Hamilton City.

Rotokauri North comprises approximately 140ha of land proposed to be zoned for urban activities, specifically;

- 137.6 hectares is proposed as a Medium Density Residential zone ("**MDRZ**");
- 1.2 Hectares is proposed as a Business 6 zone (Neighbourhood) ("**B6Z**");
- 0.5 hectares will retain its current zone as a Significant Natural Area ("**SNA**"), i.e. no change from the operative provisions.

Based on the PPC area, the development could yield approximately 2,000 houses.

The majority (approximately 133 ha) of the area, falls within land holdings falling under the GSCL umbrella.

This ICMP also includes 63.5 hectares of Rotokauri land which will retain its Future Urban zoning ("**FUZ**"), but as that land falls within the catchment subject to this application, it has been included within this ICMP.

1.1 Sub-Catchment ICMP Scope and Area

The land to which this ICMP relates is located in an area south of Te Kowhai Road (State Highway 39 "**SH39**") and east of Exelby Road to the north west of Hamilton City, as shown in Figure 2 below.

This document is a "sub-catchment" ICMP focused specifically on the Rotokauri North area. Although some of the catchments extend beyond the HCC territorial boundary, this IMCP only covers land within the HCC territorial boundary (technical assessments have covered the catchments as a whole).

As development at Rotokauri North has been anticipated and envisaged for some time, the land was included in the adopted Rotokauri Integrated Catchment Management Plan ("**Rotokauri ICMP**"), which covers the Rotokauri Structure Plan area identified in Chapter 3 of the HCDP (approximately 196 hectares) and within the Mangaheka ICMP (approximately 15 hectares identified as area "G" within the Mangaheka ICMP).

The Rotokauri North area, therefore, constitutes a "sub-catchment" within the wider Rotokauri area, and as such, this document is prepared a "Sub-Catchment ICMP" to be read as part of the Rotokauri ICMP and the Mangaheka ICMP.

1.2 Other Supporting Documents

This ICMP is supported by the following technical reports which are provided as attachments to this report:

(a) Rotokauri North Catchment Stormwater Modelling Report prepared by Aecom [October 2018 DRAFT]

(b) Flood Impact Assessment prepared by Opus [February 2019]

(c) Rotokauri North Development Area: Technical review of stream classifications prepared by Tonkin & Taylor Ltd, dated 7 December 2018.

(d) Receiving Environment and Rapid Erosion Assessment Rotokauri North Sub-Catchment prepared by Morphum Environmental Ltd November 2018 DRAFT ("**Morphum**")

(e) Rotokauri North SHA: Archaeological Assessment prepared by CFH Heritage dated 3 December 2018

(f) Rotokauri North SHA Geotechnical Assessment Report prepared by HDGeo dated 25 October 2018

(g) Rotokauri North SHA – Response to HCC Peer Review prepared by HDGeo dated 27 February 2019

(h) Rotokauri North Preliminary Site Investigation by HDGeo dated 11 July 2018

(i) Rotokauri North ICMP: Desktop Review of Hydrogeological Conditions Influencing Stormwater Design prepared by Beca dated 17 July 2018 DRAFT

(j) Rotokauri North Stormwater and MUSIC Modelling Report prepared by McKenzie & Co Consultants Ltd dated April 2019.

(k) Rotokauri North Water and Wastewater Servicing Options by McKenzie & Co Consultants Ltd dated April 2019.

(l) Rotokauri North Catchment Modelling Report Report prepared by McKenzie & Co Consultants Ltd dated April 2019.

This ICMP is also supported by the following technical reports (which are not provided as attachments to this report but can be provided upon request).

(m) Rotokauri ICMP prepared by Hamilton City Council; and

(n) Mangaheka ICMP prepared by Beca

1.3 Purpose of the Sub-Catchment ICMP

The purpose of this sub-catchment ICMP is:

- To provide an integrated management approach based upon best practicable option(s) ("**BPOs**") to avoid as far as practicable and otherwise minimise, the cumulative adverse effects of all new stormwater activities in the sub-catchment;

- To provide guidance on how water, wastewater and stormwater within the catchment will be managed in an integrated way and in accordance with proposed land uses that occur within the site;

- To ensure the effects of stormwater discharges are mitigated in accordance with the requirements of the Rotokauri ICMP, discharge consents held/to be obtained and Waikato Regional Council ("**WRC**") guidance;

- To provide a platform for considering the implementation of water sensitive principles (including but not limited to) to reduce demand for water, minimise wastewater generation and minimise the need for three waters infrastructure where appropriate.

- Investigating how Level of Service ("**LOS**") and industry best practice can be met; and

- Investigating whether and how ICMP specific issues can be addressed.

This ICMP will be read in conjunction with the adopted Rotokauri ICMP document and Mangaheka ICMP document, and on-going decision making, and will be required for integrated management of the three waters infrastructure in the catchment and specific information to provide further detail and clarification to developing land within the ICMP's.

It is anticipated that this ICMP will undergo periodic review (including that required by a condition of a discharge consent) by GSCL (or its successor), to maintain relevance to national, regional and local policy. It is also recognised that monitoring of possible changes within the sub-catchment will be required as the development progresses.

1.4 Key Infrastructure Projects

Roading

No new upgrades to the state highway network are required for the planned development (apart from intersections). New collector and minor arterial roads identified in the Rotokauri North Structure Plan ("**RNSP**") area will be progressively developed to support the transport network.

Wastewater

The Hamilton City Council ("**HCC**") Long-term Infrastructure Strategy 2015-2045 defines the future direction of the bulk wastewater network within the City. This document illustrates the Council's strategy to service Rotokauri through the development of a reticulated network, that will require transfer pump stations and reticulation infrastructure. It is acknowledged that the development proposed is occurring prior to the planned date for servicing the Rotokauri North area.

Water Supply

The HCC Long-term Infrastructure Strategy 2015-2045 defines the future direction of the bulk water supply network within the City. This document illustrates the Council's intention to accommodate future growth by extending the reticulated network into Rotokauri. It is acknowledged that the development proposed is occurring prior to the originally planned date for servicing the Rotokauri North area.

1.5 Outcomes

In addition to the Rotokauri and Mangaheka ICMP's this ICMP outcomes are to:

- Set best practicable integrated three water management options for stormwater, water and wastewater within the catchment that are environmentally, culturally, socially and economically sustainable (particularly given the requirements for affordable housing in Rotokauri North).

- Identify potential constraints, demands for services and any infrastructure improvements necessary to accommodate growth, and to confirm that the available three waters infrastructure and infrastructure capacity can appropriately service the potential urban growth, development and land use intensification within the catchment;

- Provide clear direction for the adoption of appropriate water-sensitive techniques to achieve water conservation, and minimise water demand, wastewater generation and stormwater runoff.

2.0 STRATEGIC CONTEXT

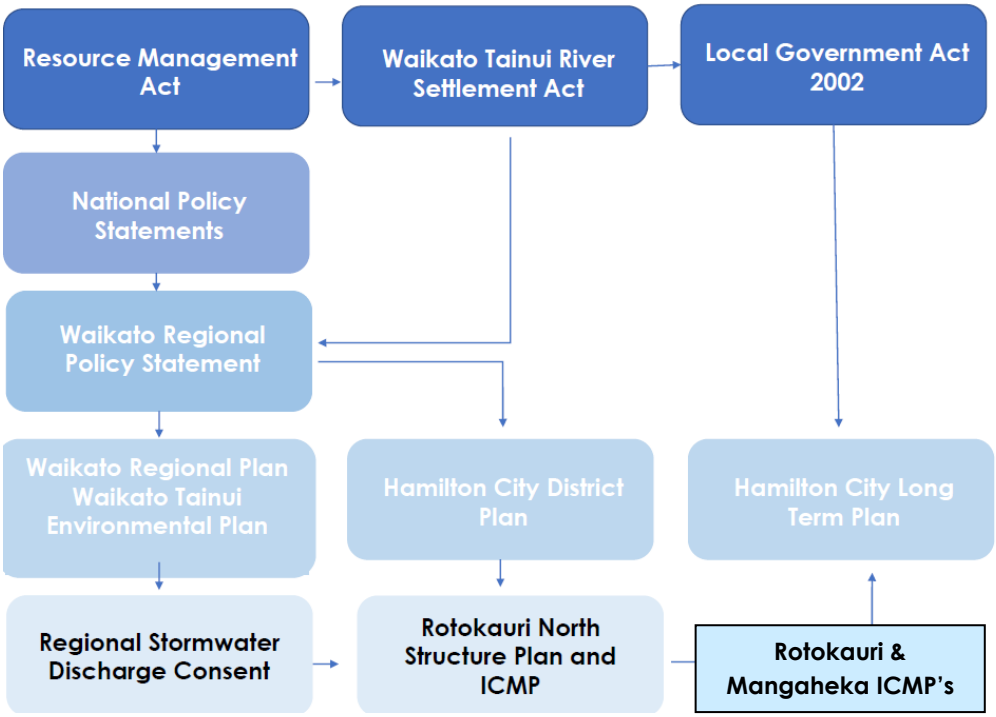
Development within the catchment is influenced by central and regional government policies, plans and resource consents, HCC policies and plans, and Waikato District Council ("**WDC**") policies and plans. Most policies and rules ultimately flow from the Waikato Regional Policy Statement ("**RPS**") which is given effect through planning documents such as District Plans and Regional Plans. The RPS also reflects iwi aspirations for the region and National Policy Statements.

The ICMP relies on current best practice stormwater management in the context of the existing strategic and legislative framework. Any changes to these external drivers must be considered during future reviews of the ICMP and HCC's Infrastructure Technical Specifications ("**ITS**") to maintain alignment of objectives.

The key planning documents relevant to catchment management planning in the Waikato Region are discussed in this section. Their hierarchy is demonstrated in Figure 1. This sub-catchment falls within an area that has been anticipated for Hamilton's future urban growth.

This ICMP and its prescribed best practicable options ("**BPOs**") predominately focuses on mitigation of the adverse effects associated with the proposed land-use changes due to urban development. It includes best practicable options for water supply, wastewater and stormwater infrastructure, and management of receiving environments across the RNSP area.

Figure 1: Relationship of documents relevant to ICMP preparation



2.1 Legislation/Key Policy Documents

Development within Rotokauri North is influenced by central and regional government policies, plans and resource consents, HCC policies and plans (and in the lower catchment WDC policies and plans). Table 1 provides a list of the key source documents that provide policy direction and guidance for the management of three waters and have been taken into account in the preparation of this ICMP.

Table 1: Key Source Documents

Document	Outline/Summary
National Legislation:	
Resource Management Act 1991 ("**RMA**")	Specifically, Section 15 of the Act includes controls on the discharge of contaminants into the environment, including from stormwater, and states that no person may discharge any water into water or onto land unless the discharge is expressly allowed for in a national environmental standard, regional plan or resource consent.
Waikato-Tainui Raupatu Claims (Waikato River) Settlement Act 2010 ("**Settlement Act**")	A co-management agreement was signed between Waikato Raupatu River Trust (Waikato-Tainui) and WRC. The Act sets up Te Ture Whaimana o Te Awa, a Vision and Strategy relevant to all activities within its catchment with the purpose of "*restoring and protecting the health and well-being of the Waikato River for future generations*". The agreement clarifies a range of factors and acknowledges integrated catchment management requires coordination and collaboration between each Party's respective planning documents and implementation processes.
National Policy Statements:	
National Policy Statement for Freshwater Management ("**NPS-FM**")	The NPS-FM endeavours to safeguard freshwater's ecological and human health values through the sustainable management of land and discharges of contaminants, manage freshwater quantity, manage by catchments, and provide for community and tangata whenua involvement in management. The NPS-FM also identifies tangata whenua and community values regarding freshwater and uses water quality measures to set objectives to protect these values as well as the 2017 amendments which introduced national environment bottom lines.
Regional Policy:	
Waikato Regional Policy Statement	The RPS provides an overview of the resource management issues of the region and the ways in which integrated management of the region's natural and physical resources will be achieved.

Document	Outline/Summary
	It sets an overarching direction for the management and protection of Waikato's resources as well as objectives and policies for how these issues will be addressed. The RPS recognises the Waikato River's Te Tura Whaimana o Te Awa as the primary document for management of the Waikato River and promotes catchment-based approaches to water quality and freshwater biodiversity. In 2016 the second generation of the RPS became operative. It stipulates the importance of classifying waterways and assessing their ecological value to protect and restore the Waikato River and its tributaries. Any activities which could result in destabilisation of beds/banks of waterbodies, contaminant discharge, adverse effects on flora and fauna, loss of public access or adverse effect on any cultural association of Waikato-Tainui with the Waikato River must be controlled. The WRPS specifies the policy direction for the HCDP.
Waikato Regional Plan ("**WRP**")	The WRP contains issues, objectives, policies and rules, relating to the discharge of stormwater into water and the discharge of stormwater onto or into land. Water management is a key issue in the Waikato Region. The WRP includes requirements for efficient use of water, stormwater discharges and changes or disturbances to watercourses.
Sub Regional Three Waters Strategy	The vision of the strategy is to achieve the delivery of integrated, sustainable and well managed Three Waters services for the sub-region which ensures the cultural, social and economic needs of the community are met, and the quality of the Waikato River is improved.
Te Ture Whaimana o Te Awa o Waikato (Vision and Strategy for the Waikato River).	It is noted above that Te Ture Whaimana o Te Awa o Waikato (the Vision and Strategy for the Waikato River) has been included in full as part of the RPS. Te Ture Whaimana o Te Awa o Waikato sets out a vision whereby a healthy Waikato River sustains abundant life and prosperous communities who, in turn, are all responsible for restoring and protecting the health and wellbeing of the Waikato River, and all it embraces, for generations to come.
District Policy:	
Hamilton City District Plan	The HCDP became operative on 18 October 2017. It offers a framework for integrated resource management regarding the use, development or protection of land and associated natural and physical resources. The HCDP provisions include requirements for the preparation of integrated catchment management plans, sub-catchment

Document	Outline/Summary
	integrated catchment management plans and water impact assessments. There are also provisions which set standards such as water efficiency, surface permeability, and building coverage. Together with the ITS, the HCDP is a key tool for on-going management within the Rotokauri North sub-catchment.

In addition to the above, Table 2 provides a list of some of the key source/reference documents that have been reviewed during the development of this sub-catchment ICMP:

Table 2: Key Reference Documents

Document Title	Date/Version
Waikato River Authority Vision & Strategy	July 2011
National Policy Statement for Freshwater Management	August 2014
Sub-regional Three Waters Strategy	September 2012
Southern Growth Corridor Strategic Land-use and Infra SP	October 2015
HCC Long-term Infrastructure Strategy 2015-2045	2015
HCC Comprehensive Stormwater Discharge Consent (#105279)	June 2011
HCC Water Take Consent (#113941)	March 2009
HCC Wastewater Discharge Consent (#114674)	September 2007

2.2 Three Waters Master Planning, Integration and Hierarchy

Three waters means the three key areas of strategic water management (including associated infrastructure) within the City – comprising water supply, wastewater and stormwater.

Three waters integration recognises that there is significant interaction between the three types of waters, surrounding natural water systems and land and that it is beneficial to consider their interconnectedness. To ensure protection of the environment and the ongoing availability of services to growth areas, they need to be managed in an integrated manner.

The HCDP adopts a best-practice hierarchy for three waters management based on principles for sustainable resource management, environmental protection and efficiency. In addition, the ITS and HCDP offer detailed information on the range of water sensitive techniques which are available for greenfield developments to minimise the impact of development.

The development and implementation of BPO's should have regard to and reflect the established hierarchy for the management of the three waters (as outlined in the ITS):

Minimise Demand (Water, wastewater) -> Reuse (stormwater) -> Treat & Dispose to Ground (stormwater) -> Treatment & Detention (stormwater) -> Reticulation (stormwater, wastewater)

The ideal stormwater management system for a developed site is one that replicates the undeveloped scenario. A range of water sensitive techniques are available to minimise the impact of development and enhance the environment.

2.3 Strategic Objectives

One of the purposes of ICMPs is for HCC to define and set objectives for its catchments.

Common strategic objectives have been set across all catchments within the HCC jurisdiction (refer to

Table 3). Strategic objectives for integrated catchment management planning have been developed by HCC to guide decision making.

Table 3: Strategic Objectives (applicable to all ICMP's)

Ref No	Strategic Objectives
SO1	***Protect freshwater systems*** Maintain, protect and enhance freshwater ecosystems and natural drainage systems by safeguarding the life-supporting capacity, improving water quality where degraded and protecting significant values of wetlands and outstanding freshwater bodies.
SO2	***Protect terrestrial systems*** Maintain, protect and enhance indigenous biodiversity values and functions for terrestrial ecosystems and protect significant habitat of indigenous fauna.
SO3	***Kaitiakitanga*** Give effect to the relationship of tangata whenua as kaitiaki of receiving water bodies and including the relationship of Waikato-Tainui with the Waikato River.
SO4	***Stormwater Management*** Stormwater management related to land use and development shall encourage and enable low impact design and incorporate best practicable mitigation measures to minimise actual and potential adverse effects on: • Receiving water bodies in terms of quantity and quality of stormwater discharges, • Locations and communities subject to flood hazards, • Natural groundwater levels, • Baseflows for freshwater systems.
SO5	***Wastewater Management*** Wastewater management shall incorporate best practicable options and be managed so that: • Conveyed network volumes are minimised, (e.g. by demand management and management of stormwater infiltration) • Dry weather overflows are prevented, and wet weather overflows are minimised.

