Report

Rotokauri
Integrated Catchment Management Plan

Status: **FINAL - June 2017**

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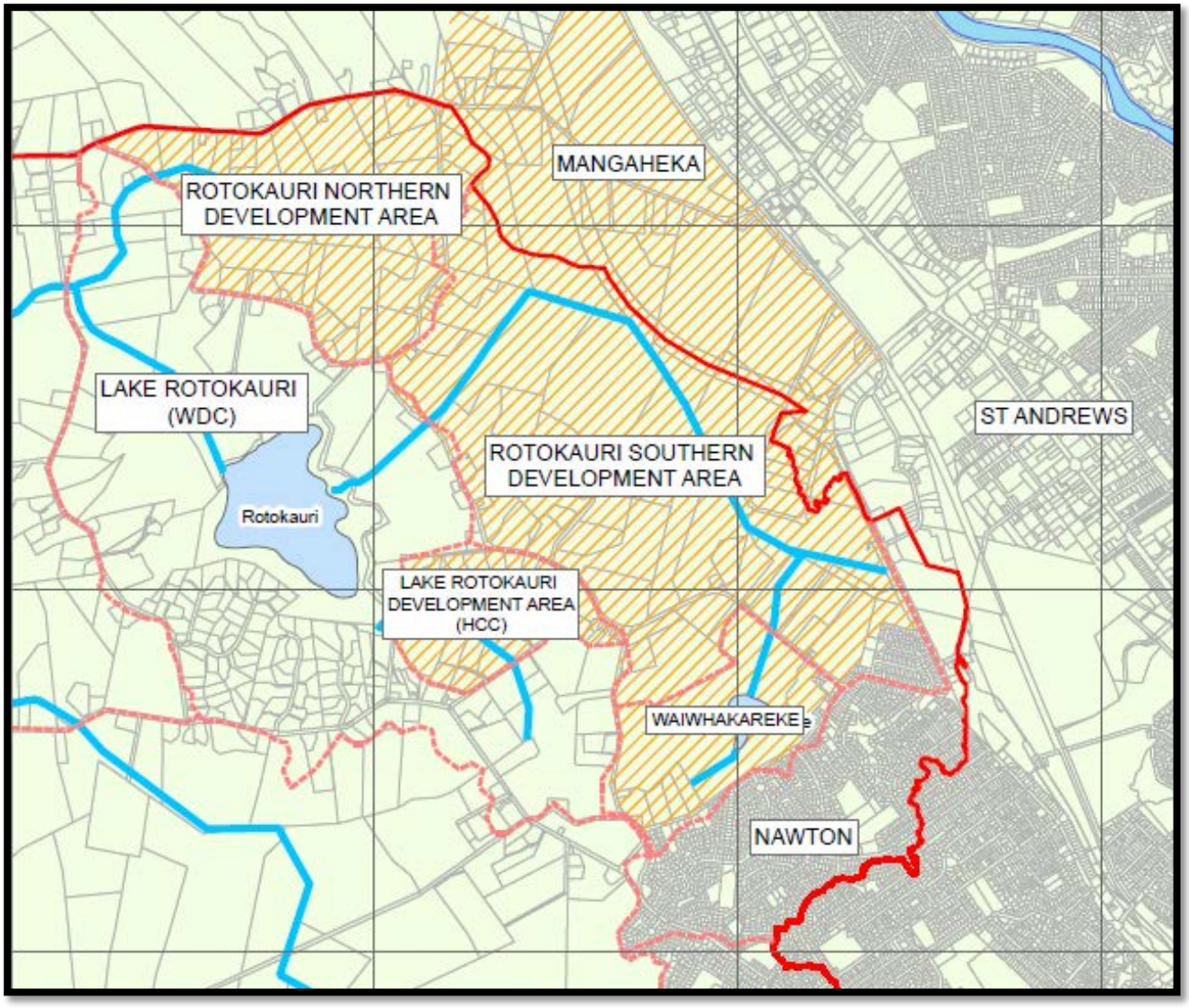

Hamilton City Council
Te kaunihera o Kirikiriroa

Quality Information

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Revision Schedule

Revision	Date	Details	Authorised for Release	
			Name / Position	**Signature**
0.1	7-Nov-2016	Draft Version 1 (For Targeted Consultation)	Andrew Parsons - Manager City Development	
0.2	28-Feb-2017	Final Draft (For WRC Approval)	Andrew Parsons - Manager City Development	
0.3	26-May-2017	Final Draft (Strikethrough Version)	Andrew Parsons - Manager City Development	
1.0	2-June-2017	FINAL	Andrew Parsons - Manager City Development	

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ABBREVIATIONS

Abbreviations

Abbreviation	Full text
ANZECC	Australia New Zealand Guidelines for Fresh and Marine Water Quality
ARI	Annual Return Interval
BPO	Best Practicable Option
CDA	Central Development Area
CMP	Catchment Management Plan (as relating to the HCC CSDC)
CSDC	HCC Comprehensive Stormwater Discharge Consent
Cu	Copper
ED	Existing Development
FWI	Far Western Interceptor

Abbreviation	Full text
GRMP	HCC Gully Reserves Management Plan
HCC	Hamilton City Council
HUGS	Hamilton Urban Growth Strategy
ICMP	Integrated Catchment Management Plan
ISQG	ANZECC Interim Sediment Quality Guidelines
ITS	HCC Infrastructure Technical Specifications
LGA	Local Government Act
LOS	Levels of service
LRDA	Lake Rotokauri Development Area
LRMC	Lake Rotokauri Management Committee
LTP	Long Term Plan
MCW	Main Corridor Wetlands
MPD	Maximum Probable Development
NAMTOK	Nga Mana Toopu O Kirikiriroa Resource Management and Cultural Consultants
O&Ts	Objectives and Targets
Proj Water	Waikato River Catchment Services – Level of Service and Funding Policy (Project Watershed)
RDA	Rotokauri Development Area
RNDA	Rotokauri North Development Area
RPS	WRC Regional Policy Statement
RRMP	HCC Riverside Reserves Management Plan
RSDA	Rotokauri South Development Area
RSP	Rotokauri Structure Plan
Sust Strat	HCC Environmental Sustainability Strategy
SMP	HCC Stormwater Management Plan
TN	Total Nitrogen (also N / Nitrogen)
TP	Total Phosphorous (also P / Phosphorous)
USEPA (CMC)	United States Environmental Protection Agency Water Quality Criteria (Criteria Maximum Concentration)
WDHB	Waikato District Health Board (Public Health Unit)
WDA	Waiwhakareke Development Area
WDC	Waikato District Council
WINTEC	Waikato Institute of Technology
WNHP	Waiwhakareke Natural Heritage Park
WRA	Waikato-Tainui Raupatu Claims (Waikato River) Settlement Act
WRC	Waikato Regional Council
WRC/ICM	WRC Integrated Catchment Management Directorate
WRC/RUD	WRC Resource Use Directorate

Abbreviation	Full text
WRP	WRC Waikato Regional Plan
Zn	Zinc

Executive Summary

The Rotokauri Integrated Catchment Management Plan (ICMP) forms part of the Hamilton City Council (HCC) Three Waters ICMP Programme and has been developed in accordance with the relevant policy and planning framework (Section 1). It has also been developed in consultation with key stakeholders and the community, the former having had significant input to the overall outcomes of the ICMP (Section 7).

Catchment Description, Issues and Outcomes

The Rotokauri Catchment is a predominantly 'greenfield catchment', located in the north-western area of Hamilton City and the upper headwaters of the Ohote Stream Catchment. It is approximately 788 hectares in area and incorporates all of the Rotokauri Structure Plan (RSP) area west of Mangaheka Catchment, the two catchments being generally divided by the Mangaharakeke Drive/Te Rapa Bypass.