Ref No	Strategic Objectives
SO6	***Potable Water Management*** Water supply is planned and provided for in a way that meets existing and future requirements to: • Provide firefighting water supply (flow and pressure) by conforming to the Code of Practice for Fire Fighting Water Supplies • Meet domestic, commercial and industrial water demand. • Ensure water consumption is managed to minimise peak and total demand.
SO7	***Three Waters Management*** Three waters networks are planned, managed and operated in an integrated manner to: • Meet existing and future development requirements whilst maintaining human and ecosystem health. • Meet design standards, consent conditions and regulatory levels of service. • Ensure assets, technology and resources have capacity, redundancy (n+1), knowledge and plans to prevent or cope with unplanned events. • Minimise the need for new infrastructure including by optimising the use of existing assets.

The following strategic objectives have been identified that are specific to this ICMP. As the area falls within both the Mangaheka and Rotokauri ICMPs the strategic objectives of both of these catchments have been considered and are incorporated below.

Table 4: Strategic Objectives applicable to this ICMP

Ref No	Strategic Objectives
Objectives across the whole ICMP area:	
CS1	**Alignment with the RNSP** Development and three waters infrastructure is designed, constructed, operated and maintained in general accordance with the overarching vision, objectives, policies and guiding principles of the RNSP. In particular to: • Manage stormwater in a manner that minimises the effects of development on downstream receiving waters • Provide a 'green corridor' for stormwater drainage which connects the wider network of open spaces and natural features • Ensure that new urban development is appropriately serviced • Ensure that the LOS required for each sub-catchment is commensurate with that catchment and can be implemented in conjunction with the urbanisation of each sub-catchment.

Ref No	Strategic Objectives
CS2	**Flood protection and downstream LOS** The major stormwater drainage infrastructure is designed, constructed, operated and maintained to: • Meet cross jurisdictional flood protection LOS (HCC, WDC and WRC) • Align the sizing of flood storage and conveyance infrastructure requirements to that which is reasonably needed to service the development of the RNSP area (taking into account capital and ongoing operation and maintenance costs)
CS3	**Protecting water quality** Require the stormwater network to incorporate a treatment train approach which is designed, constructed, operated and maintained to improve water quality of onsite watercourses: • Minimise temperature fluctuations in receiving waterbodies • Maximise contaminant removal efficiencies at all times • Be resilient to accidental or deliberate contaminant spills and discharges • Meet or exceed the stormwater treatment requirements for the catchment, including as a minimum 75% total suspended solids removal prior to discharge to the receiving environment

2.4 Levels of Service

Levels of Service are documented in different levels of detail in various key documents. These currently include;

- Stormwater – management of 2, 10 and 100 year storm events (in accordance with land-use type);
- Wastewater - no additional overflows due to development (volume and frequency); and
- Water pressure – 10m of head at the boundary

Table 5 outlines documents to review for further levels of service and design standards information.

Table 5: LOS and Design Standards

Document Title	Date/Version
HCDP	October 2017
HCC ITS	December 2016
HCC Three Water Management Practice Notes	September 2016
HCC 2015-2025 10 Year Plan	June 2015
WRC 2015-2025 Long Term Plan	June 2015
HCC Bylaws (including Water bylaw and Stormwater bylaw)	

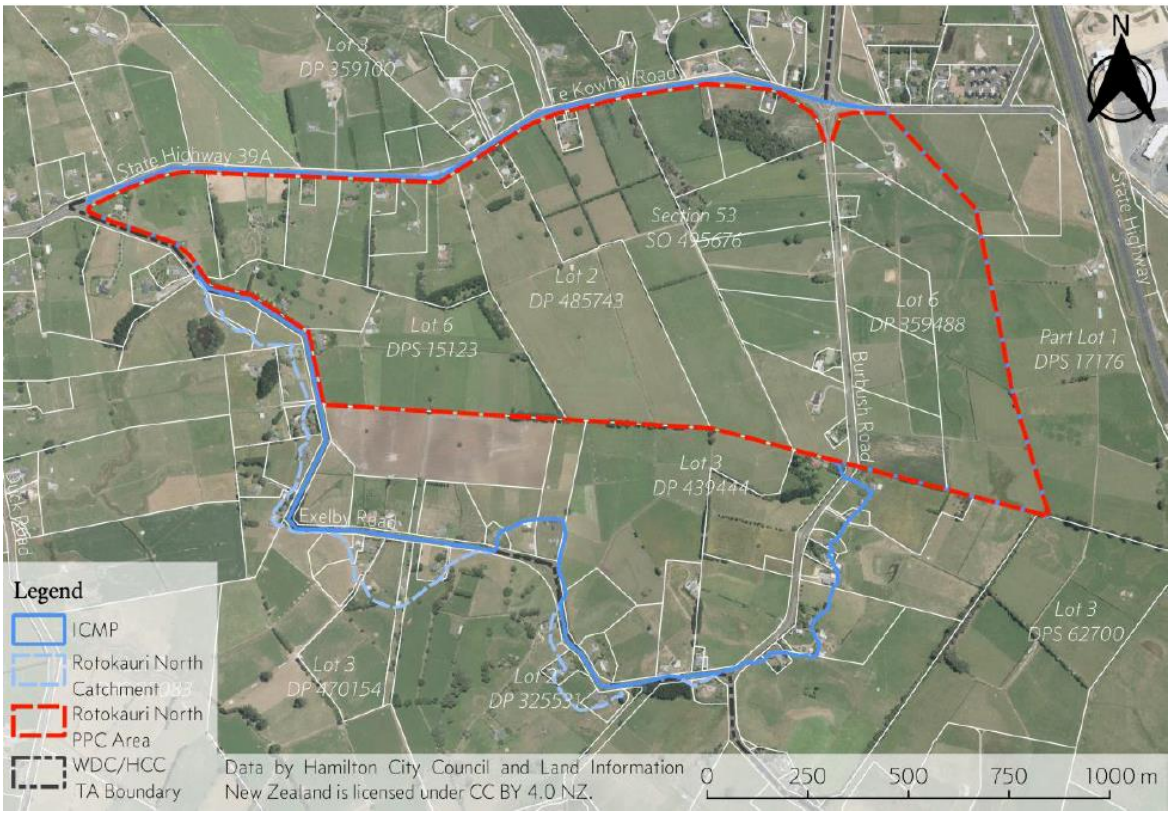
HCC Water Master Plan	June 2015
HCC Wastewater Master Plan	June 2015

3.0 SUB CATCHMENT / SITE DESCRIPTION AND CONTEXT

3.1 The Site

The site is located at the north west extent of Hamilton City and consists of a total area of approximately 203 hectares as shown in Figure 2 below. It is bounded by the Te Kowhai Road (SH39) to the north, greenfield lands to the east and south and Exelby Road to the west and south. Burbush Road runs north to south through the eastern portion of the site.

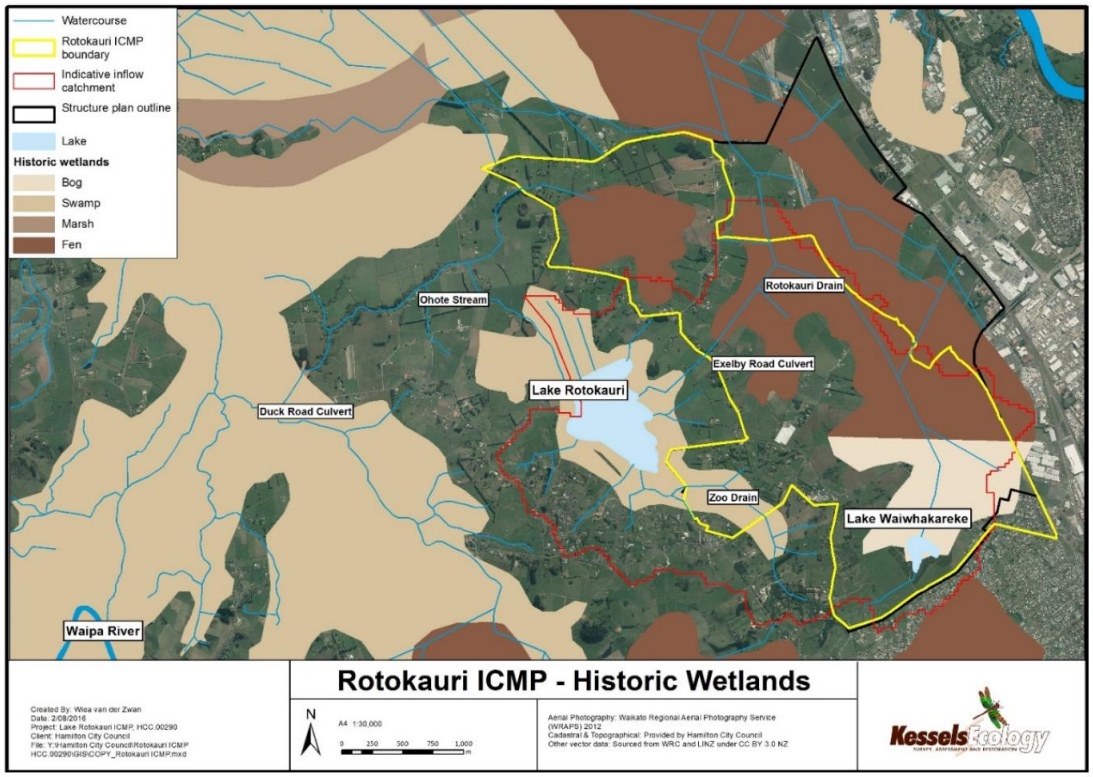
Figure 2 :ICMP area



3.2 Historic and Current Land Uses

Historically the site was partially covered by a wetland (fen) which, as identified in the archaeology section below, was drained to make way for agricultural land practises in the early 1900's. Figure 3 below is included in the Rotokauri ICMP (as Figure 2-2) and identifies the location of the fen / wetland.

Figure 3: Historical fen / wetland



The current land use is for agriculture, with some lifestyle dwellings. Historic uses of the site are associated with farming for livestock and dairying.

Vegetation on the site is mainly grazed pasture grasses and exotic tree species used for hedging and shelterbelts. Some native trees are present on the site but are generally located in amenity gardens surrounding dwellings. There is a significant existing stand of kahikatea in the northeastern corner of the site, which is identified by the HCDP as an SNA.

Proportionally across Rotokauri North, the land uses are as follows:

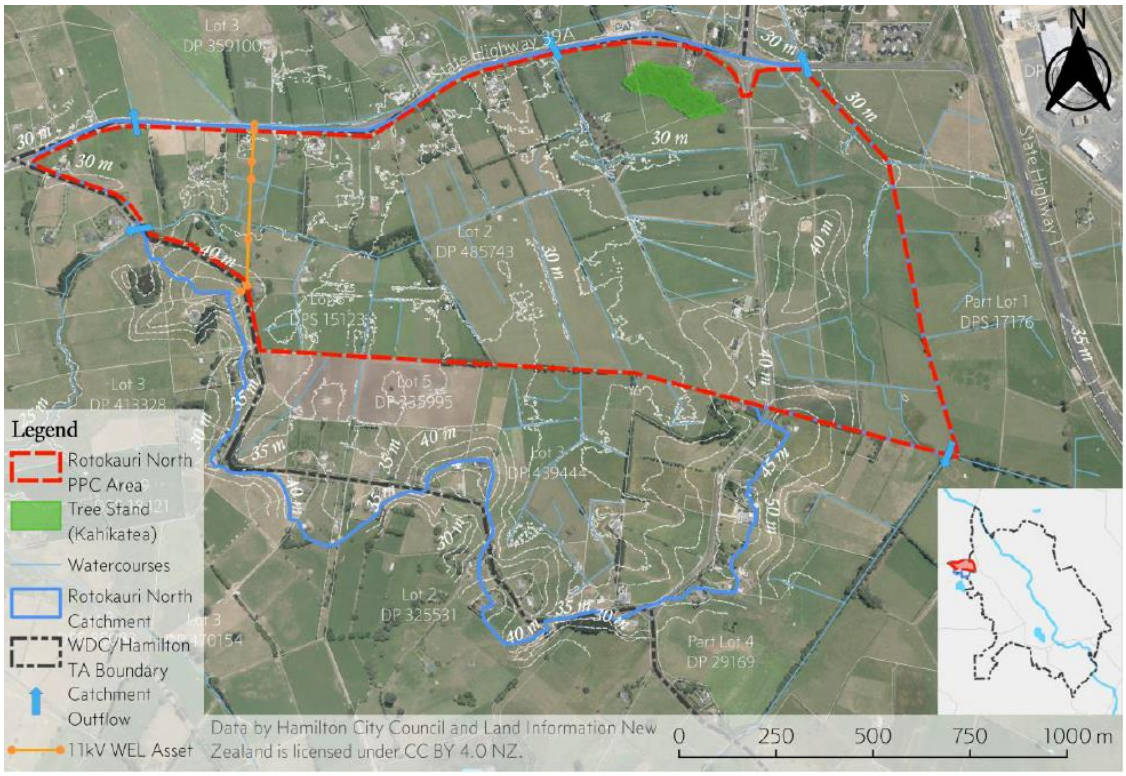
- 97.4% of land classified as exotic grassland,
- 1.6% classified as exotic forest, and
- the remaining 1.0% classified as indigenous forest as per the Land Cover Database (version 4.1).

3.3 Topography and Catchment boundaries

As identified in Figure 4 below, the majority of Rotokauri North is relatively flat, generally 28-30 RL. There are some terraces along the southern and eastern edges of the development area which are up to 40 RL.

As identified in Figure 4 below, the majority of Rotokauri North is relatively flat, generally 28-30 RL. There are some terraces along the southern and eastern edges of the development area which are up to 40 RL.

Figure 4: Topography map



The Rotokauri North area is within the catchments of the Ohote, Te Otamanui, Mangaheka and Rotokauri South stream networks.

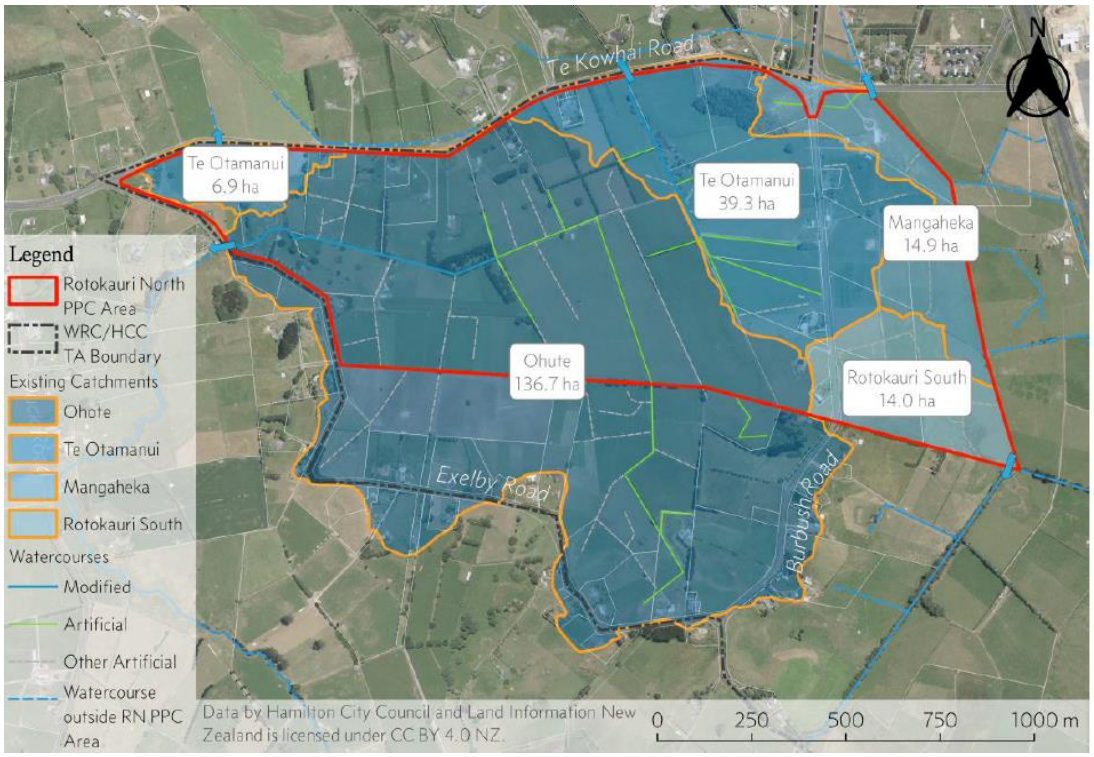
The majority of the stormwater catchment discharge is via the Ohote catchment, which runs predominantly east-west through Rotokauri North and comprises approximately 136.7 hectares of land. The Ohote catchment ultimately discharges to the Waipa River approximately 6 kilometres downstream. The catchment drains through a culvert located at Exelby Road, which is also the eastern catchment boundary.