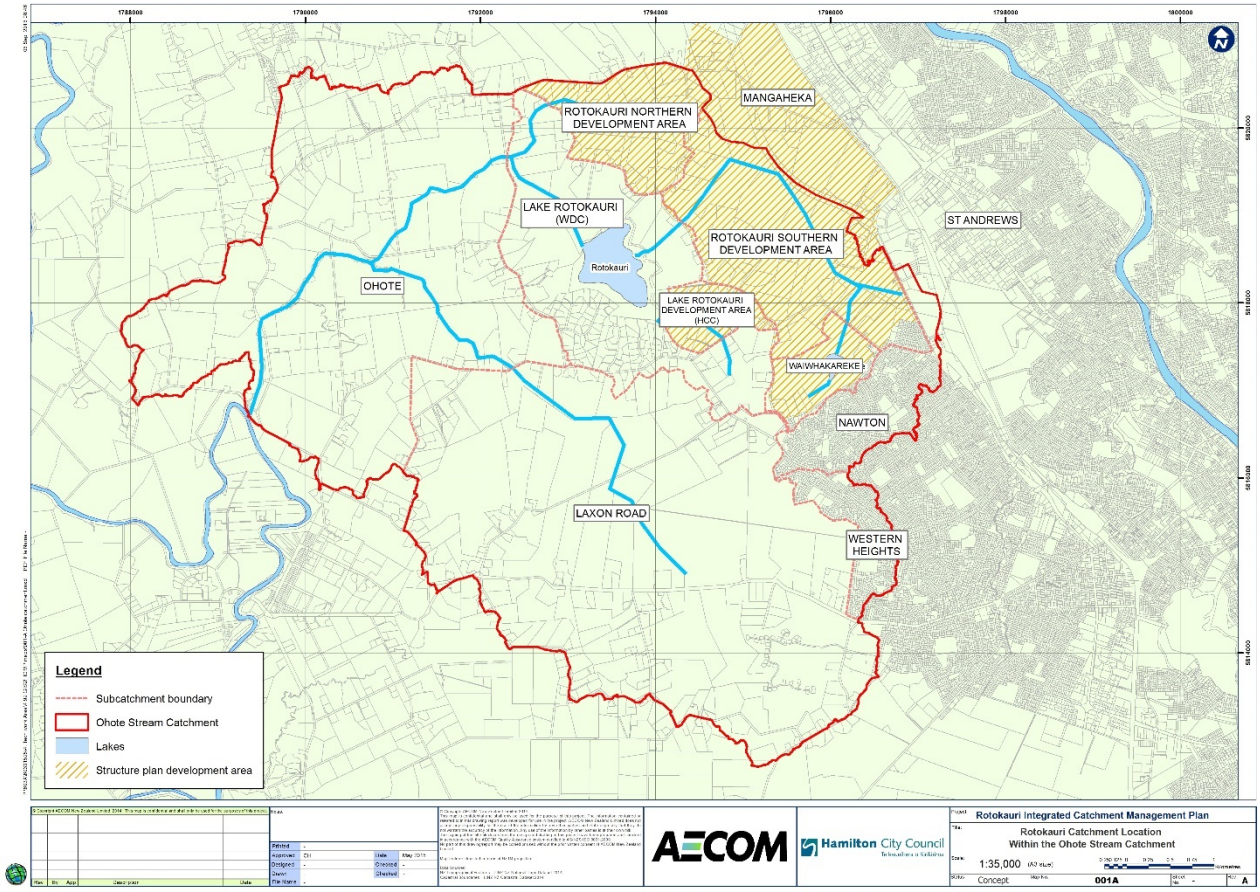

Figure 1: Rotokauri Catchment location within the wider Ohote Stream Catchment

Catchment topography is generally very flat, punctuated with peripheral ridgeline and gully areas that further characterise the catchment. The Waiwhakareke Natural Heritage Park is located in the upper headwaters of the southern area of the catchment, so-named after Lake Waiwhakareke which drains from the catchment via a highly modified stream known as the 'Rotokauri Drain'. The Rotokauri Drain forms the single main outlet to this part of the catchment, passing beneath Exelby Road (the HCC jurisdictional boundary) prior to entering Lake Rotokauri. Beyond this point, the Ohote Stream forms the outlet to the lake and drains to the Waipa River, which in turn drains to the Waikato River where they meet at Ngaruawahia. The northern area of the catchment drains directly to the Ohote Stream.

With regard to Lake Rotokauri, this surface water feature is located within the jurisdictional area of Waikato District Council (WDC) who maintain an open drain network within the immediate lake reserve area. Beyond this area the Waikato Regional Council / Integrated Catchment Management Directorate (WRC/ICM) administers and maintains the

Rotokauri Drainage Area along with the lake level control weir structure. This ensures that minimum lake operating levels are maintained and rural drainage standards met. Figure 2 below shows the general catchment layout, including the main sub-catchment areas and surface water features.

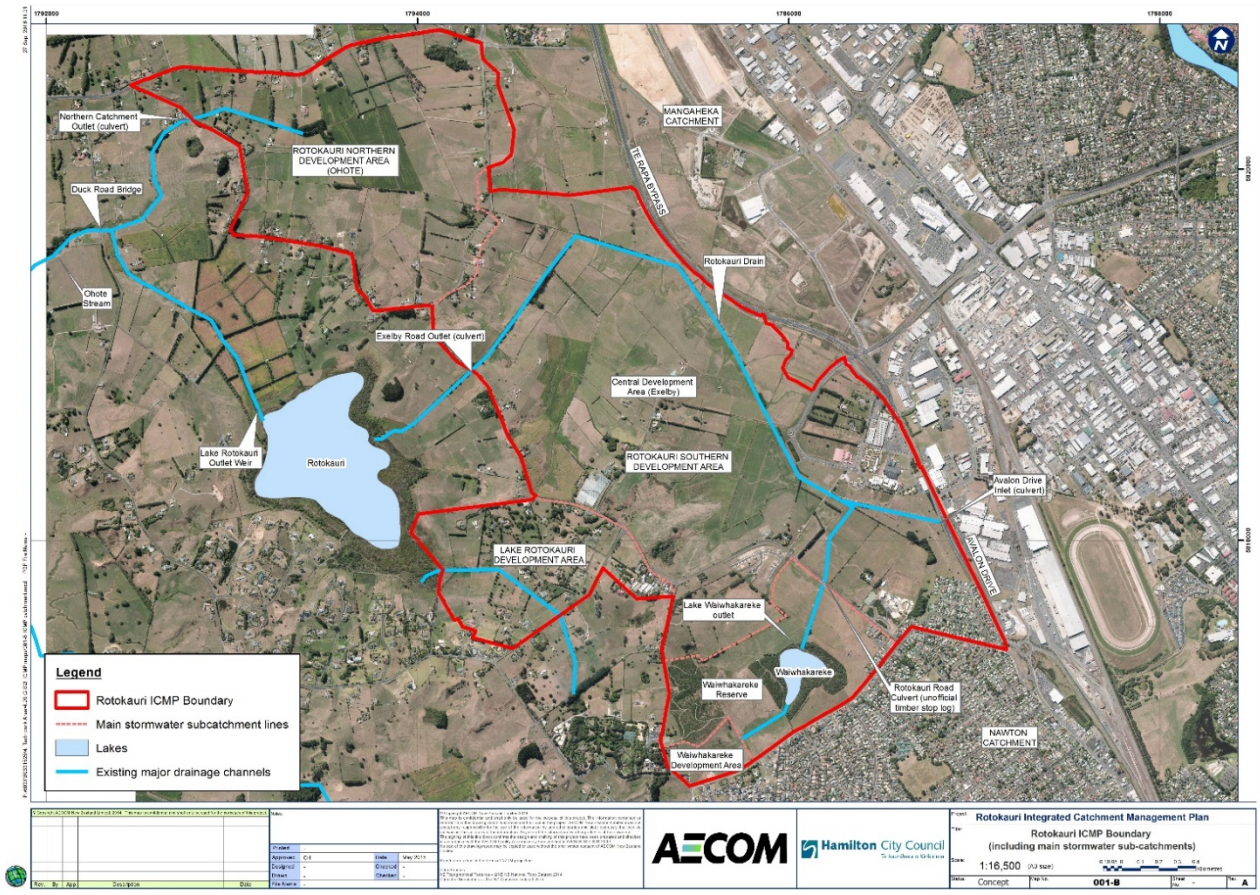

Figure 2: Catchment layout

The catchment overall is highly valued for its existing natural areas and several agencies are proactively engaged in restoring the two lakes and surrounding sub-catchment areas. Both lakes are managed to support wide ranging values including ecological, historical, cultural, public access and recreation. They also possess significant biodiversity values and are protected through various policy and planning provisions[1].

The main known issues for the catchment and subsequent constraints for development range from:

- Existing poor water quality status of the two main lakes which are subject to various cross agency improvement initiatives
- High groundwater levels combined with low permeability soils which limit the potential for widespread use of soakage
- Extensive flood management issues which require significant flood storage mitigation within the development area to safeguard downstream flood protection levels of service, and
- Moderate to high erosion susceptibility in the upper headwater areas of the catchment, along with high erosion susceptibility and existing hotspots in the downstream reach of the Rotokauri Drain.

[1] Including the Waikato Regional Policy Statement, Waikato Regional Plan, HCC District Plan, WDC District Plan and Reserve Management Plans.

All of these issues have been extensively investigated by HCC, initially in support of the Rotokauri structure planning exercise through to more recent technical investigations and assessments undertaken in support of the ICMP. The main outcomes of these investigations and assessments are presented in Section 3 of this document, followed by identification of the opportunities, options and ultimately Best Practicable Options (BPOs) and integrated management solutions in Section's 4 and 5 respectively[2].