Te Otamanui catchment falls south of Te Kowhai Road within the HCC territorial boundary, with the northern portion of the catchment (outside of Rotokarui North area) within the WDC territorial boundary. Land within this catchment comprises approximately 46.2 hectares. Two culverts under Te Kowhai Road convey flow from the south to north. One culvert services the western area (6.9 ha) and the other the eastern area (39.3 ha). Te Otamanui catchment discharges northwesterly to the Waipa River approximately 8 kilometres downstream.

The Mangaheka catchment flows from south to north, with the portion falling within Rotokauri North being 14.9 hectares and is the upper portion of the catchment. The catchment eventually discharges to the Waipa River approximately 2.5 kilometres south of Ngaruawahia. This catchment has an approved Mangaheka Integrated Catchment Management Plan.

The portion of Rotokauri North within the upper reach of the Rotokauri South catchment comprises approximately 14 hectares. The catchment flows southwesterly to Rotokauri Lake approximately 1.5 kilometres away. The Rotokauri South catchment also has an approved Rotokauri Integrated Catchment Management Plan.

Figure 5: Existing Catchments

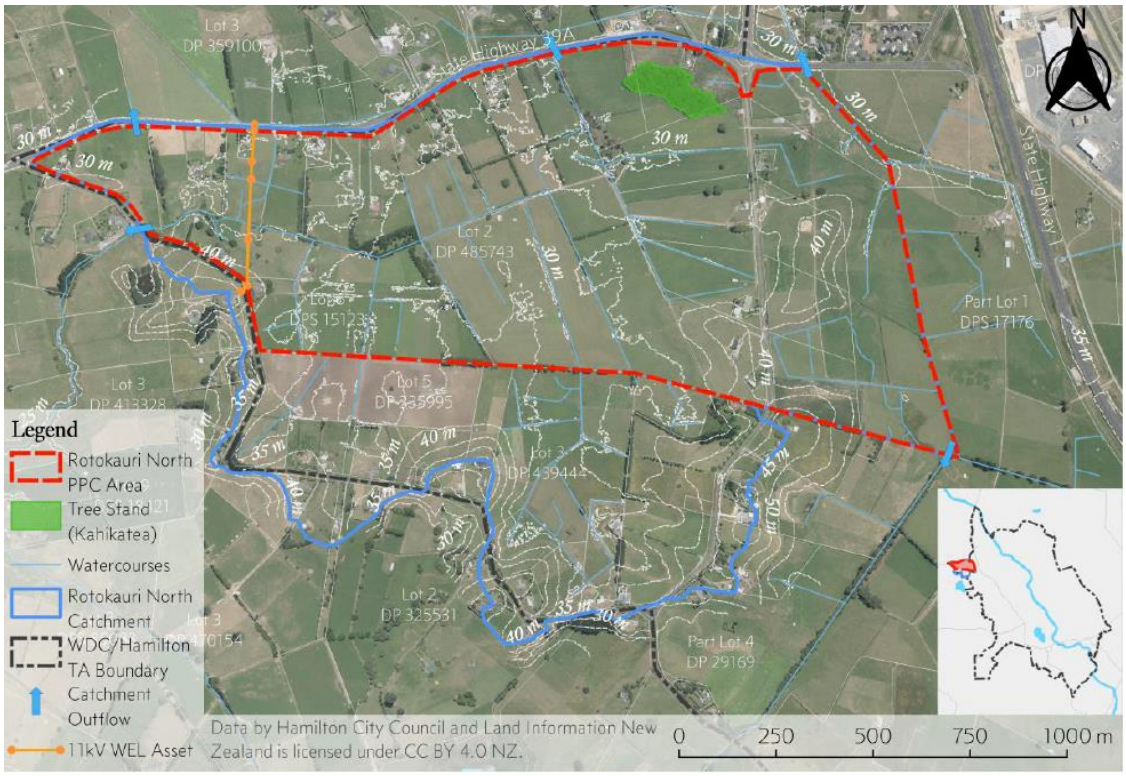


The majority of the land is currently used for farming, with minimal impervious areas.

3.4 Overland flowpaths and flooding

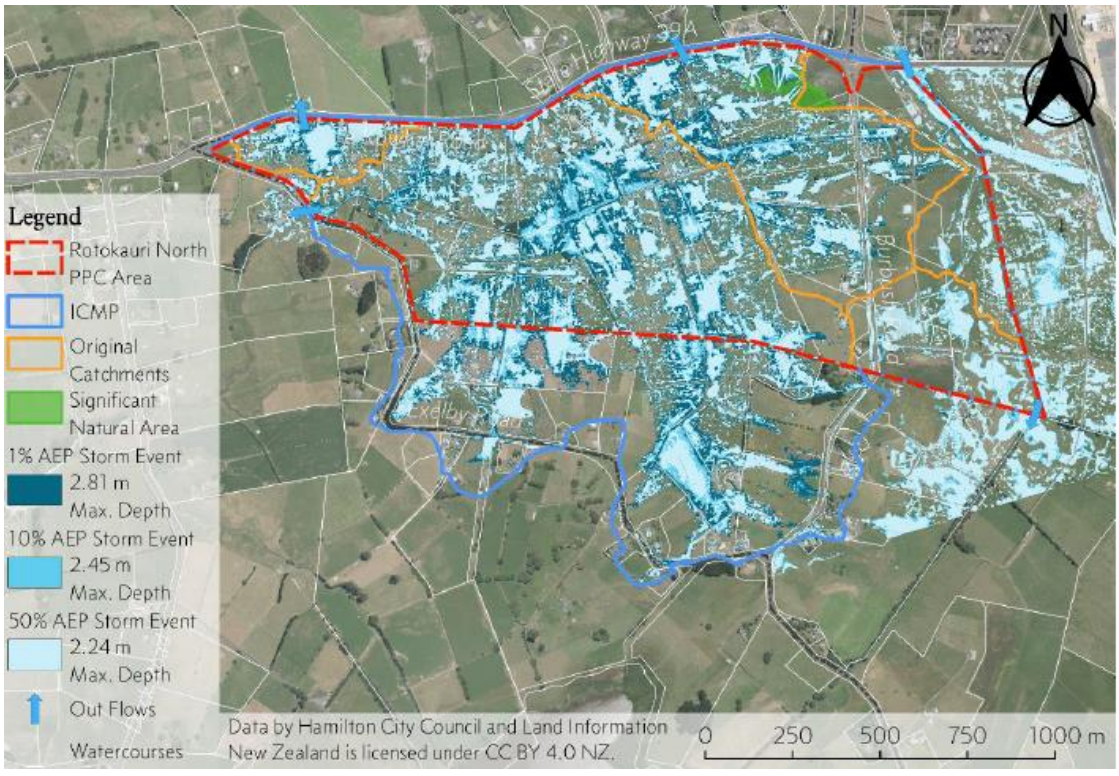
Figure 6 the main network of overland flow paths within the site. Classification of the modified and artificial watercourses is in accordance with Tonkin & Taylor stream classification report (2018). Figure 7 shows the existing flood extent and indicates that part of the site is subject to flooding.

Figure 6: Existing overland flows



The below Figure 7 shows the map of the existing flood extent:

Figure 7: Flooding



3.5 Geology

The site is located roughly central to the broader Hamilton Basin which is characterized by low rolling hills (Hamilton Hills) and plains with low terraces and gullies draining into the Waikato and Waipa Rivers (Hamilton Lowlands) as described below (HDGeo, 2018):

- The Hamilton Hills are linear, sinuous hills and ridges that are remnant of an older erosion surface. They consist of alluvial material and non-welded ignimbrites (Walton Subgroup) and are typically overlain by a number of metres of airfall volcanic ash (Kauroa Ash and Hamilton Ash).

- The Hamilton Lowlands are a broad, low angle alluvial fan created by the Waikato River in the Late Quaternary. The fan materials are derived from rhyolitic eruptions in the central North Island and generally consist of late Pleistocene primary and secondary volcaniclastic sediments with a wide variety of grain sizes (Piako Subgroup and Hinuera Formation). Deposition of the fan materials ceased when the Waikato River entrenched into its current course approximately 17 ka and thin airfall tephra layers accumulated on the fan surface (Hinuera Surface).

The New Zealand Geological map (QMap) for the Waikato Region shows that local soils within Rotokauri North consist of the Walton Subgroup, the Hinuera Formation, and Piako Subgroup materials. The Walton Subgroup falls predominantly along the ridges west, south, and east of the Rotokauri North area and are described as Early Pleistocene to Middle Pleistocene alluvium dominated by primary and re-worked non-welded ignimbrite. The main basin within the Rotokauri North area consists of the Hinuera Formation and Piako Subgroup. The Hinuera Formation makes up the majority of the low- lying areas of the site, with small areas in the south and southeast of the site described as the Piako Subgroup. The Hinuera Formation is described as Late Pleistocene cross-bedded pumice sand, silt and gravel with interbedded peat. The Piako Subgroup is described as Late Pleistocene locally derived mud, silt, gravel and peat.

Site conditions encountered by HD Geo were typically consistent with the mapped geology.

The low-lying portions of the site contain sand and silty soils with a high groundwater table, which can be susceptible to liquefaction under earthquake-induced cyclic loading. Liquefaction of this magnitude is not uncommon in the Waikato, but it does have the potential to affect options for stormwater management. Specifically, chosen options must consider the potential for "lateral spreading". Lateral spreading is a phenomenon were liquefied material allows the soil above to move horizontally towards a free face, such as a stream bank. HD Geo have indicated that the site currently has an isolated lateral spreading risk adjacent to the Mangaheka stream near Te Kowhai Road in the north-eastern corner of the site. As noted by HDGeo (2018) specific assessment of lateral spreading hazards will be required during detailed design. Potential mitigation options include:

- Dewatering of the adjacent ground so that liquefaction is unable to occur;

- Adoption of slope stabilisation methodologies;

- Buttress swale edges; and

- Adoption of foundation designs that are tolerant to lateral spreading.

In response to Council's peer review of the HD Geo work a further response dated February

2019 also identifies mitigation utilised in the recently developed parts of Hamilton that also have a liquefaction hazard, which would be suitable for Rotokauri North. These include:

- shallow ground improvement (to separate structures from liquefiable layers);
- reinforced raft foundations (varying from simple ribraft to reinforced, resilient raft foundation piles to non-liquefying layers);
- de-watering to reduce the hazard (usually locally to a lateral spreading hazard); and,
- setbacks or barrier piles in some locations where lateral spreading was considered to be a risk.

3.6 Soils

Landcare Research identifies the soils to be a mix of Land Use Capabilities (ranging from 1 in the flats adjacent to Te Kowhai Road to 4 towards the southern extent of the catchment).

Landcare Research identifies the site as having well-drained soils (along the ridges) and very poorly drained soils within the main basin (see Figure 8). The soil moisture regime ranges from moderate (along the ridges) to very high in the main basin (see Figure 9).

Figure 8: Soil Drainage

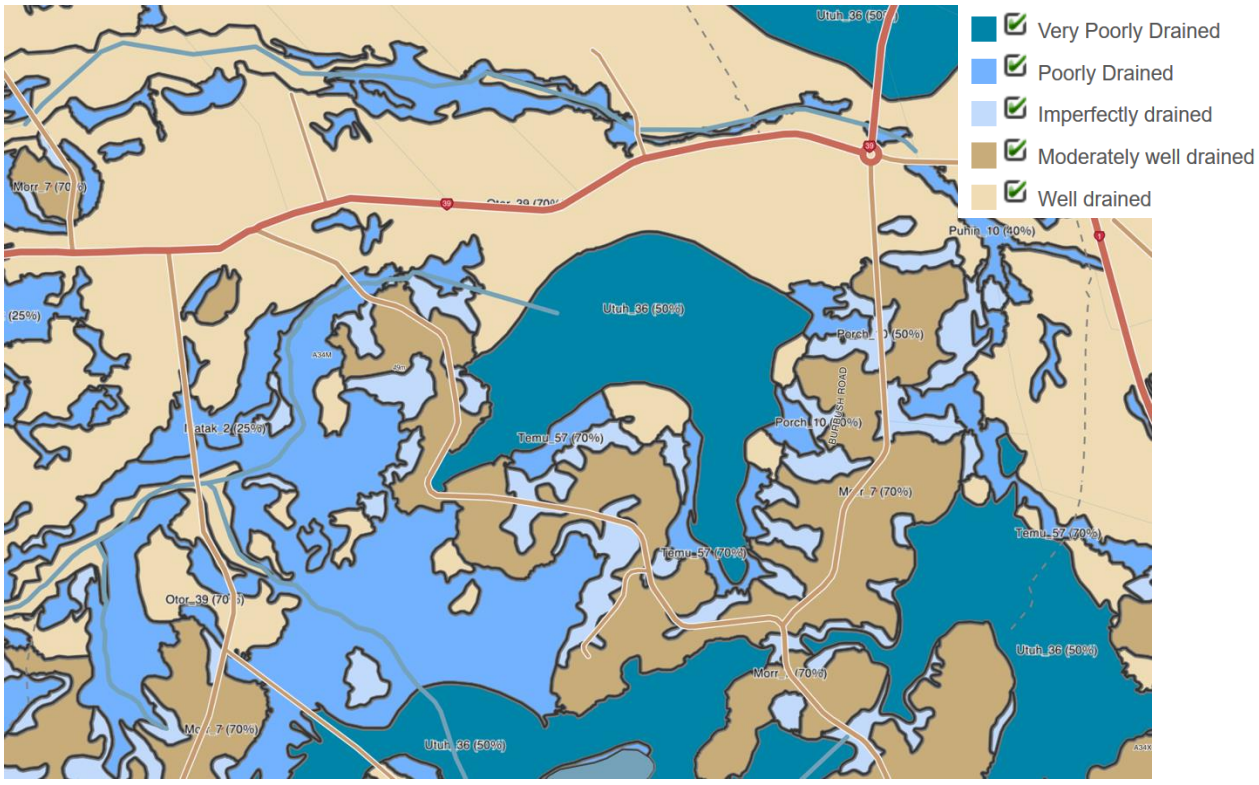
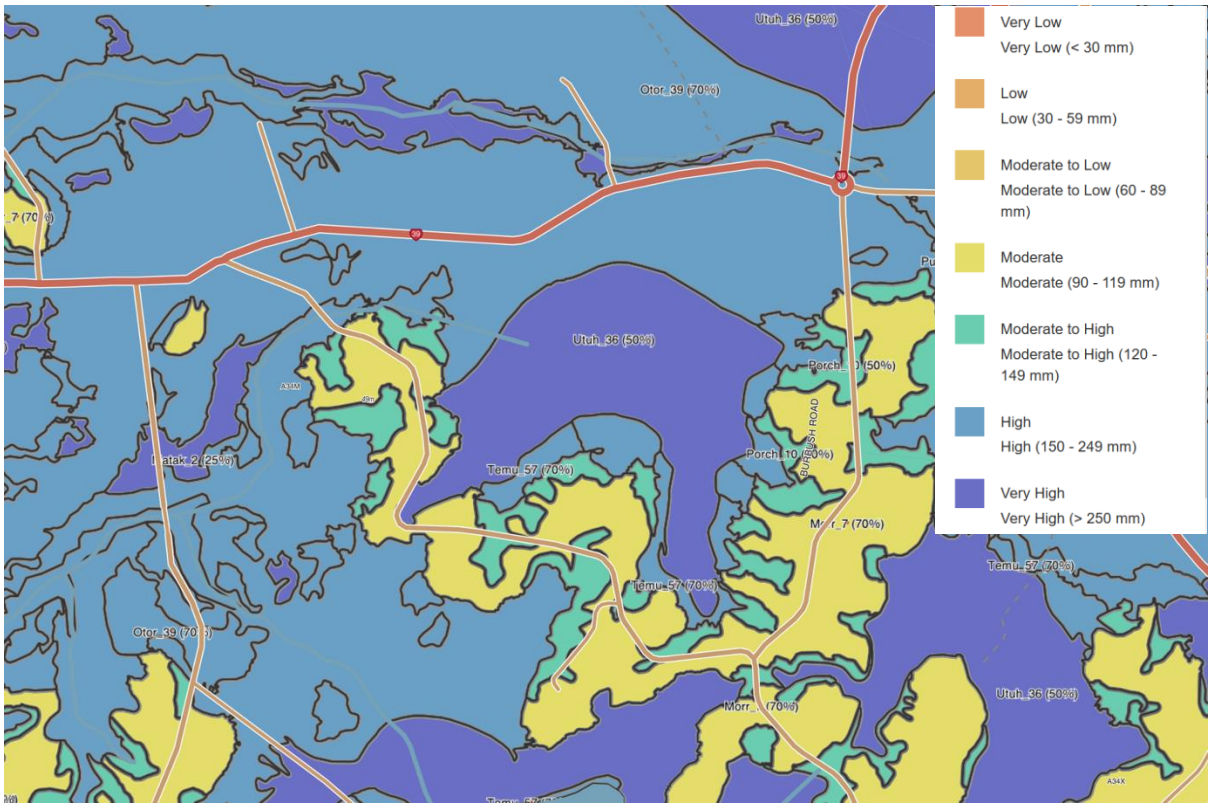


Figure 9: Soil Moisture



3.7 Hydrogeology

There are three significant surface water bodies within three kilometres of the Site:

- Lake Rotokauri, located approximately 1.3 km to the south from the southwestern-most extent of the Site;
- Horseshoe Lake, located approximately 2.5 km to the south/southeast from the south-eastern-most extent of the Site; and
- The Waikato River, located approximately 2.5 km from the eastern-most extent of the Site.

Surface water flows are expected to generally follow local topography, toward the east, north and west along drainage trenches through the site. The southeastern corner of the site drains towards Lake Rotokauri through a network of a stream tributaries feeding into Lake Rotokauri, and then into the Waipa River. The bulk of the catchment flows westwards along a network of farm drains into the Ohote stream and then into the Waipa River. The headwaters of Te Otamanui stream fall within the central northern portion of the site. And the Mangaheka stream flows along the eastern boundary of the site. Both Te Otamanui and Mangaheka catchments floe northwards out to the Rotokauri North site and then westwards to the Waipa River. However, groundwater is likely to be largely constrained from following the same routes by the hills to the east, west and south, and is likely to travel northeast towards the Waikato River Beca (2018).

A groundwater investigation conducted at the site by HD Geo (2018) revealed groundwater at a depth of approximately 0.1 to 1.5m (below ground surface) in the low-lying areas and

approximately 6m in the elevated areas.

3.8 Contaminated Land

An assessment and site inspection was undertaken to identify potentially contaminated sites by HD Geo (2018). The findings are summarised in the Preliminary Site Investigation ("**PSI**") included in the PPC supporting documentation.

Hazardous Activities and Industries List ("**HAIL**") sites are identified as sites where any potentially hazardous activities listed on the HAIL have occurred (or is currently occurring) as a result of past or current land use. The area is considered a HAIL site due to the potential sources of contamination identified in the PSI from rural activities.

The PSI recommends that prior to the development of the site (i.e. earthworks or subdivision) where potentially contaminating land uses and/or activities have taken place, a Detailed Site Investigation ("**DSI**") is recommended. The DSI would confirm if the identified land uses and/or activities have affected the site soils and will confirm the consenting requirements for those areas of the site in respect to remediation.

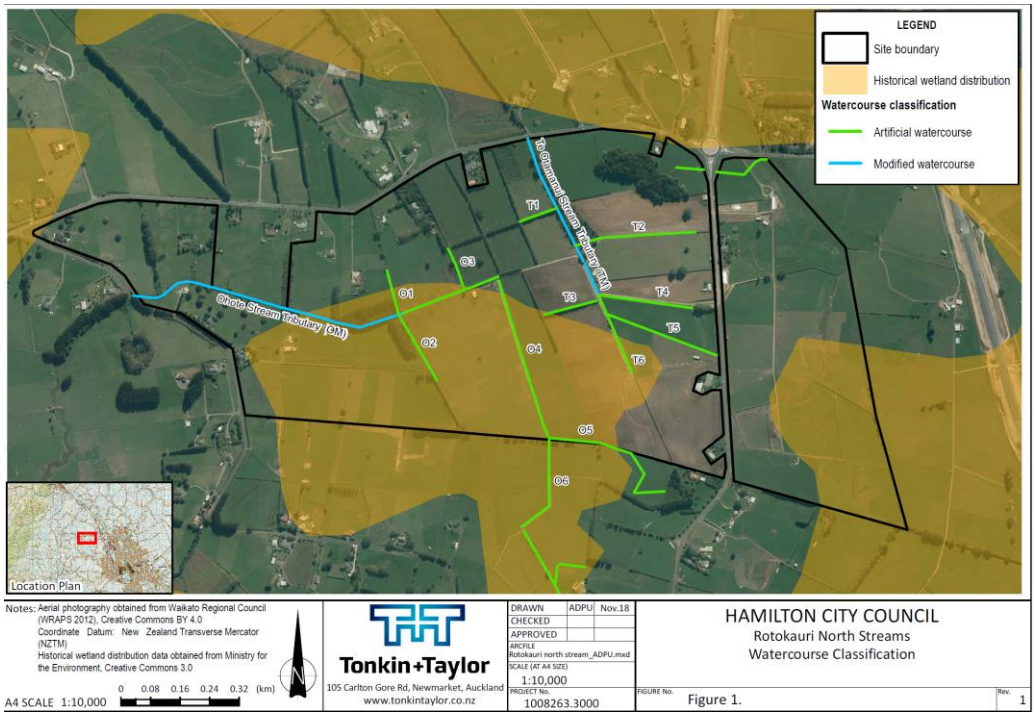
3.9 Fresh Water Environment

1.0. Stream Locations/Classifications

Tonkin & Taylor undertook an assessment to identify and classify (in accordance with WRP definitions) the watercourses located within the site.

The majority of the watercourses present within the site are consistent with the WRP definition for an "artificial watercourse", and all watercourses have been mapped as per Figure 10 below:

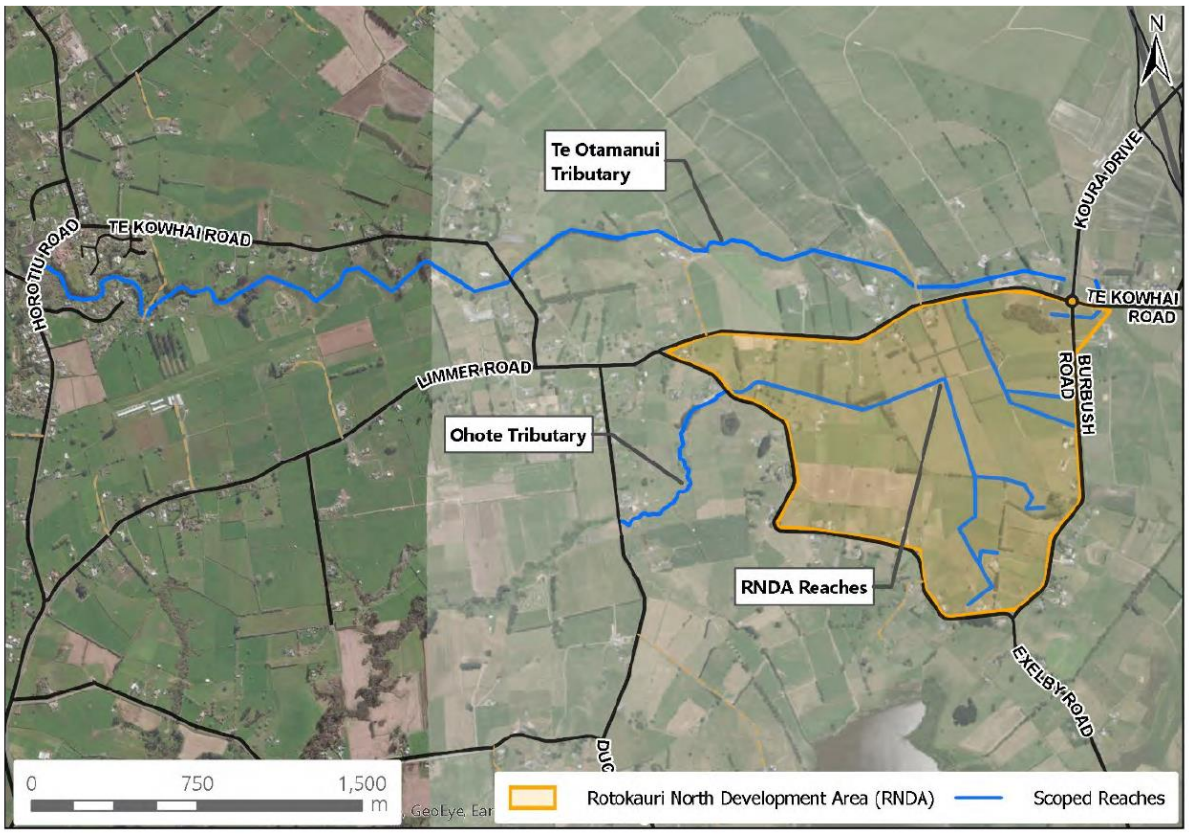
Figure 10: Watercourse Classification



2.0 Ohote and Te Otamanui Catchments

Morphum was engaged to undertake a watercourse ecology assessment of the Rotokauri North sub-catchment and its receiving environments of Te Otamanui Tributary and Ohote Stream, as shown in Figure 11.

Figure 11: Wider Tributaries



The watercourses in the sub-catchment and the receiving environments are soft-bottom streams and silt/sand are the dominate benthic substrate types. The flat topography of the area is reflected by the slow-flowing streams in the catchment.

The majority of the watercourses are located within agricultural pastoral land, with small areas of rural residential land use. These "agricultural streams" were found to have little to no native woody riparian vegetation and direct stock access to the stream channel is common with damage from stock, such as pugging of banks, evident along many reaches.

Generally, the watercourses show evidence of channel modification such as straightening, widening and deepening. Adjacent land use is dominated by agricultural, pastoral activities. Sparse vegetation consisting of gorse, barberry and poplar dominated these reaches. In the downstream reaches of Te Otamanui mixed vegetation provides moderate shading to the stream channel.

Erosion scarring of stream banks is largely attributed to anthropogenic activities such as 'drain cleaning', stock damage and a lack of riparian vegetation. Bank benching, bank instability and fine sediment deposition can be largely attributed to stock damage rather than erosion from high stormwater flows. In the downstream reaches of Te Otamanui, there is some evidence of fluvia erosion caused by larger flows through constricted channel.

No "highly unstable" banks were identified. However, nine reaches (downstream of Rotokauri North in Te Otamanui catchment) in total were found to be "unstable". Erosion hotspots were

also identified downstream of Rotokauri North.

Water Quality

Water quality results indicate poor water quality, with five measured parameters – including nitrogen and phosphorus exceeding the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (referred to hereafter by its industry reference as "**ANZECC**") trigger values. Sediment quality was indicative of agricultural land use, with high concentrations of arsenic at one site, but relatively low concentrations of heavy metals such as zinc and lead across the sampled sites. Specifically, the Morphum reporting found:

> *Five parameters exceeded the ANZECC trigger values set for lowland rivers and streams (protection of 95% of species) and the 'satisfactory' levels set by Waikato Regional Council for river water quality in the region (WRC, 2012)….*
>
> *Turbidity exceeded the guideline values at all five sites, and by a magnitude of five at TEOT2 (25 NTU). Turbidity indicates water clarity and studies have shown turbidity levels above 5 NTU have adverse effects on underwater light – and thus on plant and invertebrate production (Davies-Colley, 1991). Loss in water clarity also adversely impacts migration of common native freshwater fish species (Boubee et al., 1997). High sediment loads from the surrounding land use is contributing to high turbidity in the sub-catchment.*
>
> *Total nitrogen concentrations also exceeded the guideline values at all five sites. The highest concentrations were recorded in RNDA1 (4 g/m3) and TEOT1 (4.3 g/m3). Similarly, Total Kieldahl Nitrogen, which indicates the concentrations of biologically available nitrogen, exceeded guideline values at these two sites. The nitrogen concentrations results fall within the 'C' attribute state of the NPS-FM indicating an adverse effect on some sensitive species. These sites are downstream of cattle farms and stock access to the stream was recorded upstream of both these sites.*
>
> *Total phosphorus concentrations were also high in RNDA (0.18 g/m3), TEOT1(0.03 g/m3) and TEOT2 0.07 g/m3). Additionally, the site OHOTE, situated in the downstream reaches of the Ohote Stream (OHO_TRIB_1) also exceeded WRC guideline concentrations. Overall, the high concentrations of nutrients (N and P) are reflective of intensive agricultural land use in the sub-catchment."*

With regard to sediment quality, one site (within Te Otamanui catchment) exceeded the ANZECC Interim Sediment Quality Guidelines (ISQG) high trigger values for arsenic.

Overall, the guidelines proposed in the NPS-FM, ANZECC and supporting WRC documents suggest that the watercourses in Rotokauri North and the receiving environments are degraded.

Aquatic Ecology

Surveys for black mudfish were conducted at 4 sites, while sediment and water quality were conducted at five sites within the study area. No black mudfish were recorded at the sample sites.

No natural in-stream fish barriers such as cascades, waterfalls or dams were found in the sub-catchment, however, farm culverts within Rotokauri North were identified as currently posing a barrier to fish passage.

2.0 Mangaheka Catchment

Boffa Miskell were engaged to undertake a watercourse ecology assessment of the receiving environments of Mangaheka Stream in conjunction with the preparation of an ICMP (prepared by Beca) for the Mangaheka Catchment. Although not specifically prepared for the PPC area, the comments made in the report relating to that part of the Mangaheka catchment falling in the PPC area are relevant and have been relied on for this assessment.

> *"Downstream of the industrial area and Waikato Expressway, artificial farm drains flow north and northwest to Koura Drive, where they meet at the drain main stem. The drain then flows northwest through farmland before transitioning to a modified stream channel with perennial flow where natural topography forms a surface drainage channel. Outside the Hamilton City boundary, the catchment of the drains is almost entirely rural (dairy farming), comprising artificial farm drains, with very little riparian vegetation"*

Over the majority of the Mangaheka catchment (including that part included in Rotokauri North) the reporting identifies that vegetation has been widely modified over time with historic vegetation cover, including peat bog vegetation, replaced with exotic pasture grasses or crops and with exotic shrubs and trees established as shelterbelts. Indigenous plants are recorded as virtually non-existent throughout.

Aquatic Ecology / Water Quality

With respect to water quality the report generally identifies that in the upper catchment the watercourse type is an artificial watercourse (excavated drain) which generally provide poor habitat for fish and aquatic macroinvertebrates. Low or no flow, high temperatures, low dissolved oxygen, and very poor water clarity are likely to present fish passage barriers in this section of the catchment.

With respect to aquatic life the reporting generally finds that based on a fish survey (which was conducted in 2016) a total of four native species were identified, being: shortfin eel (Anguilla australis), longfin eel (Anguilla dieffenbachii), banded kokopu (Galaxias fasciatus), and black mudfish (Neochanna diversus); and one exotic species (mosquitofish). However, it was acknowledged that prior to development of the industrial land parcels in the upper catchment area in (in approximately 2011/12), three native species (mudfish (12 individuals), longfin eel (2 individuals) and shortfin eel (16 individuals)) were caught and translocated under permit from the upper catchment to the wetland area near Crawford Road in the lower part of the Mangaheka catchment.

4.0 Rotokauri South Catchment

There is no stream within this part of the PPC area.

5.0 Terrestrial Ecology

The site comprises mostly pasture and agricultural land. As previously outlined, there is a significant stand of kahikatea Trees adjacent to the intersection of Burbush Road and SH39 which is already protected under the HCDP provisions (and has a SNA overlay applied). All other vegetation is either associated with waterways (as accounted for in the assessment above), is of a shelterbelt/hedging variety, or associated with the garden areas of the dwellings.

As the area is already protected by the HCDP no further assessment of the values it holds have been undertaken nor are considered warranted.

Opportunities for the enhancement of terrestrial habitat are also proposed to be addressed through a specific assessment criterion for subdivision within the RNSP area.

3.10 Archaeology values

The area falls in drained swamp (fen) country. Archaeology reporting identified that in in 1919 the area was "drained swampy country" with "undulating country in grass" to the east, in the vicinity of Burbush Road. It is believed that due to the presence of the swamp and its subsequent draining there is no evidence of the land or buildings being used for European settlers until the 20th Century. No recorded European heritage features have been identified in the vicinity of the site.

The closest recorded archaeological site to the development area is S14/11, 700m southwest of Exelby Road. The site is recorded as being a pre-European Maori burial site.

Based on the archaeological survey of the site (CFH Heritage, 2018), there is no evidence of any pre-1900 archaeology or heritage, or any significant 20th century heritage.

3.11 Cultural values

The HCDP does not record any cultural or archaeological sites within Rotokauri North. The Burbush Road forest (SNA) is noted to be of high value. It has been acknowledged by the work undertaken for the Rotokauri ICMP and Structure Plan (Chapter 3 of the HCDP) that the wetland areas surrounding Lake Rotokauri may contained buried taonga.

Further background information on the cultural and archaeological significance of the catchment was provided in the cultural assessment undertaken by Nga Mana Toopu O Kirikiriroa (2001) in conjunction with the Rotokauri ICMP and Structure Plan.

Cultural Impact Assessments and iwi engagement for this ICMP are ongoing. Bi-weekly meetings are being held with THaWK hapu to work through cultural values (general) and any specifics that may occur for the RNDA. A Working Draft (suitable for lodgement) has been provided with the PPC.

3.12 Existing Three Waters infrastructure

As the site functions similar to a rural environment, there is no current wastewater infrastructure (other than specific onsite devices associated with the rural lifestyle land uses). There is an existing 100mm diameter watermain on the north side of Te Kowhai Road extending to the western extent of Rotokauri North.

Existing key culverts for stormwater conveyance were also identified in the description of the catchments in section 3.3 above.