Best Practicable Options and Integrated Management Solutions

The BPOs and integrated catchment management solutions address the main issues for the catchment and meet generic and catchment specific 'objectives and targets' which are presented in Section 1.7. The majority of BPOs and solutions are based on provision for growth, and avoiding or otherwise minimising issues related to growth. In this regard, the report titled *'Rotokauri ICMP - Three Waters Infrastructure - Integration Report*' (Appendix B) has been specifically developed to support the ICMP. The report brings together more detailed aspects associated with the planning, staging and implementation of three waters infrastructure in the catchment and should be read in conjunction with the ICMP. It is further noted that the BPOs and solutions combine to address all of the main issues identified. The implementation of all BPOs/solutions is therefore necessary to effectively implement the ICMP in its entirety and avoid, or otherwise minimise, adverse effects on the catchment.

The BPOs and integrated catchment management solutions include (but are not limited to):

Stormwater and Receiving Environment

- Establishing a Green Corridor Network to address/achieve multiple issues and objectives by creating an open blue-green corridor network[3]
- Consultation and collaboration with key stakeholders to align with wider catchment and multi-agency management and development initiatives (where possible)
- Coordinated infrastructure staging and the controlled release of land for development to ensure the provision of major infrastructure to service new development
- Application of best practice site controls during development and physical works to minimise sediment laden runoff throughout the transitional stages of development
- Application of best practice environmental protection and mitigation measures during catchment development and physical works to minimise adverse environmental effects throughout the transitional stages of development, and to safeguard existing biodiversity values
- Maximum use of soakage/infiltration systems where ground and groundwater conditions permit for the purpose of reducing runoff volume and maintaining groundwater levels as far as practicable
- Maintain groundwater levels in proximity to Waiwhakareke Natural Heritage Park to maintain lake level
- Major drainage solution – the provision of optimised flood storage and conveyance infrastructure in the Southern Development Area in combination with the natural storage and attenuation capacity of Lake Rotokauri

[2] Given the known catchment sensitivities and immediate development pressures, the ICMP is largely focused on the Southern Development Area. However, the Northern Development Area has also been considered to sufficiently inform three waters management solutions for the area and is addressed in this ICMP.

[3] This solution is fundamental and breaks down into major drainage, stormwater treatment and ecological protection and enhancement elements.

- Stormwater treatment train solution inclusive of central sub-catchment wetlands and upstream source controls – to avoid adverse water and sediment quality effects in stormwater receiving waterbodies, sufficient to meet the catchment specific water and sediment quality targets[4]
- Ecological protection and enhancement through eco-sensitive infrastructure design and the restoration and protection of habitiat – to integrate eco-sensitive design elements into major drainage and stormwater treatment infrastructure and restore habitat and biodiversity values to resemble historic states where practicable
- Undertake eco-sensitive stream channel stabilisation and protection works to enable increased flow volumes and durations due to development – Waiwhakareke Development Area, downstream of Exelby Road Outlet and other locations as required
- Undertake regular site inspections and receiving environment monitoring – to ensure that development, permanent stormwater infrastructure and stream channel protection works are meeting the objectives and targets and the overall design objectives and requirements of the ICMP

Wastewater

- Extension of the Far Western Interceptor (FWI) to enable servicing of new development in Rotokauri
- FWI alignment with central roading and drainage corridors to optimise a gravity solution for the catchment and minimise the infrastructure footprint
- Best practice infrastructure design to maximise design life, reduce asset maintenance and operational safety requirements

Water Supply

- Connection of 520mm bulk mains from Pukete Reservoir to improve water supply to the Rotokauri area
- Creation of water zones to improve water supply to the Rotokauri area
- Extension of existing supply lines and trunk mains to enable servicing of new development in Rotokauri
- Rainwater reuse to lower water supply demand and meet multiple three waters integration objectives.

The BPOs and solutions are supported by 'design parameters and requirements' to be achieved for stormwater management in the Rotokauri Catchment (Section 5.4). These essentially set out the minimum levels of protection to address catchment specific risks and sensitivities, and must be met (or exceeded) in the design of stormwater management and treatment devices as applicable. The BPOs and solutions are also supported by 'means of compliance' measures which outline the general requirements and major infrastructure for the catchment (Section 5.5). These provide the means to comply and effectively implement the Rotokauri ICMP through various stages of development planning, permitting (resource and building consents), development and building works. In addition, some 'future actions' are identified to be considered and undertaken as part of the ongoing planning and implementation of the ICMP (Section 5.5.3). As per the BPOs and means of compliance requirements, each key action is assigned a priority which reflects the implementation urgency that is associated with it.

Figure 3 below shows the means of compliance requirements for stormwater treatment and major drainage infrastructure in the Southern Development Area. This includes a table of the sub-catchment source control options and depicts indicative central sub-catchment wetlands integrating with the central drainage corridor.

[4] The main contaminants of concern include copper (Cu), zinc (Zn), nitrogen (N) and phosphorous (P). Catchment specific targets have been determined to avoid further degradation of water and sediment quality in the main receiving waterbodies as a consequence of development and urban stormwater runoff (Section 3.2.4).

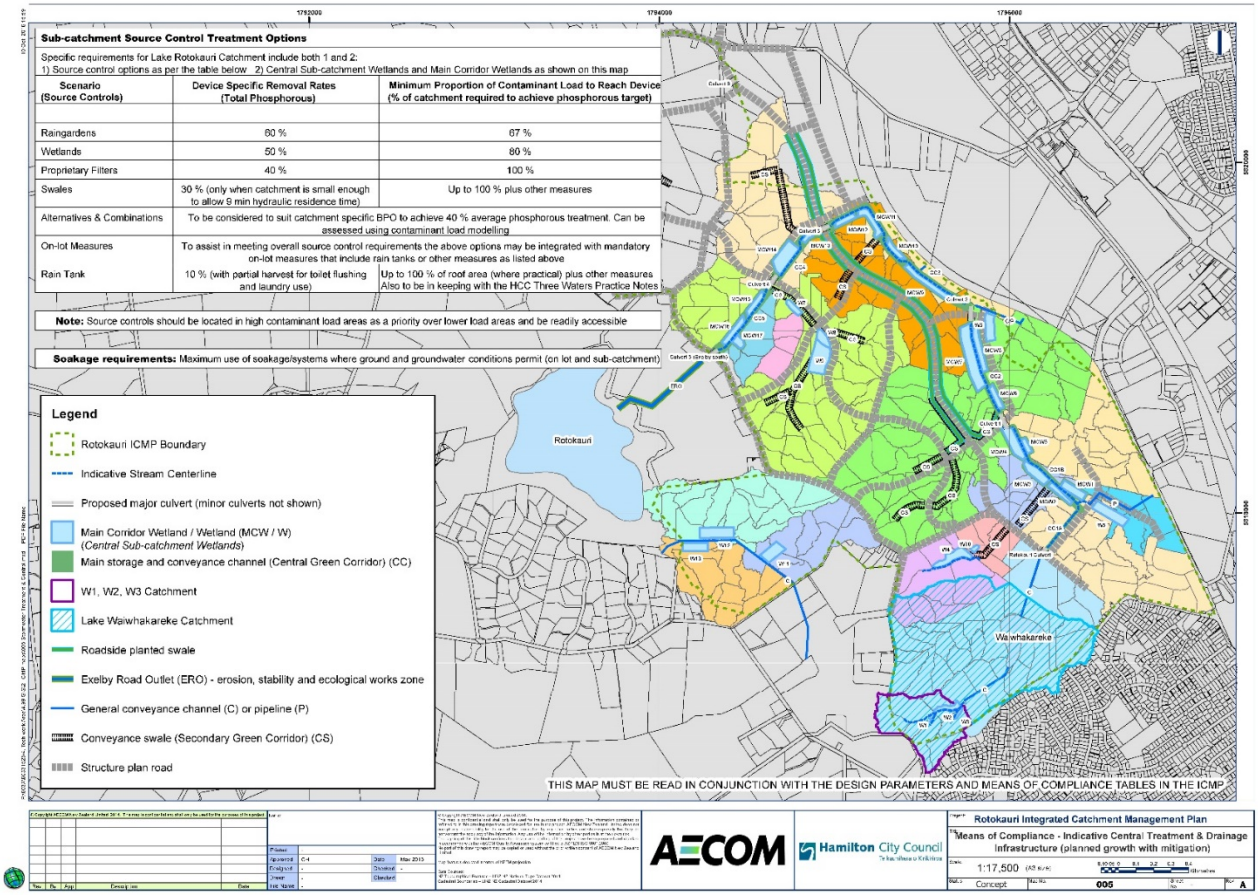

Figure 3: Means of compliance requirements for stormwater treatment and major drainage infrastructure in the Southern Development Area

Catchment Monitoring

Development and associated 'resource use' activities in the Rotokauri Catchment will be monitored in accordance with the condition requirements of relevant land, water and discharge consents. With regard to new stormwater discharge consent activities, these will be monitored in accordance with:

- Relevant monitoring conditions - prior to consent transferral to HCC and surrender in accordance with the requirements and administrative procedures of the HCC Comprehensive Stormwater Discharge Consent / #105279 (HCC CSDC), (Condition 3 and Appendix 2)
- An extended HCC CSDC Monitoring Programme (Condition 37) as informed by site specific monitoring requirements, the requirements of this ICMP and any subsequent revisions to the Monitoring Programme as allowed for.

All monitoring information should be evaluated and assessed against the relevant condition and monitoring programme requirements, the design parameters for stormwater management (Section 5.4) and the relevant means of compliance requirements (Section 5.5) of this ICMP. All necessary follow-up actions should be identified and undertaken as determined through assessment.

The main types of monitoring to be undertaken by HCC relate to the issues and outcomes discussed in the ICMP (Section 3.2), supporting technical report recommendations (Appendix C) and the HCC CSDC Monitoring Programme as reviewed and updated to include the monitoring identified. This includes groundwater level, water and sediment quality, ecological and stream channel erosion monitoring on an ongoing basis.

Other types of monitoring include 'asset monitoring' by HCC and 'complementary monitoring initiatives' by other agencies. With regard to asset monitoring, this is carried out on all three networks including condition assessment and capacity reviews. Similarly, the HCC CSDC Stormwater Management Plan sets out various stormwater network

operation and maintenance procedures, inclusive of a Stormwater Quality Improvement Programme (Condition 28). It is therefore envisaged that the Stormwater Management Plan will be reviewed and updated to fully support the implementation of the Rotokauri ICMP, and to ensure that all stormwater management devices are appropriately operated and maintained.

Consent Compliance of this ICMP

Condition 30 of the HCC CSDC requires that, in accordance with Condition 3(c), Catchment Management Plans (CMPs) which are prepared to guide new stormwater diversion and discharge activities in developing catchments shall be to a standard acceptable to the Waikato Regional Council / Resource Use Directorate (WRC/RUD), and shall be submitted to the WRC for written approval in a technical certification capacity. Condition 30 further requires that CMPs shall determine and recommend an 'integrated catchment management approach' which is based upon the BPO to avoid as far as practicable and otherwise minimise the cumulative adverse effects of all new stormwater activities in developing catchments.

In this regard a compliance assessment of the ICMP against Condition 30 of the HCC CSDC is presented in Section 6.1. This is followed by a more detailed assessment against Condition 30(g) and (h) requirements which relate to the environmental impacts of new stormwater activities on the catchment (Section 6.2). There is also an assessment of the ICMP against the Waikato Tainui Environmental Plan (Section 6.3).

It is noted that the ICMP has been reviewed and approved by WRC/RUD in accordance with Condition 30 of the HCC CSDC (WRC letter dated 12 April 2017).

ICMP Review

The ICMP is a living document. The need to review it will be assessed on a priority basis. In general, priority is given if/when one or more of the following triggers have been observed:

- Substantial changes in major infrastructure development that is likely to result in different ICMP outcomes
- Changes in the legal framework (Waikato Regional Policy Statement, Waikato Regional Plan, District Plan, central government legislation e.g. National Policy Statement for Freshwater Management)
- New information (e.g. LIDAR, further catchment investigations and assessments undertaken by HCC and/or other agencies)
- Review, renewal or replacement of the HCC CSDC and subsequent requirements.

In addition, the ICMP will provide guidance to any future changes in land-use when implementing the current structure plan (for example through consent processes), and when preparing and processing formal plan changes. Ideally a future plan-change and a future update of this ICMP should be aligned to avoid any water related issues being generated which will be more difficult and expensive to address retrospectively.

The ICMP will be reviewed periodically to ensure that it remains relevant to current policy settings and considers the results of any ongoing monitoring and changes within the catchment which will occur through development.

1 Framework

1.1 Purpose

General catchment overview

The Rotokauri Catchment is a predominantly 'greenfield catchment', located in the north-western area of Hamilton City and the upper headwaters of the Ohote Stream catchment. It is approximately 788 hectares in area and incorporates all of the Rotokauri Structure Plan (RSP) area west of Mangaheka Catchment, the two catchments being generally divided by the Mangaharakeke Drive/Te Rapa Bypass.

Catchment topography is generally very flat, punctuated with peripheral ridgeline and gully areas that further characterise the catchment. The Waiwhakareke Natural Heritage Park is located in the upper headwaters of the southern area of the catchment, so-named after Lake Waiwhakareke which drains from the catchment via a highly modified stream known as the 'Rotokauri Drain'. The Rotokauri Drain forms the single main outlet to this part of the catchment, passing beneath Exelby Road (the HCC jurisdictional boundary) prior to entering Lake Rotokauri. Beyond this point, the Ohote Stream forms the outlet to the lake and drains to the Waipa River, which in turn drains to the Waikato River where they meet at Ngaruawahia. The northern area of the catchment drains directly to the Ohote Stream.

With regard to Lake Rotokauri, this particular surface water feature is located within the jurisdictional area of Waikato District Council (WDC) who maintain an open drain network within the immediate lake reserve area. Beyond this area the Waikato Regional Council Integrated Catchment Management Directorate (WRC/ICM), administer and maintain the Rotokauri Drainage Area (RDA), along with the lake level control weir structure. This ensures that minimum lake operating levels are maintained and rural drainage standards met.

The catchment currently supports mixed rural land use and lifestyle block activities which have recently begun to give way to urban growth and development in accordance with the provisions of the HCC District Plan (District Plan).[5] The main focus of this ICMP, and the 'Best Practicable Options' (BPOs) it prescribes, are therefore concerned with informing sustainable and integrated management solutions for the catchment. Also, to avoid as far as practicable and otherwise minimise potential adverse effects in downstream catchment areas (WDC and WRC/ICM jurisdictions). The scope of the technical investigations and assessments undertaken to support this ICMP have, by necessity, extended into these areas and the resulting information applied accordingly.

[5] The District Plan became partly operative on 21st October 2016.