4.0 KEY STAKEHOLDERS IN THE CATCHMENT

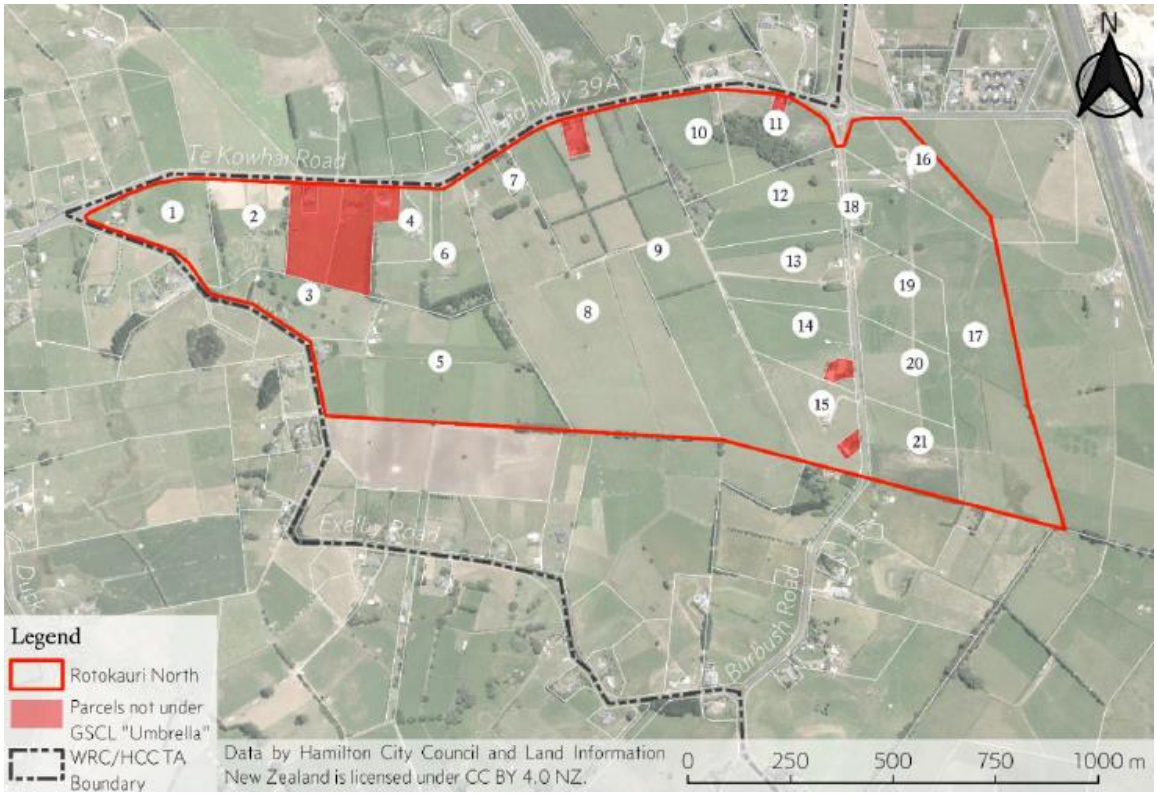
Key stakeholders for this ICMP include;

- GSCL
- HCC

- WDC
- WRC
- Waikato-Tainui
- Te Haa o te whenua o Kirikiriroa ("**THaWK**")
- Landowners

The majority of the land is under the control of GSCL through purchase by investors or is contracted to purchase. Figure 12 identifies those properties in the sub-catchment not falling under the GSCL "umbrella".

Figure 12: Properties outside GSCL control



Efforts have been made to consult all owners of land within the sub-catchment boundary as they have been identified as key stakeholders in this ICMP alongside the consultation for the PPC. A Consultation summary has been provided as an Attachment o the PPC.

5.0 DEVELOPMENT CONCEPT

5.1 Overview of Proposed Development

As outlined in detail in the PPC application, the PPC seeks to rezone 140 hectares within the identified "sub-catchment" from Future Urban Zone to:

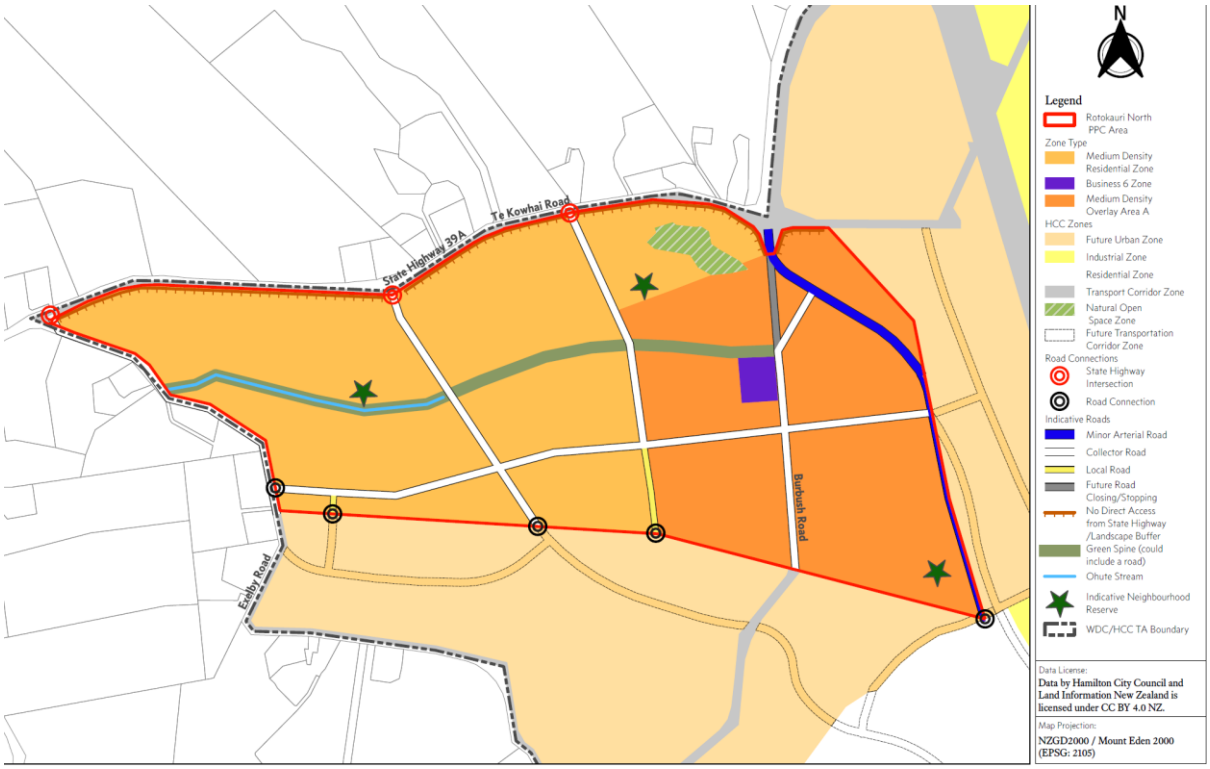
- Medium Density Residential (140 hectares); and

- Neighbourhood Centre (1.14 hectares).

The PPC and RNSP also identifies minimum vacant lot size (280m2), medium density housing opportunities, duplex housing opportunities, increased height overlays, indicative open space locations for neighbourhood reserves, an indicative sports park, and a hierarchy of key roads in indicative alignments and locations, along with key connections to the surrounding network and sites.

Approximately 2,000 dwellings are anticipated to be developed within Rotokauri North.

Figure 13: Rotokauri North Structure Plan



The remaining land within the ICMP will be retained as FUZ. However, maximum probable development scenarios have adopted an 80% impermeable rule for the development of the stormwater model and the ICMP.

5.2 Impervious Surfaces

Based on the zoning layout and the proposed PPC (and HCDP) provisions, the impervious areas expected within the development are outlined in Table 6 below:

Table 6: Impervious surfaces

Zone / Area	Percentage Impervious
Medium Density Residential	80% (per lot) – roofs, driveways, paved areas
Neighbourhood Centre	90% (across the entire B6Z)
Roads (approximate)	60% (each road) – carriageway seal, footpaths, vehicle crossings, paved areas

The 80% impervious rule for lots is based on HCDP rules and the definition for impermeable surfaces (notably for this ICMP they include pervious areas which are used for vehicle parking/manoeuvring).

5.3 Key Issues, Opportunities and Constraints

Taking into account any key site constraints identified above, the following Table 7 outlines any issues and constraints for the management of three waters and identifies any key opportunities that could be addressed (to assist in determining BPO's).

Table 7: Issues, Opportunities and Options

Broad Area / Issue	Issues/Potential Effects	Opportunities	Options for Three Waters management	
Topography	The majority of the site is flat. This creates potential issues for conveyance of three waters, specifically stormwater and wastewater. Inverts of existing streams, channels and culverts limit the vertical gradient available for stormwater conveyance. Development of a piped stormwater network would have compounding issues associated with reduced gradient, increasing diameters and required clearance between other services and carriageways. The flat topography will result in gravity wastewater network being at considerable depth (>5m). A transfer pump station will then be required to convey flows to the existing trunk wastewater (external to site).	For water: Minimal requirements for zone management across the site. For stormwater: • Potential to use of engineered wetlands for treatment (wetlands work better on flat sites). • Potential for above ground options such as swales to provide both conveyance and water quality treatment. For wastewater: • Potential suitability for low pressure system (rather than gravity serviced) to reduce depth of installation.	*Water*	As per current Technical Specifications.
			Wastewater	• Low pressure sewer network vs gravity network
			Stormwater	• Engineered wetlands for treatment and detention • Swales for conveyance

Broad Area / Issue	Issues/Potential Effects	Opportunities	Options for Three Waters management	
Soils/Permeability	Soil profile creates risk of liquefaction. Infiltration difficulties / low permeability with soils, which affects storage volumes for stormwater devices (and needs to be accounted for in design and sizing of devices, both on-lot and communal).		*Water* *Wastewater* *Stormwater*	 'Leak tight' standard (gravity system applicable only) Stabilise areas prone to liquefaction No onsite soakage
Groundwater	High groundwater table – potential for underground tanks and structures to rise (need to be weighted) and high potential for groundwater to enter stormwater devices and gravity wastewater network. Installation of gravity piped networks would require significant dewatering operations for trench excavations, increasing complexity of installation. Designers for stormwater devices to be wary that increasing excavation depth for devices will be counterproductive as it is likely that groundwater will enter device.	Utilise new above ground and green technologies for stormwater detention, etc. Utilise open channel and swale conveyance systems for stormwater. Consider low pressure sewer system to reduce infiltration to wastewater network, including whole of life cycle analysis considering capital and operating expenses inclusive of existing downstream asset (e.g., Pukete WWTP treatment costs).	*Water* *Wastewater* *Stormwater*	 Low pressure sewer system for reduced infiltration, and reduced construction difficulties. Groundwater monitoring for depth of groundwater table prior to design of wetlands/raingardens, etc. Provide impermeable lining for stormwater devices as identified by monitoring. Limit underground devices OR provide additional weighting to reduce buoyancy (additional cost.

Broad Area / Issue	Issues/Potential Effects	Opportunities	Options for Three Waters management	
	Gravity wastewater network would expose risk of infiltration occurring over asset design life, leading to reduced future capacity, increased treatment costs at Pukete Wastewater Treatment Plant.			
Significant Natural Area	Ensure all works are outside the SNA including devices and pipes for three waters.	Retain SNA (protected by a Zone in the HCDP).	*Water*	NA
			Wastewater	
			Stormwater	
Stream Network	Natural streams and farm drains (artificial watercourses) transverse the site. Stream channels are narrow with limited hydraulic capacity. Stability of existing farm drains uncertain in regards to liquefaction potential. Currently water quality is degraded. Depth of any proposed gravity wastewater networks affected by	Retain permanent natural watercourse (identified as modified watercourses by Tonkin & Taylor, 2018). Potential to utilise for conveyance of stormwater – widen stream margins, also providing benefit for reduction of liquefaction potential. Margins of stream corridors could be enhanced and works undertaken to naturalise straightened portions of streams	*Water*	
			Wastewater	Low pressure sewer system to reduce disturbance to watercourses. Removal of poorly performing septic tanks and disposal fields.
			Stormwater	Utilise natural stream network for conveyance – widen margins to accommodate additional flows. Treatment prior to entering streams.

Broad Area / Issue	Issues/Potential Effects	Opportunities	Options for Three Waters management	
	separation between watercourses and new assets. Gravity wastewater network will require emergency overflow structure(s) to manage abnormal flow conditions, specifically at pumping stations.	On lot treatment to improve water quality of the stream network and riparian planting. Low pressure sewer would follow road corridors and cross above watercourses at culvert locations. Existing performance of septic tanks and disposal fields for existing properties unknown. Removal of these has potential to improve stream water quality.		Riparian planting of stream margins (above the permanently wet flow level). Naturalise portions of stream where possible. Where possible remove farm culverts across natural watercourses. Allowance for fish passage.
Overland Flowpaths ("OLFP")	Stormwater runoff from the catchment has also been modelled. Potential risk should be accounted for in the design of flow path corridors. Gravity wastewater network manholes within road reserve that would be within overland flowpath.	Enable flows to pass through the site unimpeded by preserving OLFP routes (i.e., entry and exit points, along with capacity through the RNSP design). Consider type of wastewater manhole and chamber lids within road reserve to reduce potential for inflow from overland flowpaths. Utilise 'leak tight' wastewater networks to reduce the number of chambers within overland flow paths.	*Water*	
			Wastewater	Utilise 'leak tight' wastewater network or low-pressure sewers.
			Stormwater	Utilise road carriageway. Swales/communal corridor for flow conveyance.
Existing Culverts	• Some are undersized for flows (i.e., Exelby Road).	Remove farm culverts.	*Water*	
			Wastewater	

Broad Area / Issue	Issues/Potential Effects	Opportunities	Options for Three Waters management	
	• Some are restricting fish passage. • Onsite farm culverts.	Provide fish passage in new devices and naturalised baseflow channel. Upgrading of undersized culverts to be assessed based on capacity of downstream system (channels, streams, bridges/culverts outside the site).	*Stormwater*	Naturalise stream channels/remove farm drains/culverts, provide fish passage. Evaluate capacity of downstream networks to enable large culverts for additional flows.
Multiple Stormwater Catchments	• Multiple catchments across the site.	During development, align catchments boundaries to road network (rather than retain in current locations). Subject to further detailed assessment some catchments may have downstream capacity to take additional flows (i.e. increase some catchment areas).	Stormwater	Catchment boundaries modified at development stage to align with key roading network (utilising opportunities for conveyance associated with roads). Consider redirecting part of Te Otamanui to the Ohote to avoid the small Te Otamanui catchment/culvert under SH39.
Fragmented land ownership	• 15% of land subject to this ICMP falls in separate ownership. This creates issues for cost allocation associated with devices and conveyance networks, i.e., only one stormwater device at the bottom of the catchment creates a large land loss and cost obligation on one landowner. Coupled with	Within the stormwater network identify areas that can manage own stormwater. Site development in stages to allow for incremental construction of trunk water and wastewater networks. Mitigation measures for watermains risks developed (flushing programmes as needed).	*Water* *Wastewater* *Stormwater*	Develop stages for trunk network construction. As for Water. Sub-catchments falling outside of zoned and/or GSCL ownership be required to provide for own detention and treatment – at the time of development of those land areas.

Broad Area / Issue	Issues/Potential Effects	Opportunities	Options for Three Waters management	
	the fact that 10% of the land is not to the subject of the private plan change (and will retain its FUZ zoning) this also creates issues for HCC in having to maintain overdesigned/larger devices than what is necessary to treat the zoned land until such time that the remaining land is developed. • Similarly for the water and wastewater networks, the first landowner undertaking development will be required to install the trunk infrastructure to service the overall plan change development area. • Bulk watermains may have water age risks initially due to small stages. Performance of the water network dependent on HCC implementing upgrades as identified in the HCC Long Term Plan ("**LTP**"), with some upgrades to be constructed sooner than previously planned.	Mitigation measures developed for wastewater risks (odour, septicity, corrosion).		

Broad Area / Issue	Issues/Potential Effects	Opportunities	Options for Three Waters management	
	• Initial trunk wastewater assets likely to be oversized, thereby having odour, septicity and corrosion risks. Long Term Plan upgrades at the WWTP may need to be brought forward to deal with increased flows.			
Change in land use (from agricultural); AND Increase in impervious surfaces	• Concentration of flows and change in peak flows and volume for stormwater. • Increases in peak flow rates and volumes for all waters. • Increased temperate/heat. • Increased volume, velocity and heat of stormwater flows, can affect the physical shape and form of streams, cause scour and erosion within stream channels and at discharge points. • Increased water supply demand may require bringing forward network and treatment plant upgrades as per LTP. • Increased wastewater loading may require bringing forward network	Utilise water quality management and water sensitive design principles, including at source stormwater management, to mitigate increased flows and volumes from increased imperviousness. The range of lot sizes creates opportunities for a range of on-site retention and detention solutions for individual lots (for impervious surfaces). Sizing of wastewater networks to optimised using 'smart' sewers allowing all units to be telemetry controlled.	*Water* *Wastewater* *Stormwater*	Toolbox range of water sensitive design options, including those enabling potable water substitution. Low pressure 'smart' sewers to be provide telemetry controlled network for flow shifting and optimisation. Improve water quality through new on-lot and communal devices.