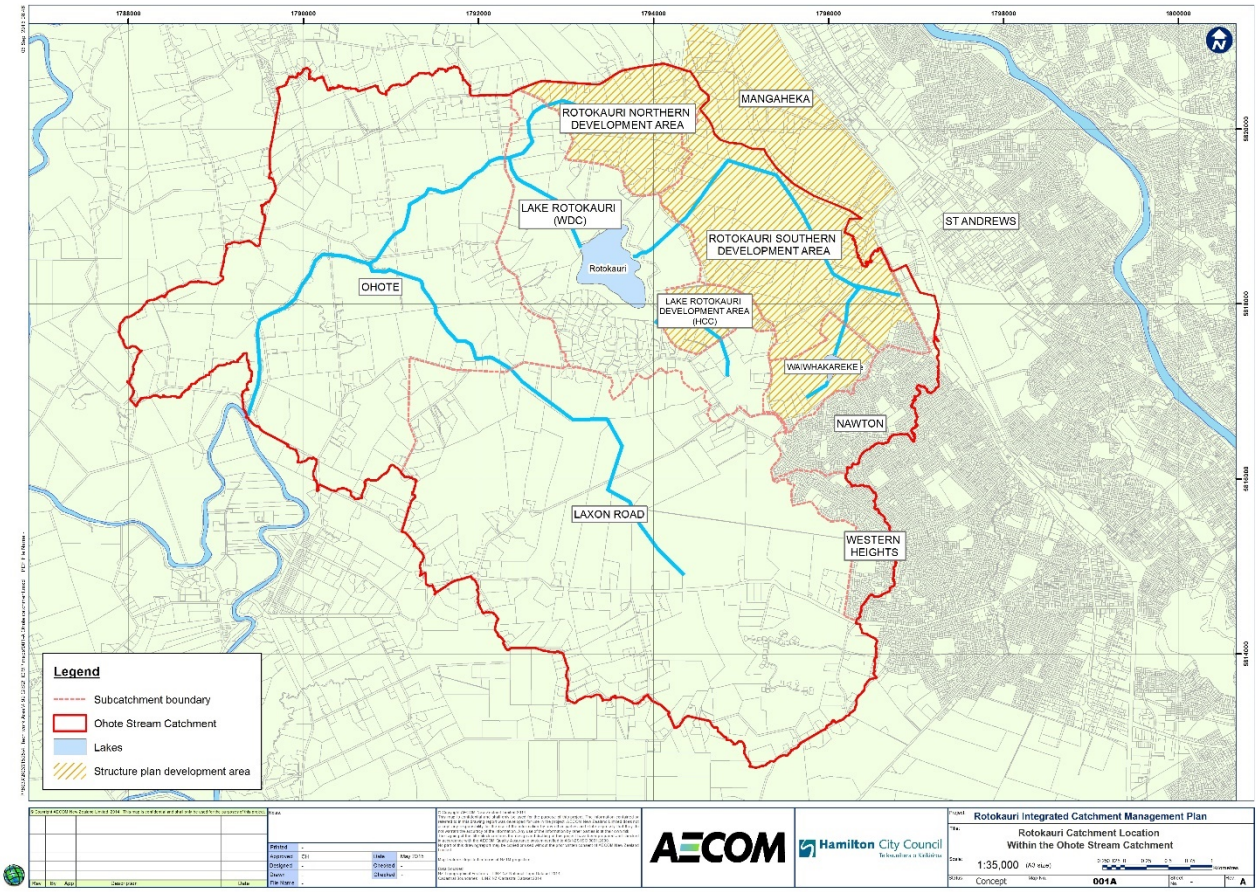

Figure 1-1: Rotokauri Catchment location within the wider Ohote Stream Catchment

Main purpose of the Rotokauri ICMP

The main purpose of the Rotokauri ICMP is to help inform the implementation of the RSP west of the Mangaharakeke Drive/Te Rapa Bypass, by:

- Providing an integrated management approach based upon the best practicable option(s) to avoid as far as practicable and otherwise minimise, the cumulative adverse effects of all new stormwater activities in the catchment
- Providing guidance for all new stormwater activities in the catchment and to help ensure that these are able to meet the condition requirements of the Hamilton City Council (HCC) Comprehensive Stormwater Discharge Consent / #105279 (HCC CSDC), issued by the Waikato Regional Council Resource Use Directorate (WRC/RUD). This includes meeting the requirements of Condition 3 (a) and (c) and Condition 30 which requires all new stormwater activities in developing catchments to be consistent with a WRC approved Catchment Management Plan
- Providing guidance on how water, wastewater and stormwater management in the catchment can accommodate growth in an integrated manner and in accordance with proposed new land-uses
- Recognising and/or determining the environmental values of the catchment and its water bodies
- Setting objectives and targets reflecting these values and relevant statutory and non-statutory plans, policies, standards and conditions
- Producing flood hazard maps that can be used to manage development so as to minimise flood related risks
- Ensuring that the Levels of Service (LOS) of the existing three water networks and the WRC drainage areas are not compromised and to provide a platform for considering the implementation of water sensitive principles

(including but not limited to devices) to reduce demand for water, minimise wastewater generation, minimise wastewater overflows and minimise the need for three waters infrastructure where appropriate

- Optimising the use of existing infrastructure and minimise the need for new infrastructure
- Investigating how legal obligations and consent conditions can be met
- Engaging with, and considering the needs of, stakeholders with an interest in the catchment
- Investigating how LOS and industry best practice can be met
- Investigating whether and how ICMP specific issues can be addressed
- Providing input into the Capital Works Programme / HCC Long Term Plan (LTP) and Annual Plan process
- Providing an implementation plan including future actions, education and monitoring
- Providing guidance to developers on what they need to do to comply with the ICMP.

1.2 Plan Structure

The Rotokauri ICMP has used the RSP (Partly Operative District Plan, 21st October 2016) as the future scenario considered. Because most assets will last a lot longer than the planning horizon used in this structure plan, other future scenarios have also been considered to enable risk assessment and to cater for possible future needs.

In addition, this ICMP will provide guidance to any future changes in land-use when implementing the current structure plan (for example through consent processes), and when preparing and processing formal plan changes. Ideally a future plan-change and a future update of this ICMP should be aligned to avoid any water related issues being generated which will be more difficult and expensive to address retrospectively.

The ICMP will be reviewed periodically to ensure that it remains relevant to current policy settings and considers the results of any ongoing monitoring and changes within the catchment which will occur through development.

The ICMP has also been developed to satisfy Condition 30 of the HCC CSDC #105279.

1.3 Strategic Context

Development within the catchment is influenced by central and regional government policies, plans and resource consents, HCC policies and plans and WDC policies and plans. Most policies and rules ultimately flow out of the 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 HCC strategies and policies such as the LTP provide objectives for ICMP development such as LOS.

Figure 1-2 below shows diagrammatically the hierarchy between many important documents that need to be considered when developing ICMP's.

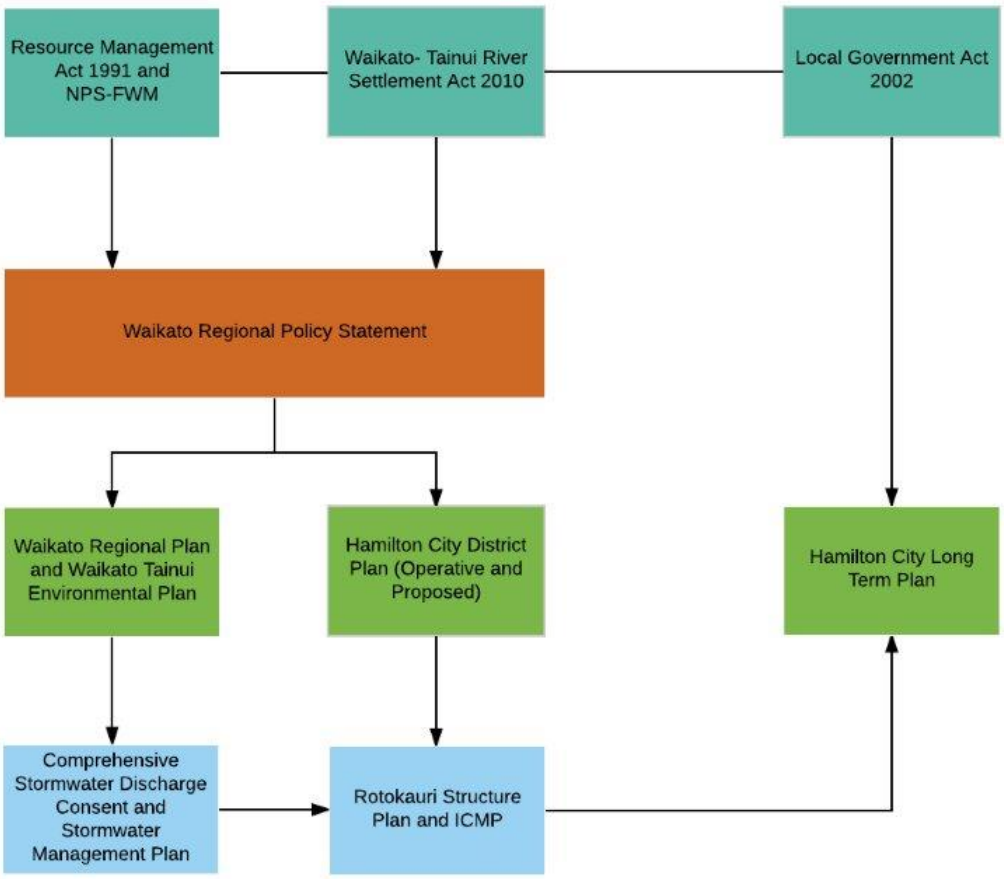

Figure 1-2: Planning document hierarchy and linkages

The documents which are considered to be particularly important to this ICMP include:

- The HCC Business Case for ICMPs
- The Waikato-Tainui Raupatu Claims (Waikato River) Settlement Act 2010
- Nga Wai o Maniapoto (Waipa River) Act 2012
- The RPS (including Vision and Strategy for the Waikato River – to restore and protect the Waikato and Waipa Rivers and their tributaries)
- The WRC Regional Plan (WRP) (including Proposed Waikato Regional Plan Change 1 – Waikato and Waipa River Catchments)
- The Waikato-Tainui Environmental Plan
- The District Plan and RSP
- The HCC CSDC #105279 (issued and administered by WRC/RUD)
- The HCC LTP (to secure funding for Capital Works Programme).

Other important documents for this ICMP include:

- The WRP / Section 3.2.4.6 - sets the minimum water level for Lake Rotokauri (RL 22.5m – RL 22.8m Moturiki Datum)

- The WDC District Plan – informs land use in the downstream Lake Rotokauri sub-catchment, the lake design flood level (RL 23.5m Moturiki Datum) and minimum building platform levels
- The WRC/ICM Resource Consent #120860 – authorises the Lake Rotokauri weir outlet structure and the impoundment of water for lake level control purposes
- Future Proof Growth Strategy and Implementation Plan (Future Proof)
- The Hamilton Urban Growth Strategy (HUGS)
- The Waikato District Development Strategy
- The Waiwhakareke Natural Heritage Park Management Plan
- The Rotokauri Lake Management Plan, and
- The Lake Rotokauri Ecological Enhancement Plan.