Broad Area / Issue	Issues/Potential Effects	Opportunities	Options for Three Waters management	
	and treatment plant upgrades as per LTP.			
Lot Sizes – Less than 280m2 and affordable lots	• Site area constrains above ground reuse and/or detention tanks. • Usually higher impervious surfaces/greater building coverage. • Insufficient area for soakage (and high groundwater table). • Cost of detention tanks and dual plumbing in the provision of affordable housing opportunities where fixed price points for sale of house and land packages apply.	Utilise new technology for above ground devices. Potential for communal devices to provide centralised treatment and storage location. Communal location allows for stormwater harvesting for secondary uses, e.g., reserve/garden watering.	*Water* *Wastewater* *Stormwater*	Limited potential for reuse. Limited toolbox range of devices to use.
Lot sizes greater than 280m2		Potential for a lower impervious surface threshold (i.e. 70%) due to site size and backyard size. Greater flexibility in type of retention and detention devices that can be used onsite.	*Water* *Wastewater* *Stormwater*	Some reuse potential Increased number of devices available in toolbox range. Additional planning rules for impervious surfaces.

Broad Area / Issue	Issues/Potential Effects	Opportunities	Options for Three Waters management	
Roads	Key contaminants of concern from high use roads into stream environments are heavy metals, sediment. Potential for increase in water temperature. Need quality treatment close to source. Space constraints due to access ways and services (but reduced where rear lanes access ways are used). Risk to road pavement where unable to provide subsoil drainage due to above ground stormwater conveyance and devices. Water and wastewater networks to be located within the road reserve.	Stormwater contaminants will need to be mitigated using devices compliant with TR 2013/035, Table 7 and designed according to the TP 10 water quality requirements. Pavement subsoil drainage to be integrated with stormwater conveyance system.	*Water*	Locate water supply network within berms as per current Technical Specifications.
			Wastewater	Locate wastewater networks with berms and carriageway as per current Technical Specifications.
			Stormwater	Potential for treatment train of devices (at source) to remove contaminants. Groundwater monitoring for depth prior to design of subsoil drains, etc.
Car Parking Area (Neighbourhood Centre areas).	Key contaminants of concern from high contaminant parking areas into stream environment are heavy metals (zinc/copper), sediment and increase in temperature.	Stormwater contaminants will need to be mitigated using devices compliant with TR 2013/035, Table 7 and designed according to the TP 10 water quality requirements.	*Water*	
			Wastewater	

Broad Area / Issue	Issues/Potential Effects	Opportunities	Options for Three Waters management	
	Need treatment close to source. Space constraints due to access ways and services. Risk to road pavement due to stormwater device having higher water level than adjacent subsoil drainage.	Consider treatment devices at car parking area to complement architecture and landscaping design.	*Stormwater* *Wastewater* *Stormwater*	Potential for treatment train of devices (at source) to remove contaminants. Groundwater monitoring for groundwater table depth prior to design of subsoil drains etc

5.4 Operational Objectives

Taking into account the above issues and opportunities, the following operational objectives have been derived to address the issues and to align with the strategic objectives outlined in above.

Due to the overlap with the Mangaheka catchment (and similarity in many of the issues) the objectives below have been derived generally from the Mangaheka operational objectives. However minor difference have been identified with ***bold and italics*** for clarity.

Table 8: Operational Objectives

Operational Objective	Description
OO1	**Maintain or Enhance Mangaheka, *Te Otamanui and Ohote* Streams' Water Quality** (a) Contaminants derived from urban or road stormwater are managed through appropriately designed treatment devices, so that any increase in mass contaminant loads and concentrations in the receiving environment following development, are minimised as much as practicable. For general guidance purposes the following guidelines (or updates thereof) are referred: i. For in-stream water quality and comparison with baseline contaminant concentrations: ANZECC, 2000 – 'Australian and New Zealand Guidelines for Fresh and Marine Water Quality'; ii. For in-stream sediment quality and comparison with baseline contaminant concentrations: ANZECC, 2000 –'Australian and New Zealand Guidelines for Fresh and Marine Water Quality / Interim Sediment Quality Guidelines ("**ISQG**")'**;** ***and*** ii. For treatment device design and performance efficiencies: HCC ITS. (b) Primary stormwater treatment devices must achieve at least 75% sediment removal on an average long-term basis. (c) Devices servicing roading should be suitable for the removal of hydrocarbons and heavy metals. (d) To avoid increases in temperature in downstream receiving waterways, open water areas must be avoided in treatment devices and wetland vegetation cover must exceed 80% of the device surface area. (e) Where it is shown that a single device will not address receiving environment sensitivities, ~~***that***~~ ***then*** a treatment train approach should be adopted to minimise temperature effects and maximise contaminant removal.

Operational Objective	Description
	(f) Construction generated sediment shall be controlled to meet Waikato Regional Council standards and shall comply with relevant city bylaws and District Plan requirements *This objective aligns with strategic catchment objective 6.*
OO2	**Minimise Alterations to the Natural Flow Regime** (a) The erosion and scour of the bed and banks of the Mangaheka***, or Ohote or Te Otamanui*** stream**s** and other catchment waterways is not increased following proposed development within Hamilton City Council boundary. Where it is identified that stormwater discharges will have an effect on aquatic habitat and water quality values, then additional mitigation measures will be required (e.g. on-lot treatment / detention). (b) Where stormwater discharge to the Mangaheka, ***Ohote or Te Otamanui*** stream**s** needs to occur, extended detention shall be provided by the proposed stormwater management structures in accordance with ITS to control flow velocities and erosion. (c) Energy dissipation and erosion protection measures are provided at all discharge locations, and preference is given to green engineering solutions over hard engineering solutions based on rock and concrete. (d) Stream flooding in a land drainage area shall be managed to the extent that the ponding from a storm with a 10% probability of occurring in any one year (the 10% Annual Exceedance Probability (AEP) event or '10 year storm') shall be removed within three days. *This objective addresses aligns with strategic catchment objective 4.*
003	**Utilise Water Sensitive Practices** (a) Where on-lot, ***groundwater, geotechnical*** and soil conditions allow, stormwater ***can ~~shall~~*** be discharged directly to ground via soakage. This will minimise increases in discharge volume, help to recharge groundwater, maintain stream base flows, and mimic the natural water cycle. (b) The use of 'water sensitive practices' shall be incorporated into the stormwater management approach for the catchment. (c) Where it is shown that a single device will not address flood risk or receiving environment sensitivities a treatment train approach shall be adopted. *This objective addresses aligns with strategic catchment objectives 2 and 7*
004	**Promote Riparian Margin Enhancement and Re-Vegetation** (a) Riparian planting shall be undertaken ***within the RNSP area*** to mitigate effects of urbanisation in potentially affected areas. (b) Stock fencing shall be erected along stream banks to reduce bank erosion as well as help reduce suspended solids and pathogens in the water column.

Operational Objective	Description
	(c) Works using natural solutions or green engineering which will enhance habitat and maintain natural stream processes in a soft sediment environment are preferred over hard engineering solutions using rock and concrete. *This objective aligns with strategic catchment objectives 1, 2 and 5.*
005	**Have Due Regard for Economic Affordability and Safety** (a) Proposed stormwater management systems are cost-efficient during long term operation and maintenance. (b) Stormwater and wastewater management systems are designed for public safety. (c) Where it is shown that a single device will not address flood risk or receiving environment sensitivities, that a treatment train approach, incorporating an approved at source device upstream of a centralised public device, shall be adopted. (d) Limitations for onsite mitigation associated with affordable housing are acknowledged. This objective aligns with strategic objectives 1, and 4.
006	**Protect Cultural Values** (a) Riparian planting shall be encouraged by Hamilton City Council throughout the catchment in conjunction with developers, landowners, local iwi and other interested parties. Planting shall include an appropriate mix of native eco-sourced plant species. This objective aligns with strategic catchment objectives 1, 2, 3 and 5.
007	**Maintain or Improve Flood Protection Level of Service** (a) Where existing flooding is known, or potential flooding is predicted, peak flow management is generally required with reduction to 70% of predevelopment flow for the 100 year ARI storm event. (b) Overland flow paths shall be provided for all stormwater discharges in accordance with Hamilton City Council standards. Wherever possible, the use of private property for overland flow paths shall be avoided. (c) Sufficient freeboard protection, in accordance with Hamilton City Council standards, shall be provided to building floor levels. This objective aligns with strategic catchment objectives 1 and 4.
008	**Minimise water consumption and wastewater discharge** (a) That rainwater re-use tanks are installed and plumbed into non-potable water systems on-lot ***where practicable***. (b) That water efficient fittings are incorporated into ***dwellings and*** businesses and promote sustainable water use practices. (c) That the size of infrastructure is minimised by promoting sustainable water use.

Operational Objective	Description
	(d) That future infrastructure upgrades are avoided or minimised by identifying and managing inefficiencies such as leakage, inflow & infiltration and unauthorised use. *This objective aligns with strategic catchment objective 7.*
009	**Integrated water management** (a) Plan and implement three waters networks on a catchment wide basis to minimise the number of public stormwater treatment devices, wastewater pump stations and storage devices. (b) Where it is shown that a single device will not address receiving environment sensitivities, that a treatment train approach, incorporating an approved at source device upstream of a centralised public device, shall be adopted and include minimisation of temperature effects, metals, metalloids and PAHs. Construction generated sediment shall be controlled to Waikato Regional Council standards and relevant city bylaws. *This objective aligns with strategic catchment objective 7.*

6.0 THREE WATERS MANAGEMENT AND CAPACITY - WATER

6.1 Existing Network Capacity

Water supply for Rotokauri North is dependent on trunk main extensions from the eastern side of the Waikato Expressway, and extension of watermains through Rotokauri South.

Given funding availability within the LTP for the trunk main extensions, and the time to develop (and hence extension of the watermain network) land from the south, an alternative supply source will be required.

6.2 Estimated Water Demand and Modelling

Water supply for Rotokauri North will be located within the Pukete Zone, as per HCC Water Master Plan philosophy. The same Water Master Plan has identified trunk network upgrades to service both Rotokauri North and South. However, the Master Plan had not allowed for the level of development currently being considered within the PPC within Rotokauri North at this time. Detail of the demand and modelling is provided in the McKenzie & Co (2019) Water Supply & Wastewater Report.

Rotokauri North will be serviced from the existing and master planned HCC networks at Te Kowhai Road and Wetini Drive. Water supply modelling results showed that these connections had sufficient capacity to service the area, once upgrades as programmed in Master Plan for 2061 were implemented. Modelling results for the DN350 ring main network showed that it would have sufficient capacity to meet the level of service requirements, principally firefighting demand.

Rotokauri North will cover approximately 140 hectares, with an equivalent population estimated to be more than 5,900. Based on Waikato Local Area Shared Services Regional

Infrastructure Technical Standards (Section 6) the key water flow scenarios are:

- Average Day Demand = 1,537 kL/d (17.8 L/s)
- Peak Day Demand = 89 L/s
- Peak Hour Demand = 109 L/s

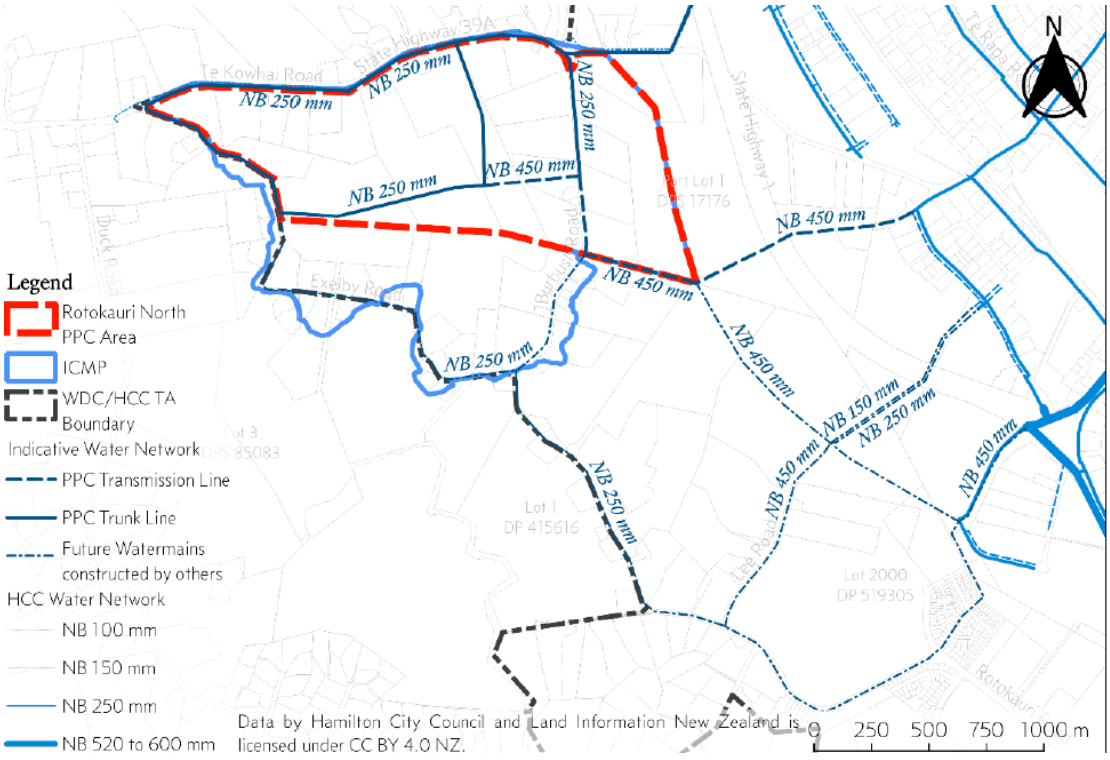
For land that will remain FUZ under this ICMP and PPC, the ultimate network for RNDA and Rotokauri South will have sufficient capacity to enable future connections at such time that land is re-zoned for future development. The HCC water supply network would have sufficient capacity to service the FUZ land after implementation of upgrades as per HCC water supply masterplan.

It is acknowledged that the site conditions could make it desirable at development stage to consider options for a low pressure system rather than a gravity fed wastewater system. This detail can be explored further in conjunction with site development.

6.3 Required Water Upgrades

In order to serve the RNSP the water supply network needs to be provided as per Figure 14 below, and as per the HCC Water Supply Masterplan. However, it is not intended that under this ICMP or development of the RNSP area that the ultimate solution be delivered.

Figure 14: Indicative Water Network



7.0 THREE WATERS MANAGEMENT AND CAPACITY - WASTEWATER

7.1 Existing Network Capacity

The existing 1050mm Far Western Interceptor ("**FWI**") is available on the western side of the Waikato expressway, some 200m south of Te Kowhai Road (SH39). The FWI is intended to service (subject to an extension to this infrastructure) Rotokauri North for wastewater. However, the proposed RNSP will impose additional demand on the Wastewater Treatment Plant ("**WWTP**") ahead of what is planned under the Rotokauri Structure Plan of the HCDP and existing Rotokauri ICMP.

7.2 Estimated Wastewater Demand and Modelling

Design Criteria

Wastewater networks have been designed with regard to the Regional Infrastructure Technical Standards ("**RITS**"), Waikato Local Area Shared Services ("**LASS**"). Detail of the demand and modelling is provided in the McKenzie & Co Consultants (2019) Water Supply & Wastewater Report.

Wastewater Flow Summary

- Rotokauri North will be serviced by an existing connection to the HCC FWI, with this connection provided as part of future proofing of the interceptor. The flow contributing to the HCC network was based on an approximate area of 140 hectares, with an equivalent population of ~5,900. Based on Waikato Local Area Shared Services Regional Infrastructure Technical Standards (Section 5) the key wastewater flow scenarios were:
    - Average daily flow = 1,481 kL/d (17.1 L/s);
    - Peak dry weather flow = 39 L/s; and
    - Peak wet weather flow = 64 L/s.

Wider wastewater infrastructure (trunk, WWTP)

A wastewater impact assessment using the HCC Wastewater Master Plan model was undertaken based on the equivalent population of approximately 5,900. The assessment considered the impact of Rotokauri North on the receiving wastewater network for the 2061 horizon. It was noted that any significant increases in density, and consequently the equivalent population, will affect modelling results. Hence, further modelling may be needed to assess the network under any new density parameters. Based on the model outputs, taking in to account the assumptions and limitations, it was concluded that:

(a) The FWI appears to have sufficient capacity to accommodate the additional RNDA development flows without worsening, or creating any existing, or new network system performance issues, respectively.

(b) System performance results for spare pipe capacity and maximum water level were over predicted due to the effects associated with point loading of the Rotokauri

North catchments. The magnitude of over prediction could not be quantified as part of the assessment. The predicted spare pipe capacity was likely to be greater than indicated by this assessment for both modelled scenarios (with and without Rotokauri North, if the discharge enters the trunk reticulation servicing the development before entering the existing network (FWI).

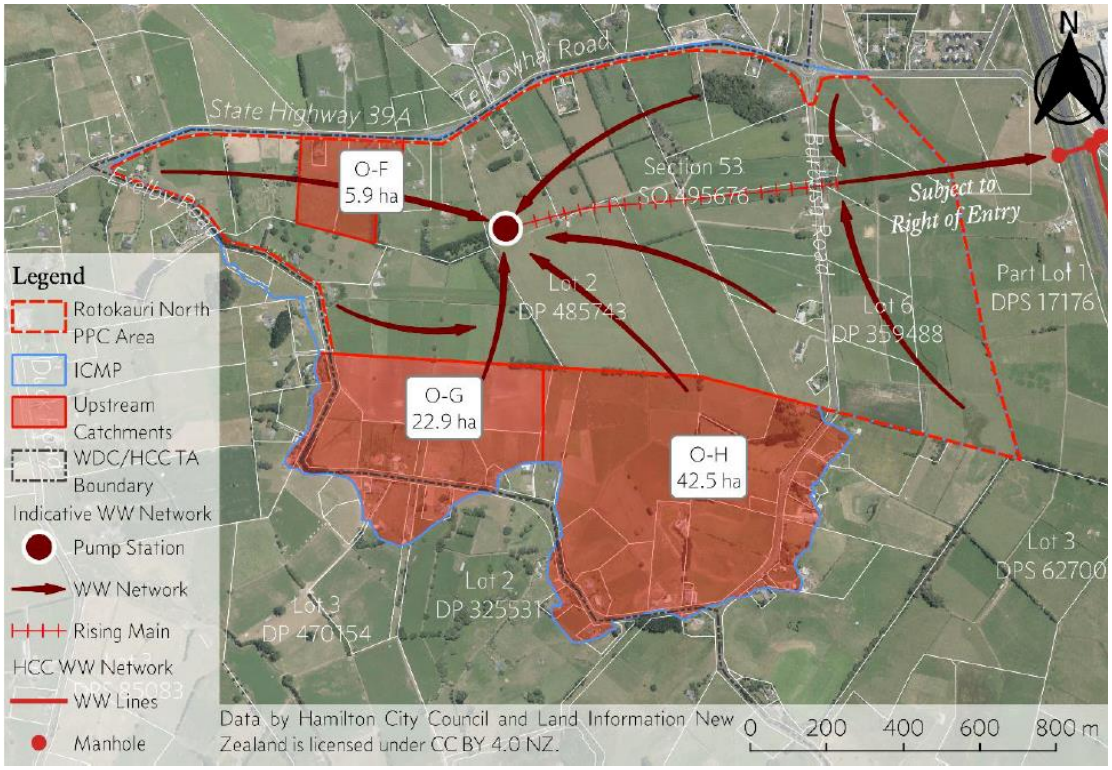
(c) Rotokauri North is likely to increase pipe filling in some sections to nearly 100 percent, thereby utilising capacity as installed or master planned. However as per (b.) above, this is likely to an over estimate of actual pipe filling.

(d) Future development discharges to the FWI in addition to current allowances, and Rotokauri North, may cause new issues or worsen existing network system performance.

7.3 Required Wastewater Infrastructure and Existing Infrastructure Upgrades

In order to serve the RNSP area, the wastewater network needs to be provided as per Figure 15 below.

Figure 15: Indicative Trunk Gravity Network.



8.0 THREE WATERS MANAGEMENT AND CAPACITY - STORMWATER

8.1 Objectives of the Stormwater Strategy

The overarching stormwater objective is to minimise the effects of urban development on the receiving environment by managing the water quality, post development hydrology and the risk of flooding.

The objectives of the ICMP to achieve the overarching objective are:

- Detention of all event (2-, 10- and 100-year events) flows to mitigate onsite and downstream flooding;
- Extended detention of all flows to protect the receiving environment from erosion;
- Treatment of stormwater for pollutants prior to discharge;
- Reticulation of the 2/10-year rainfall event (2-year for residential areas, and 10-year for commercial areas); and
- Accommodation of overland flow paths for the 100 year+cc ARI rainfall event.

8.2 Stormwater Design Parameters

General

This section summarises the key design requirements contained within the IRTS for stormwater and the HCDP's information requirements for a sub-catchment ICMP. It is not exhaustive, but instead covers all those issues considered core requirements in the approach to managing stormwater within the sub-catchment.

The RITS for stormwater sets out the requirements for the design and construction of stormwater systems for land development and subdivision in the following specification documents;

- RITS – Section 4 – Stormwater – May 2018
- Section 4 – Stormwater – Drawings; and
- Section 4 – Stormwater – Forms and Checklists

The key design and construction requirements from these documents (and any predecessor documents) should be used to guide design of specific devices.

Water Efficiencies

HCDP rule 25.13.4.5 requires the use of water efficiency measures being at least one water sensitive technique for stormwater to be incorporated, connected to, achieved or maintained as part of any new residential unit or other new buildings containing a kitchen, laundry or bathroom facility.

Water efficiency measures may consist of any of the following:

- Detention of stormwater to 80% of pre-development runoff by an appropriate means;
- Permeable surface areas emphasised where possible, to achieve at least 20% above the minimum standard of the zone;
- Rainwater tank for non-potable reuse; and
- Other equivalent features.

These measures are required in addition to any quality and quantity requirements under RITS, and are described below and have been incorporated into the overall management of stormwater.

Water Quality

The proposed development will include residential and commercial land use, which are comparatively low contaminant producing activities.

Under RITS the majority of the proposed development would be considered a "normal contaminant load profile", as roads are expected to convey less than 10,000 vehicles per day, buildings will have inert roofs, and the residential areas will not have carpark areas greater than 750m^2.

However, the Neighbourhood Centre (B6Z) may have relatively large uncovered carparks greater than 750m^2, which will be considered "high contaminant load profile" areas.

The RITS stormwater treatment requirements are summarised in Table 9 below:

Table 9: RITS Treatment Train Design Requirements

Landuse Contaminant Category	Treatment Train Requirements
Normal Contaminant Load Profile.	Primary pre-treatment at source via water efficiency measure (e.g., Detention tank, raingarden, rainwater reuse, permeable surfaces, or soakage). Centralised stormwater treatment device (including extended detention volume ("**EDV**") if required).
High Contaminant Load Profile.	Primary pre-treatment at source via a gross pollutant trap or other treatment device (which will include meeting any District Plan requirements) to manage high sediment loads or any contaminants specific to the land use. Centralised stormwater treatment device (including EDV if required).

These measures have been incorporated into the overall stormwater concept below.

8.3 Stormwater Concept

In general land falling within the Mangaheka and Rotokauri South catchments (identified above) should adhere to the BPOs and implementation requirements of those relevant ICMPs. It is not the intention of this ICMP to reassess existing BPOs. **However,** there are some overarching recommendations of this ICMP which impose additional restrictions over and above the adopted ICMPs. These are clearly identified in the breakdown of recommendations below. Where the recommendations of this ICMP exceeded the requirements of the Mangaheka or Rotokauri ICMPs, the higher requirements imposed under this ICMP shall apply. Refer also to the Stormwater Modelling and MUSIC Modelling report prepared by McKenzie & Co. Consultants (2019).

8.3.1 Strategy

The overarching strategy for stormwater is detailed in section 5 of the Stormwater Modelling and MUSIC Modelling report prepared by McKenzie & Co. Consultants (2019).

It includes a treatment train approach from individual lots to communal devices prior to discharge to the receiving environment and includes the following;

- Quality;
- Retention/Re-use and Detention;
- Conveyance for 10-year$_{cc}$ and 100-year$_{cc}$ rainfall events; and
- Application of Water Sensitive Design for road reserves and lots.

The flow effects will also be mitigated by applying at source stormwater detention wherever practicable.

The McKenzie & Co. Consultants (2019) Modelling report provides greater detail on device and flow sizing, etc., for each component of the "treatment train".

8.3.2 Design Parameters

Overall, a treatment train approach is expected for all development within Rotokauri North, which provides for at source treatment and detention for "standard" lots (> 280m^2), and communal treatment and detention for "small" lots (< 280m^2) prior to discharge to the receiving environment. Key targets and design parameters that the development is expected to achieve in all catchments include the following:

Table 10: Design Parameters

Item/Parameter	Requirement
Flow	
Extended Detention	24mm, 24 hours (RITS)
Peak Flow Attenuation	2, 10 and 100-year storm events (discharge of peak flow at 80% of ED).
Flood Storage (100-year event)	
Flood storage proportional to development	Catchments to provide equitable flood storage to development area. Where land is owned/under control of the same party, flood storage may be provided across catchments.
Flood Storage (General)	Flood storage to be achieved in green corridors, conveyance channels, swales and road reserves sized to detain difference between MPD and 80% ED.
Flood Storage (on lots)	Lots which have sufficient space to provide for flood storage/detention (i.e. single dwelling lots larger than 280m^2) should contribute to flood storage to achieve 5m^3.
Overland Flows	
Overland Flows	Overland flow in roads, conveyance channels, swales or designated green corridors to convey Maximum Probable Development. 100-year flow as per the RITS.
Freeboard	
Residential lot Freeboard	Freeboard shall be provided as per the requirements of the RITS. Where the RITS refers to freeboard above the calculated flood level, the calculated flood level shall be the higher of: • The appropriate flood level based on the subdivision and • development design (i.e. 100-year ARI overland flow paths and local freeboards); • The final design flood level of the major drainage system; and • Further assessment will be required to define these levels.
Water Quality at the discharge point of communal devices (or on lot in the absence of a communal device) and after reasonable mixing	
Stormwater	Increase in concentration <10% of existing

Item/Parameter	Requirement
Discharges	Concentration shall not exceed 100 g/m³ Minimum 75% TSS removal achieved via overall treatment system / treatment train
Temperature	No more than 3°C change in water temperature AND not greater than 23°C
Turbidity	No greater than 25 NTU in the stormwater discharge in a water quality storm (1/3rd of a 2 year 24 hour storm).
Dissolved Oxygen	Greater than 80% of saturation concentration. However, if the concentration of dissolved oxygen in the receiving environment is below 80 percent saturation, any discharge into the water shall not lower it further.
Ammoniacal Nitrogen	<0.88 g/m³
Nitrogen	6.9 mg/L
Colour/Visual Clarity	No conspicuous change in colour or clarity (1/3rd of a 2-year 24-hour storm).
Hydrocarbons	No visible sheen
Gross Pollutants	No gross pollutants
Other Contaminants	Removal in accordance with the RITS. Restrict roofing material (inert only) to avoid further contaminants (zinc/heavy metals) On lot devices may also be required for high use activities.

8.3.3 Stormwater Catchments

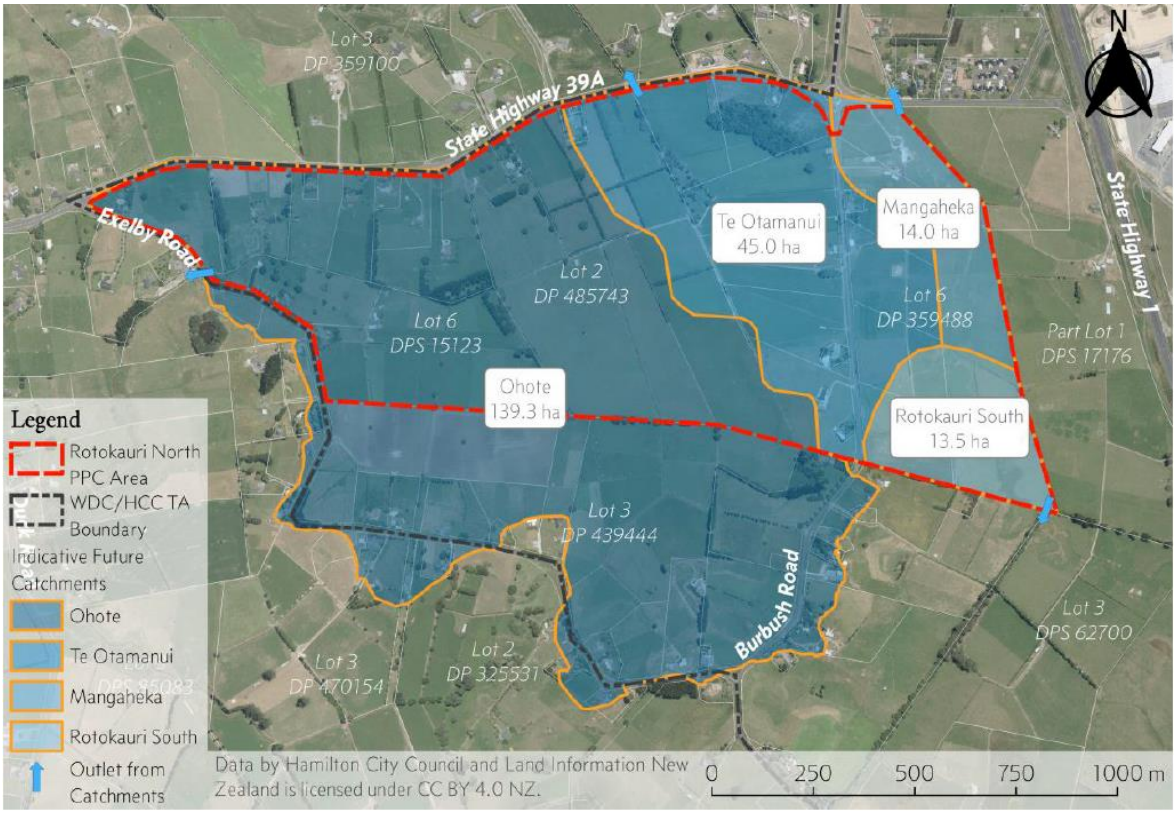
Stormwater Catchments and Sub Catchments Outline

The proposed site topography ties into the existing landform as much as possible (within the requirements of Council design standards), with the road network and green corridors generally following existing natural overland flow path locations. Any changes to the catchments boundaries to align with development roading/green corridors have ensured that the overall flow at discharge points at the ICMP boundaries are the same as/similar to existing scenarios.

Table 11: Proposed Catchment boundaries/areas

Catchment Reference	Existing Area (ha)	Proposed Area (ha)	Comments
Ohote	136.7	139.3	Catchment area was the area upstream of Exelby Road culvert
Te Otamanui West	6.9	0.0	Area to be redirected to Ohote catchment
Te Otamanui East	39.3	45.0	Boundary adjusted with Ohote catchment
Mangaheka	14.9	14.0	Minor adjustment with the Te Otamanui and Rotokauri North catchments
Rotokauri South	14.0	13.5	Minor adjustment with the Mangaheka catchment

Figure 16: Proposed Catchment boundaries/areas



The Ohote catchment has been subdivided further into five indicative sub-catchments; Te Otamanui into two indicative sub-catchments, Mangaheka into three, and Rotokauri South into three indicative sub-catchments. It is expected that each sub-catchment directs stormwater via swales to a wetland (see indicative wetland inlet locations indicated in

Figure 16). Stormwater is then conveyed by swale to the various receiving environment at the

boundary of Rotokauri North. Offline dry detention basins or other similar devices can be used to provide the necessary detention.

Individual catchment extended detention and flows are contained in section 3.7 of the McKenzie & Co. Consultants (2019) Modelling report.

Stormwater Catchment/Flow Options

In addition to the design parameters and catchment descriptions described above, the following options have also been identified for the Ohote Catchment in respect to discharge flows from the catchment:

Table 12: Ohote Catchment Discharge Options

Option	Description	Benefits/Opportunities	Risks/Costs
Option 1	Retain current discharge rate at Exelby culvert.	status quo re downstream erosion effects.	Additional detention volume required to control flows and mitigate against potential flooding and erosion effects downstream.
Option 2	Retain current discharge rate and upgrade culvert to allow 80% ED flow to pass unattenuated.	Potential to reduce onsite detention/flood storage within the RNSP area.	Culvert upgrade required.
Option 3	Increase culvert size and modify invert levels to allow greater flow than 80% ED downstream of Exelby Road within third party land. Further assessment can be undertaken prior to and in conjunction with any application to the Regional Council for stormwater discharge. Final sizing of culvert is dependent on this investigation.	Potential to reduce onsite detention/flood storage within the RNSP area.	Culvert upgrade. Downstream mitigation works (potentially). May require downstream storage (design dependant)

8.3.4 Evaluation of Device and Location Options (Toolbox)

Table 13 provides a summary of methodologies that could be used to potentially address stormwater management issues in the catchment, with commentary regarding how the option could be implemented and strengths/weaknesses of the devices/options. This was used to evaluate devices to determine the best practicable option.