Some of the key issues that need to be managed in the catchment through appropriate urban development planning and three waters infrastructure implementation, include:

- Ground and groundwater levels (particularly in proximity to Lake Waiwhakareke)
- Water quality and mauri of catchment waterbodies
- Lake, stream and riparian habitat
- Erosion and instability of stream channels
- Flood risk and natural flow regimes
- Water supply to meet demand and LOS
- Wastewater services to meet demand and LOS Water conservation
- Water re-use
- Fiscal responsibility.

These issues along with opportunities, options and solutions to effectively manage them, are addressed further on in this document.

1.4 Three Waters Master Planning and Integration

Three waters means the three key areas of strategic water management (including associated infrastructure) within the City. Three Waters comprises:

a) 3 Water integration

i. The term 'Three waters integration' is recognition that there is a strong interaction between all three types of waters, natural water systems and land and that they need to be managed sustainably and in an integrated way to ensure the availability of services to growth areas and protection of the environment for future generations

ii. Application of BPOs must strongly consider Hamilton City Council's established hierarchy for the management of the three waters as follows:

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

iii. HCC has adopted this best practice hierarchy, based on sustainability, cost and efficiency principles. This is reflected within the District Plan and Infrastructure Technical Specifications[6]

iv. The ideal stormwater management system for a developed site is one that replicates the undeveloped scenario

v. A range of water sensitive techniques[7] are available to minimise the impact of development and enhance the environment

vi. Notwithstanding, future initiatives should focus on water re-use as opposed to network upgrades. For Greenfield areas yet to be consented, the opportunity remains to integrate the three waters and use water sensitive techniques

vii. Integration of the water supply and stormwater system is most easily achieved by rainwater tanks. Generally, the existing city water source and network will be adequate to meet future demand; however, climate change predictions indicate that Hamilton will become drier for extended periods

viii. Measures that help supplement water sources such as rainwater tanks are beneficial tools to manage water resources and should be encouraged to help alleviate water scarcity in dry periods. Other benefits include:

    i. Reduced peak flow impacts due to fast response runoff from impermeable areas

    ii. Reduced water taken from the water source

    iii. Lower treatment and network operational costs

    iv. Maximum use of the existing Water Treatment Plant but with the potential to delay future upgrades

    v. Emergency supply

    vi. Reducing demand may also assist in deferring future capital works and letting existing assets last longer – resulting in lower costs to council and ratepayers

b) Water supply

i. Including drinking water and other water abstracted from the Waikato River, treated and used within the City such as water for irrigation (farming, parks) and water for firefighting purposes

ii. Water conservation is an important tool to minimise water use. An added benefit is that any future capital works to meet future demand can be delayed which can result in significant costs savings for council. Water conservation includes:

    i. Reduce water loss in public and private networks

    ii. Reduce water demand using financial tools such as volumetric metering

    iii. Reduce water demand by using more efficient appliances and change behaviour

c) Wastewater

i. Liquid waste (including liquids containing waste solids) from domestic, industrial and commercial premises including toilet wastes, grey water and trade-wastes

ii. The strategic wastewater network and the treatment plant will be under pressure in the future so volume minimisation will also be beneficial. Meeting wastewater overflow targets needs to be factored into the planning. This can be achieved by a range of tools including reducing Inflow and Infiltration (I/I) where this is

[6] Previously referred to as Development Manual

[7] Refer to the definition in District Plan Vol 2 Appendix 1.1.2 and the Infrastructure Technical Specifications and Three Waters Management Practice Notes for more details

the optimal solution to meet wastewater overflow targets. Reduction of I/I can also be beneficial to free up capacity for growth or to meet other objectives

iii. Part but not all wastewater network performance criteria are included in a discharge consent

iv. Options to consider wide scale wastewater disposal or grey water re-use at source to manage wastewater volumes in existing interceptor pipelines and the treatment plant may be considered in future, however, due to their complexity, environmental and health concerns, these options are not currently preferred

v. Requirements for existing and future could cover:

    i. Wet weather overflows performance: overflow frequencies, volumes, discharge location

    ii. Inflow and infiltration including risk assessment relative to the location of floodplains and overland flow paths

    iii. Assessment of capacity of the network and wastewater treatment plant

    iv. The need to meet (other) wastewater network discharge consent conditions

d) Stormwater

i. Rainwater that runs off a surface into streams, waterways, underground aquifers, rivers and eventually, far beyond Hamilton's boundaries, ends up in the sea

ii. Volumes and quality of stormwater are largely determined by land-use. Once it enters the stormwater network, opportunities to manage, mitigate and treat are limited and often expensive

iii. Hence making a clear link to land-use requirements and practices are important to prevent any effects of increased runoff, especially for new development or redevelopments.

1.5 Levels of Service

LOS are commonly used to describe targets in the LGA process. It's like a contract between the council and its customers. LOS are, however, not always specific enough to measure network performance or environmental outcomes against. Therefore, the 'formal LOS" are translated into objectives and targets for this ICMP.

LOS are documented in different levels of detail in various key documents.

1.6 Additional Strategic Considerations and Potential Developments

In addition to the legal and (existing) strategic context as covered in the previous sections it is important to be aware of any additional considerations and developments at a national, regional or local level that could have consequences for the ICMP now or in the future. Below is a brief summary of the ones considered most relevant to this ICMP and not necessarily covered elsewhere:

- Continuing policy development in the area of freshwater management and indigenous biodiversity (for example NPS Freshwater Management/Phase 2, Draft NPS Indigenous Biodiversity)
- WRP review and Proposed Waikato Regional Plan Change 1 – Waikato and Waipa River Catchments (including the proposal for Lake Management Plans)
- Changes in regional and local growth strategies (Future Proof, HUGS, WDC Growth Strategy)
- Changes in national guideline documents (for example MfE ANZECC Guidelines for Fresh and Marine Water Quality, MfE Microbiological Guidelines for Marine and Freshwater Recreational Areas)
- Changes to lake management plans and/or implementation initiatives within the catchment (ICMP alignment and HCC/stakeholder collaboration opportunities)
- Potential review changes to the HCC CSDC and/or stormwater management requirements following the WRP review.

1.7 Objectives and Targets

One of the purposes of an ICMP is to ensure that relevant objectives and targets (O&Ts) are met now and in the future. The HCC document 'Integrated Catchment Planning – Planning Guidance and Principles' provides contextual guidance for ICMP development and refers to several source documents which have relevance to the O&Ts developed for HCC ICMPs. These source documents can be referred to for further background details as required, and are listed in Table 1-1 below.

Table 1-1: Source documents

Document Title	Date/Version	TRIM Reference
Waikato River Authority Vision & Strategy	July 2011	-
National Policy Statement for Freshwater Management	August 2014	-
WRC Waikato Regional Policy Statement	May 2016	-
WRC Waikato Regional Plan	September 2007	-
Sub Regional Three Waters Strategy	September 2012	-
HCC Partly Operative District Plan	October 2016	-
Waikato Tainui Environmental Plan	On-line website	-
HCC Comprehensive Stormwater Discharge Consent (#105279)	June 2011	D-1250182
HCC Water Take Consent (#113941)	March 2009	D-1717683
HCC Wastewater Discharge Consent (#114674)	September 2007	D-283284

Other HCC documents providing guidance for O&Ts include the following:

HCC Infrastructure Technical Specifications	October 2010	On-line website
HCC Stormwater Modelling Methodology	May 2013, Rev 1	D-980115
HCC 2015-2025 Activity Management Plan- Water	May 2015, Rev 3	D-1483257
HCC 2015-2025 Activity Management Plan-Wastewater	May 2015, Rev 3	D-1479904
HCC 2015-2025 Activity Management Plan-Stormwater	May 2015, Rev 3	D-1523798
HCC 2015-2025 Long Term Council Community Plan	June 2015	D-240056

The O&Ts developed for HCC ICMPs and which are relevant to this ICMP, are outlined in Table 1-2 below.