Table 13: Device Options

Device Type	Application Area				SW Function	Strength/ advantage	Weakness/ limitations	Suitable for Rotokauri North ICMP area
	Res	Business	Roads	Other				
Above ground tanks	Yes	Yes	No	No	Reuse Detention	• Reuse reduces water usage and water demands as water can be re-use on site (dual plumbing and/or garden watering) • Reduces impact of built environment on natural flow regime • Capture first flush runoff • Reduce peak flows for up to 10 year events • Medium volume reduction; • Minor cost reduction of water supply.	• Not viable for impermeable ground surfaces due to surface flow not being able to enter tank. • Reliance on many individual parties maintaining infrastructure (risk) • Moderate cost of installation and ongoing maintenance. • Above ground tanks take up space in rear yards (space varies dependant on type of tank used) • Low peak flow control • Need to consider setback from foundation of house for design purposes • Most effective when designed to meet a specific need for water reuse, i.e., non-potable use within dwelling/apartment building. • Need to consider enabling planning framework in PPC	Yes - but need to be restricted to larger sized lots due to space constraints, or affordability limitations associated with 10% affordable housing

Device Type	Application Area				SW Function	Strength/ advantage	Weakness/ limitations	Suitable for Rotokauri North ICMP area
	Res	Business	Roads	Other				
Below ground tanks	Yes	Yes	Yes	Yes	Reuse Detention	• Reuse reduces water usage and water demands as water can be re-use on site (dual plumbing and/or garden watering) • Reduces impact of built environment on natural flow regime • Capture first flush runoff • Reduce peak flows for up to 10-year events • Medium volume reduction; • Minor cost reduction of water supply.	• Requires hydraulic head or pump to discharge detention volume. • Increased cost to weigh devices down due to high groundwater table • Reliance on many individual parties maintaining infrastructure (risk) • Moderate to high cost of installation and ongoing maintenance. • Low peak flow control • Need to consider setback from foundation of house for design purposes • Most effective when designed to meet a specific need for water reuse, i.e., non-potable use within dwelling/apartment building. • Need to consider enabling planning framework in PPC	Yes - but need to consider tank buoyancy, lot constraints, and affordability limitations associated with 10% affordable housing
Bioretention device (Tree Pit,	Yes	Yes	Yes	Yes	Detention Treatment	• Can be used in all anthropogenic environments;	• Limited ponding depth;	Only in areas where the

Device Type	Application Area				SW Function	Strength/ advantage	Weakness/ limitations	Suitable for Rotokauri North ICMP area
	Res	Business	Roads	Other				
Raingarden, or bioretention swale)						• Medium volume reduction and infiltration; • Low to medium peak flow control; • Average to good water quality treatment; • Flexible in terms of size and infiltration;	• Requires vegetation tolerant of hydrologic variability; • Requires maintenance to ensure long-term viability;	water table is not too high Base of bioretention should be at least 0.5m above water table.
Constructed filters (sand, stone, etc)	Yes	Yes	No	No	Detention Treatment	• Best suited for high intensity development; • Depending on filter media volume reduction can range from medium to good; • Medium peak flow control; • Good water quality treatment;	• Requires regular inspection and maintenance • Not suitable where the water table is too high	Only in areas where the water table is not too high Base of device should be at least 0.5m above water table.
Dry Detention Basin	Yes	Yes	Yes	Yes	Detention Treatment	• Can be used in all anthropogenic environments; • Limited volume reduction and infiltration; • Good peak flow control;	• Requires periodic sediment removal • Space constraints on residential lots	Most appropriate when used in conjunction with other BMP devices.

Device Type	Application Area				SW Function	Strength/ advantage	Weakness/ limitations	Suitable for Rotokauri North ICMP area
	Res	Business	Roads	Other				
						• Low water quality treatment; • Most appropriate when used in conjunction with other devices;		
Gross Pollutant Traps	Yes	Yes	Yes	Yes	Treatment	• Medium water quality treatment; • Best used in conjunction with other devices.	• Operation and maintenance risk. • Most suited to small catchments, but can be used in all anthropogenic environments; • No volume reduction, nor infiltration; • No peak flow control;	May be most suitable in more intensively developed areas of the developmen t AND/OR Business areas
Infiltration Trench	Yes	Yes	Yes	Yes	Detention Treatment	• Can be used in all anthropogenic environments; • Medium volume reduction and good infiltration; • Medium peak flow control; • Good water quality treatment;	• Requires uncompacted soil; • Limit to storage capacity; • Void ratio within the scoria/gravel bed should be high • Not appropriate where the water table is too high • Need to consider setback from foundation of house for design purposes	Not appropriate where the water table is too high Base of device should be at least 0.5m above water table

Device Type	Application Area				SW Function	Strength/ advantage	Weakness/ limitations	Suitable for Rotokauri North ICMP area
	Res	Business	Roads	Other				
Landscape Restoration	No	No	No	Yes	Treatment	• Good water quality treatment; • Minimize fertiliser and pest control programs; • Reduced maintenance costs compared to lawns. • Other ecological and amenity benefits	• Low to medium volume reduction and infiltration; • Low to medium peak flow control; • Potential significant effect on land area available for development, along with housing yields and contributing densities to support infrastructure development	Yes (limited to stream enhancement)
Onsite Soakage	Yes	Yes	No	Yes	Detention Treatment	• Suited to residential, commercial and industrial settings; • Medium volume reduction and infiltration; • Medium peak flow control; • Medium water quality treatment;	• Maintain minimum distance from building foundation (typically 2 to 3m); • Requires observation well; • Requires regular maintenance to remove sediment. • Not appropriate in high water table; • Need to consider setback from foundation of house for design purposes.	Unlikely as the water table is high
Permeable Pavement	Yes	Yes	limited	limited	Detention Treatment	• Most appropriate for use in residential, commercial and industrial settings;	• Requires vacuuming two to three times per year (maintenance risk).	Yes, but may need to be lined when

Device Type	Application Area				SW Function	Strength/ advantage	Weakness/ limitations	Suitable for Rotokauri North ICMP area
	Res	Business	Roads	Other				
						• Medium volume reduction and infiltration; • Medium peak flow control; • Medium water quality treatment (treatment not directly addressed but removes contaminants from catchment). • Achievable within the driveway pavement;	• Void ratio within the scoria/gravel bed under permeable pavement should be high; • Need to be lined to mitigate high groundwater level	groundwater level is high.
Piped Reticulation	Yes	Yes	Yes	Yes	Conveyance	• Underground pipes require less spaces/loss of developable areas	• No volume reduction, nor infiltration; • No peak flow control; • No water quality treatment; • Limited applicability given hydraulic grade.	Where the hydrologic grade allows
Rooftop Disconnection	Yes	Yes	No	No	Detention	• Appropriate for residential and commercial development; • Good volume reduction and infiltration; • Good peak flow control.	• Low water quality treatment	Yes - Redirect rooftop flow to vegetated or permeable areas designed to

Device Type	Application Area				SW Function	Strength/ advantage	Weakness/ limitations	Suitable for Rotokauri North ICMP area
	Res	Business	Roads	Other				
								receive stormwater.
Riparian Planting	No	No	No	Yes	Detention Treatment	• Medium volume reduction and infiltration; • Medium to high water quality treatment; • Helps to maintain hydrologic, hydraulic, and ecological integrity. • Provide some amenity value.	• Limited peak flow control; • Minimum width 10m/loss of developable land	Yes – along watercourses
Stormwater Ponds	No	No	No	Yes	Detention Treatment	• Can be used in most anthropogenic environments – typically not used in intense urban settings; • Good peak flow control; • Medium water quality treatment; • Require large catchments, therefore useful as a communal device; • Can provide an amenity feature.	• Use should be limited given tendency for water temperature to rise is pond. • Limited volume reduction and infiltration; • Colonisation by invasive species could increase maintenance; • Perceived health & safety risks may result in fencing and isolation of the pond.	Not recommended

Device Type	Application Area				SW Function	Strength/ advantage	Weakness/ limitations	Suitable for Rotokauri North ICMP area
	Res	Business	Roads	Other				
Special Value Features	No	No	No	Yes	Detention Treatment	• Identify floodplains, riparian areas, woodlands, steep slopes, etc.; • Protect from development; • High volume reduction and infiltration; • Good peak flow control; • Good water quality treatment.	• Loss of developable land	Appropriate across the development, particularly the drainage reserve and significant natural (tree) area.
Swale	No	Yes	Yes	Yes	Conveyance Treatment	• Good peak flow control; • Good water quality treatment; • Size to convey 10-year storm events; • Designed for non-erosive velocities; • Best designed to aesthetically fit into landscape; • Significantly slow runoff rate.	• Device becomes wide as catchment size increases – limited to 4 hectares catchment • Limited volume reduction and infiltration; Best used in conjunction with other stormwater devices	Yes

Device Type	Application Area				SW Function	Strength/ advantage	Weakness/ limitations	Suitable for Rotokauri North ICMP area
	Res	Business	Roads	Other				
Vegetated/ Grassed Conveyance Channel	No	No	Yes	Yes	Conveyance Treatment	• Good peak flow control; • Good water quality treatment; • Size to convey 10-year storm events; • Designed for non-erosive velocities; • Best designed to aesthetically fit into landscape; • Significantly slow runoff rate.	• Device becomes wide as catchment size increases • Limited volume reduction and infiltration; • Best used in conjunction with other stormwater devices.	Yes
Topsoil depth of 300mm with 10% compost	Yes	Yes	No	No	Treatment	• Medium infiltration; • Medium water quality treatment	• Limited volume reduction; • Limited peak flow control;	Suited for all uncontrolled paved areas. Shed surface runoff across areas of at least an equal area of grassed topsoil.
Vegetated Roof/Wall	Yes	Yes	No	No	Detention Treatment	• Medium volume reduction;	• No infiltration; • Limited peak flow control;	If desired.

Device Type	Application Area				SW Function	Strength/ advantage	Weakness/ limitations	Suitable for Rotokauri North ICMP area
	Res	Business	Roads	Other				
						• Medium water quality treatment;	• Need to consider structural design. • High cost of design and installation, and ongoing maintenance	
Wetland (offline)	No	No	No	Yes	Treatment Detention	• Good peak flow control; • Good water quality treatment; • Require large catchments, therefore useful as a communal device; • Requires sustained baseflow; • Periodic sediment removal and vegetation maintenance; • Performance improved with forebay for sediment collection and removal.	• Limited volume reduction and infiltration; • Requires large land area (loss of developable land) • Periodic sediment removal and vegetation maintenance • Need to be lined to mitigate high groundwater level • Requires adequate baseflow, may therefore need to be lined.	Yes

8.4 Best Practicable Option Analysis

This section identifies options that have been considered to meet the stormwater objectives and which take into account site constraints and opportunities, and the nature of the discharges arising from development within Rotokauri North to confirm that the proposed method/s for managing stormwater are the best practicable option.

The following options have been identified and evaluated:

A. Do Nothing;

B. Toolbox of Options for private lots;

C. Pipe public and private runoff to localised wetlands;

D. Use of swales and local wetlands only; and

E. Use of swales/ local wetlands and the Toolbox from B above.

8.5 Option Description

The above options are detailed below:

Option A – do nothing

This is not possible to achieve development of an urban nature due to existing onsite flooding.

Option B – Toolbox of Options for private lots

On its own this option seems to have a range of on lot options for homeowners and developers to choose from to mitigate full stormwater quality and flood storage. On its own this option would require a significantly lower density of development than that proposed as on lot devices would need to be provided for every lot. This option also carries a large obligation (and associated risk) on individual owners to maintain devices to full operating capacity with regular maintenance.

Option C – Pipe public and private runoff to localised wetlands

Localised off-line wetlands could provide quality treatment and detention at the end of a pipe system, with no requirement for onsite treatment, nor detention on-site. As pipe conveyance has no detention or quality function and no detention is retained on individual sites end of line offline wetlands would need to be significantly larger than would be necessary when adopting a treatment train approach to stormwater management, thereby reducing developable land (and creating large significant assets).

Option D - Use of swales and local wetlands

Similar to option C, localised off-line wetlands would provide quality treatment and detention at the end of a swale and vegetated or grassed conveyance channel system. Some piped network could still be expected in the upper catchments, but no requirement for onsite treatment or detention on-site. This method could produce a partial treatment train for removal of contaminants, however, swales/conveyance channels and wetlands would still be of a significant size thereby reducing developable land (and creating large significant assets).

Option E - Use of swales/ local wetlands and the Toolbox from B

Option E is the preferred option to achieve the design parameters and the strategic and operational objectives, and is essentially a blending of Options B and D.

Option E incorporates a full treatment train approach for the management of stormwater starting on lots (via a range of on lot options for homeowners and developers to choose from) and discharging into swales, conveyance channels and then wetlands prior to discharging into the stream network. While communal assets/devices area still sizable (i.e., wetlands, swales and conveyance channels), some of the detention volume is distributed across the development through the use of on-lot devices for detention and retention/reuse, thereby creating a more equitable but manageable system.

8.6 Option Analysis

The table below analyses options A to E using an analytical hierarchical process (Saaty, 1980) to assign priority to each of the criteria considered.

What is evident from the analysis is that all options outperform the status quo, with options C, D and E addressing the criteria most effectively (and the preferred option E producing the highest outcome against the criteria).

Table 14: BPO Evaluation

	Evaluation Criteria	A	B	C	D	E
		Do nothing	Toolbox of Options for Private Lots	Pipe Public and Private to Local Wetlands	Use of Swales to Local Wetlands	Use of Swales to Local Wetlands & Option B
1	Device Function					
	Retention/Reuse	1	2	1	1	1
	Detention	1	3	5	5	5
	Quality Treatment	1	3	5	4	5
2	Other Compliance					
	Water Safety	5	3	3	3	3
	Code of Practice	1	3	3	4	5
3	Consistent with WSD Approach					
	Interdisciplinary Outcomes	1	4	3	5	5
	Protect Ecosystem	1	3	5	4	5
	Minimal Adverse Effects	1	3	3	3	5
	Uses Natural Systems	1	4	5	4	5
4	Environmental					
	Onsite Streams - permanent	1	3	5	5	5
	Vegetated overland flow paths	1	4	2	5	5
	Downstream Effects	1	2	4	4	5
	Minimal Earthworks	5	2	2	2	2
5	Landscape	3	3	3	5	5
6	Amenity	3	3	3	4	5
7	Development Yeild	1	4	3	3	3
8	Costs					
	Capex	5	3	3	3	3
	Opex	5	2	3	3	3
9	Ownership	C	P	C	C	C / P
10	Viable	×	×	✓	✓	✓
	Total Score	38	61	**69**	**74**	**84**

	Scoring System
1	Significant adverse effects/ Unlikely to be achieved
2	Adverse effects/ Difficult to implement
3	Neutral
4	Beneficial
5	Highly beneficial
C	Council Owned
P	Privately Owned

In summary Option E is considered the best practicable option for the management of stormwater for the area subject to this ICMP.

In addition, the McKenzie & Co Consultants (2019) Stormwater and MUSIC Modelling report analyses the proposed option against the WRC Low Impact Design ("**LID**") Assessment. Option E was assessed to have a total score of 25 (WRC require a minimum score of 15).

9.0 IMPLEMENTATION METHODS

In general, land falling within the Mangaheka and Rotokauri South catchments (identified above) should adhere to the implementation requirements of those relevant ICMPs. **However,** there are some overarching recommendations of this ICMP that impose additional restrictions over and above the adopted ICMPs. These are clearly identified in the breakdown of recommendations and implementation guide below. Where the recommendations of this ICMP exceed the requirements of the Mangaheka or Rotokauri South ICMPs, the higher requirements imposed under this ICMP shall apply.

Design parameters for devices shall meet 8.3.2 above.

Table 15: Implementation/Means of Compliance

Lot/Area Type	Requirements		Recommended Devices Options
All Catchments			
Single dwelling, residential lots under 280m²	Detention	LID device to manage SW from all impermeable surfaces on the site.	Tank (above or below ground depending on space constraints) Permeable pavement Green Roof/Wall Bioretention devices
	Treatment	Roof material metals contaminant runoff avoidance	Inert roof materials
	Detention	All driveways and manoeuvrings areas shall be constructed using permeable pavement materials (excluding an access lane/rear lane).	Permeable pavements
Affordable Lots/Houses	Detention	All driveways and manoeuvrings areas shall be constructed using permeable pavement materials	Permeable pavements
	Treatment	Roof material metals contaminant runoff avoidance	Inert roof materials
Single dwelling, residential lots over 280m²			
	Detention	LID devices to manage SW from all impermeable surfaces on the site. Detention device plumped into the dwelling for non-potable uses Detention device sized to a minimum 5m³ per site (which allows for reuse plus some detention in the device).	Tank (above or below ground Permeable pavement Green Roof Bioretention devices
	Treatment	Roof material metals contaminant runoff avoidance	Inert roof materials
	Detention	All driveways and manoeuvrings areas shall be constructed using	Permeable pavements

Lot/Area Type	Requirements		Recommended Devices Options
		permeable pavement materials (excluding an access lane/rear lane).	
Multiple units/duplex product	Detention	LID devices to manage SW from all impermeable surfaces on the site.	Tank (above or below ground Permeable pavement Green Roof Bioretention devices Option to make devices communal
	Treatment	Roof material metals contaminant runoff avoidance	Inert roof materials
	Detention	All driveways and manoeuvrings areas shall be constructed using permeable pavement materials (excluding an access lane/rear lane).	Permeable pavements
Commercial Activities + B6Z	Treatment	Roof material metals contaminant runoff avoidance	Inert roof materials
	Detention	Refer to HCC Three Waters Management Practice Note 06: Detention Tank (~26.5 litres per m^2 of roof)	Tanks (above or below ground) Raingardens
	Treatment	75% TSS	Runoff to main swale / treatment is provided in communal wetland
Roads	Conveyance	Upper 1.5 hectares of each tributary is managed in the road, and the lower catchment is managed via swales	Roads (no swale) Roads with vegetated or grassed conveyance
Communal Devices	Treatment Detention	75% TSS and 95% total contaminant removal Detention 0.5m above Water Quality Volume (WQV)	Wetlands Swales (vegetated for catchments up to 4 hectares) in some instances

Lot/Area Type	Requirements		Recommended Devices Options
			(see device options)
Green Corridors		Environmental enhancement	Riparian Planting Green outfalls

10.0 FURTHER WORK

Further work and actions includes:

- The refinement of the appropriate option for the Ohote catchment.
- Analysis of downstream works (if any) resulting from the development of the RNSP area vs those identified in the Morhum reporting as being attributed to the entire RNDA. This is expected to be catchment specific and undertaken alongside any Regional Consenting for stormwater discharge.
- Regional Consenting for stormwater discharge. Final identification of whether consenting is per catchment or based on smaller sub-catchments is expected.