Table 1-2: Objective and Targets – Generic to all ICMPs

Id	OBJECTIVE AND TARGETS	Sources / refs
SO1	<u>Application of natural systems in the urban form</u> Natural environment-based systems are incorporated into the urban form when technically possible, to minimise adverse effects of development. Key elements of this approach include: i. Maintaining the function and health of stream systems and their riparian margins ii. Preserving high value terrestrial ecology iii. Minimising changes to the land that alter natural drainage patterns iv. Avoiding and/or minimising impervious surfaces v. Maintaining or enhancing the natural values of the soil resource vi. Using existing landscaped areas and vegetation to help reduce runoff and to trap sediments and contaminants vii. Contributing to local "indigenous biological diversity" viii. Maximising the management and disposal of stormwater using at source methods	swAMP-s1.2 swAMP-s1.4.7 wwAMP-s1.4.7 PGP-s5.6 Pol2 PGP-s6.2 PGP-s6.2(p14.1) PGP-s6.3 (pg39) PGP-s8.3 PGP-s8.4 PGP-s8.6 PGP-s9.2 PGP-s9.3.1 PGP-s9.3.4 PGP-s14.4 CSDC
SO2	<u>Maintaining natural hydrology</u> Stormwater and land drainage systems are designed, operated and maintained so that the post-development hydrological cycle is as close as practicable to the predevelopment situation and ensure: i. groundwater levels in peat soils are sustained ii. wetland function and health is protected iii. base flows in freshwater receiving environments are maintained iv. peak flow rates and extended flow volumes do not adversely affect receiving water bodies	PGP-s4.3 PGP-s6.2 (p8.6) PGP-s6.2 (p8.7) PGP-10.1 (NDC) CSDC
SO3	<u>Quality of discharges to the existing stormwater network</u> The quality of discharges to the existing stormwater network do NOT pose a risk to human or ecosystem health.	swAMP-s1.4.7 PGP-s6.1.1 PGP-10.1 (NDC) CSDC

Id	OBJECTIVE AND TARGETS	Sources / refs
SO4	<u>Stormwater management</u> Stormwater runoff is minimised and stormwater discharges are managed to: i. minimise flood risk in existing and new urban areas, and downstream rural areas (including rural drainage areas) ii. avoid adverse effects on stream channel stability, and aquatic life supporting capacity iii. protect and enhance natural flow regimes in receiving water bodies, and iv. maintain and enhance the values of ecologically significant freshwater habitats	PGP-s6.2 PGP-10.1 (NDC) PGP-s12.1 swAMP-s1.4 CSDC And many others
SO5	<u>Mauri of the catchment and waterbodies</u> Stormwater runoff and discharges are managed to restore and protect the: i. health and mauri of the catchment and receiving water bodies ii. relationship of tangata whenua as kaitiaki of receiving water bodies	PGP-s1.1.2 PGP-s5 PGP-s6 PGP-s7 CSDC
SO6	<u>Stormwater effects on receiving environment</u> Effects on stormwater receiving water bodies, including those associated with stream channel maintenance works, are managed so that: i. a net improvement in water quality is achieved over time ii. the quality of any degraded water bodies is enhanced through improved management iii. indigenous biodiversity values are protected and enhanced iv. the natural character of water bodies is protected and enhanced	PGP-s6.3 PGP-s8.5 PGP-s9.2 PGP-s11.2 CSDC
SO7	<u>Water conservation and demand management</u> The water network is managed and developed to: i. Accommodate growth in accordance with water conservation and demand management objectives ii. Ensure potable water use is managed to minimise peak and total demand and associated wastewater generation iii. Provide for existing as well as future growth and demand	swAMP-s1.1 wwAMP-s1.1 wsAMP-s1.1 swAMP-s1.4.7 wwAMP-s1.1 CSDC
SO8	<u>Wastewater management</u> Wastewater generation is minimised and wastewater discharges are managed to avoid potential adverse effects on Hamilton City Council's existing infrastructure network or the natural environment	wwAMP-s1.4

Id	OBJECTIVE AND TARGETS	Sources / refs
SO9	Minimising infrastructure requirements Development and the infrastructure networks are managed in a way that minimises the need for new infrastructure, including by optimising the use of existing assets	PGP-s12.1
SO10	Hierarchy of preferred stormwater disposal options Development adopts the current hierarchy of preferred stormwater disposal options, which is: i. Retention for re-use ii. Soakage iii. Detention and gradual release to a watercourse iv. Detention and gradual release to stormwater reticulation	swAMP-s1.4.2 swAMP-s2.2 PGP-s1.3 PGP-s5.6 PGP-s9.3.1 PGP-s12.1
SO11	Resource consent compliance – three waters networks All network consent requirements (stormwater, water and wastewater) are met	swAMP-s2.2 CSDC
SO12	Network design for planned and unplanned events Network design considers the network response and operational implications for planned and unplanned events	CSDC
SW1	Significant flood hazards Significant flood hazards are avoided and unacceptable existing risks are mitigated as far as practicable No increase in flooding risk to neighbouring, upstream or downstream properties	SO4 PGP-s6.1(p13.2 PGP-s6.3 (pg38) PGP-s7 PGP-s8.4 PGP-s9.3.3 CSDC

Id	OBJECTIVE AND TARGETS	Sources / refs
SW2	Network capacity (design standard) including overland flow For new development areas, sufficient network capacity is provided to ensure stormwater from premises is conveyed for the design storms specified in the Infrastructure Technical Specifications For new and existing development areas the impacts of limited network capacity are limited, flood plains and overland flow where practicable Ensure WRC Level of Service requirements are met within Rural Drainage Areas affected by development within Hamilton	swAMP-s1.2 swAMP-s1.4.5 swAMP-s1.4.8 swAMP-s2.2 swAMP-s3.5 PGP-s6.1.1 PGP-s9.3.3
SW3	Resilience Additional resilience is considered and, if feasible, provided as part of the system design to mitigate potential consequences of: i. flows in excess of system design standards ii. flooding and network failure due to partial or total blockage of inlets, piped systems and/or overland flow paths iii. accidental or deliberate contaminant spills and discharges	PGP-s16.2 CSDC
WW1	Effects on receiving environment That the quality and frequency of any wastewater discharges to the existing wastewater network does not increase the risk of adverse effects to human or ecosystem health	SO8
WW2	Resilience Wastewater generation is minimised and wastewater discharges are managed such that no adverse effects are encountered on HCC's existing infrastructure network or natural environment Consideration is given to reduction of water demand and grey water re-use Opportunities to manage peak wastewater flows are investigated and implemented by the wastewater discharger where appropriate	SO8
WW3	Network capacity Ensure the wastewater network is designed and constructed in accordance with the design standards specified in the Infrastructure Technical Specifications	
WW4	Dry weather overflows No dry weather overflows now or in the future due to lack of network capacity The network is designed to have resilience built-in to reduce the risk arising from potential network and pump station failures	wwAMP-general wwAMP-s2.2

Id	OBJECTIVE AND TARGETS	Sources / refs
WW5	Wet weather overflows Wet weather overflows are managed/minimised and reduced over time	wwAMP-s1.4.8 wwAMP-s2.3 CSDC
WS1	Network Capacity Network capacity is planned and provided for in a way that meets existing and future requirements for: i. firefighting water supply (flow and pressure) by conforming to the Code of Practice for Fire Fighting Water Supplies ii. domestic, commercial and industrial water demand	wsAMP-s2.3
WS2	Water demand management Potable water consumption is managed to minimise peak and total demand now and in the future by the following measures: i. Volumetric charging in place for Commercial and Industrial activities ii. Meet a targeted average residential water consumption of < 230 l/p/d iii. Water loss to be < 16% in 2015-2018 reducing to 10% in 2018-2025	SO7 SO8 wsAMP-s1.1 wsAMP-s1.1 wsAMP-s1.4.6 wsAMP-s1.1 wwAMP-s1.4.5 wwAMP-s1.4.7 ww-AMP-s3.3 PGP-s15.2 PGP-s6.3.1 PGP-s1.3 PGP-s15.2
WS3	Resilience Ensure assets, technology and resources (in house or through consultants, service providers and contractors) have capacity, redundancy (n+1), knowledge and plans to either prevent or cope with unplanned events	wsAMP-1.1

In addition to the above O&Ts, some catchment specific O&Ts have also been established through the development of this ICMP. These have largely been informed through the catchment specific investigations and assessments undertaken in support of the ICMP, as well as from the documents listed in Table 1-3 below:

Table 1-3: Source documents

Document Title	Date/Version	TRIM Reference
WRC Waikato Regional Plan	September 2007	-
HCC Partly Operative District Plan - Rotokauri Structure Plan	October 2016	-
WDC District Plan	Under review	-
WRC/ICM Resource Consent #120860	January 2010	-
HCC Comprehensive Stormwater Discharge Consent (#105279)	June 2011	D-1250182
HCC Waiwhakareke Natural Heritage Park Operative Management Plan 2011	2011	D-126347
WDC Rotokauri Lake Management Plan 2000	2000	D-119120
WDC Lake Rotokauri Ecological Enhancement Plan	2014	D-1618181

The catchment specific O&Ts are outlined in Table 1-4 below.

Table 1-4: Objectives and Targets – Specific to Rotokauri ICMP

ID	OBJECTIVE AND TARGETS	Sources / xrefs
Catchment Specific		
CS1	<u>Alignment with the Rotokauri Structure Plan</u> 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 RSP. In particular to: i. Preserve key natural features and topography ii. Safeguard and enhance areas of significant indigenous vegetation, water features and habitats iii. Manage stormwater in a manner that minimises the effects of development on downstream receiving waters iv. Ensure that the 'central green corridor' functions as the principle stormwater drainage corridor and connects the wider network of open spaces and natural features v. Ensure that new urban development is appropriately serviced	All generic O&Ts, RSP, Waiwhakareke Natural Heritage Park Operative Mgt Plan, Rotokauri Lake Mgt Plan, CSDC
CS2	<u>Key stakeholder engagement</u> Engagement and collaboration between agencies, stakeholders and landowners to protect and enhance natural catchment values through ICMP implementation and wider catchment initiatives. These include (but are not be limited to): i. Subdivision master planning and design ii. Provision of other infrastructure (e.g. the transportation network) iii. Establishment of minimum groundwater levels in Lake Waiwhakareke Natural Heritage Park iv. Protection and enhancement of indigenous biodiversity values, including connectivity between Lake Waiwhakareke and Lake Rotokauri, and the modified watercourse tributaries of the Rotokauri Drain (central green corridor) v. Protection and enhancement of the main catchment outlet between Exelby Road and Lake Rotokauri vi. Ongoing maintenance of the Lake Rotokauri lake level management regime vii. Avoidance of cumulative adverse effects during and post development	SO1- SO6, SO9 SO10, RSP, Waiwhakareke Natural Heritage Park Operative Mgt Plan, Rotokauri Lake Mgt Plan, Lake Rotokauri Ecological Enhancement Plan, CSDC

ID	OBJECTIVE AND TARGETS	Sources / xrefs
CS3	<u>Ecological protection and enhancement</u> Development and three waters infrastructure is designed, constructed, operated and maintained to achieve the following ecological protection and enhancement objectives: i. Provision of infrastructure that protects and supports the natural values of the catchment ii. Improvement of existing aquatic and terrestrial habitat, and creation of new habitat to support indigenous flora and fauna iii. Creation of a functional ecological linkage between Lake Rotokauri and Lake Waiwhakareke, with aquatic and terrestrial habitat to support indigenous flora and fauna iv. Prevention of the establishment and spread of pest plants and animals (both aquatic and terrestrial) v. Protection (and improvement if possible) of the current water quality status of Lake Waiwhakareke and Lake Rotokauri vi. Protection (and improvement if/where possible) of significant natural areas from existing threats vii. Sustaining the mauri of the waterbodies through-out the catchment	SO1 – SO7, CS1, ICMP technical assessments, Waiwhakareke Natural Heritage Park Operative Mgt Plan, Rotokauri Lake Mgt Plan, Lake Rotokauri Ecological Enhancement Plan, CSDC
CS4	<u>Protecting groundwater levels in Waiwhakareke Natural Heritage Park</u> The major stormwater drainage infrastructure in proximity to the Waiwhakareke Natural Heritage Park is designed, constructed, operated and maintained to protect natural groundwater levels	SO2, SO4, SO5, SO6, SO9, RSP, ICMP technical assessments, Waiwhakareke Natural Heritage Park Operative Mgt Plan, CSDC

ID	OBJECTIVE AND TARGETS	Sources / xrefs
CS5	Flood protection and downstream LOS The major stormwater drainage infrastructure is designed, constructed, operated and maintained to: i. Meet cross jurisdictional flood protection LOS (HCC, WDC and WRC/ICM) ii. Minimise flood storage and conveyance infrastructure requirements (including capital and ongoing operation and maintenance costs) iii. Utilise the natural storage and attenuation capacity of Lake Rotokauri while observing the operating level limitations of the lake. These are: • Normal operating range (minimum water level requirements): RL22.5m to RL22.8m (Moturiki datum) • Design flood level: RL23.5m (Moturiki datum)	SO1, SO2, SO4, SO9, SO11, SO12, SW1, SW2, SW3, CS1, ICMP technical assessments, WRP, WDP, Rotokauri Lake Mgt Plan, WRC/ICM Consent ##120860, CSDC
CS6	Protecting water quality The stormwater network incorporates a treatment train approach which is designed, constructed, operated and maintained to: i. Minimise temperature fluctuations in receiving waterbodies ii. Maximize contaminant removal efficiencies at all times iii. Be resilient to accidental or deliberate contaminant spills and discharges iv. Meet or exceed the stormwater treatment requirements for the catchment, including > 70% total phosphorous removal prior to discharge to the receiving environment	SO1, SO3, SO4, SO5, SO6, SO11, SO12, SW3, ICMP technical assessments, Waiwhakareke Natural Heritage Park Operative Mgt Plan, Rotokauri Lake Mgt Plan, CSDC

ID	OBJECTIVE AND TARGETS	Sources / xrefs
CS7	<u>Catchment development</u> Flood storage, water quality treatment and ecological protection requirements are met through-out all stages of development. Note: this objective extends to all soil disturbance activities whereby sediment laden runoff will be strictly controlled to meet suspended solids and total phosphorous treatment requirements of 90% and > 70% respectively	SO3, SO4, SO6, SO9, SO11 CS3, CS4, CS5, CS6, ICMP technical assessments, Waiwhakareke Natural Heritage Park Operative Mgt Plan, Rotokauri Lake Mgt Plan, CSDC
CS8	<u>Catchment monitoring and information gathering</u> Catchment monitoring and information gathering is continued through-out the development stages of the catchment to ensure that the objectives and targets of this ICMP are being met, and the potential adverse effects of development are avoided or otherwise minimised	Several O&Ts, ICMP technical assessments, Waiwhakareke Natural Heritage Park Operative Mgt Plan, Rotokauri Lake Mgt Plan, CSDC

2 Catchment Description

2.1 Introduction

The Rotokauri Catchment is a predominantly 'greenfield catchment', located in the north-western area of Hamilton City and the upper headwaters of the Ohote Stream Catchment. It is approximately 788 hectares in area and incorporates all of the RSP area west of Mangaheka Catchment, the two catchments being generally divided by the Mangaharakeke Drive/Te Rapa Bypass.

Catchment topography is generally very flat, punctuated with peripheral ridgeline and gully areas that further characterise the catchment. The Waiwhakareke Natural Heritage Park is located in the upper headwaters of the southern area of the catchment, so-named after Lake Waiwhakareke which drains from the catchment via a highly modified stream known as the 'Rotokauri Drain'. The Rotokauri Drain forms the single main outlet to this part of the catchment, passing beneath Exelby Road (the HCC jurisdictional boundary) prior to entering Lake Rotokauri. Beyond this point, the Ohote Stream forms the outlet to the lake and drains to the Waipa River, which in turn drains to the Waikato River where they meet at Ngaruawahia. The northern area of the catchment drains directly to the Ohote Stream (refer to Figure 2-1 below).

With regard to Lake Rotokauri, this surface water feature is located within the jurisdictional area of WDC who maintain an open drain network within the immediate lake reserve area. Beyond this area WRC/ICM administers and maintains the RDA along with the lake level control weir structure. This ensures that minimum lake operating levels are maintained and rural drainage standards met.

The catchment overall is highly valued for its existing natural areas and several agencies are proactively engaged in restoring the two lakes and surrounding sub-catchment areas. Both lakes are managed to support wide ranging values including ecological, historical, cultural, public access and recreation. They also possess significant biodiversity values and are protected through various policy and planning provisions[8].

The main known issues for the catchment and subsequent constraints for development range from:

- Existing poor water quality status of the two main lakes which are subject to various cross agency improvement initiatives
- High groundwater levels combined with low permeability soils which limit the potential for widespread use of soakage, and
- Extensive flood management issues which require significant flood storage mitigation within the development area to safeguard downstream flood protection levels of service.

Other known issues include moderate to high erosion susceptibility in the upper headwater areas of the catchment, along with high erosion susceptibility and existing hotspots in the downstream reach of the Rotokauri Drain. Mitigation works are therefore essential to protect channel integrity and the high ecological values observed in this reach of stream.

All of these issues have been extensively investigated by HCC, initially in support of the Rotokauri structure planning exercise through to the more recent investigations and assessments undertaken in support of the ICMP. The main outcomes of these assessments are presented in Section 3 of this document, followed by identification of the opportunities, options and ultimately BPOs and integrated management solutions in Section's 4 and 5 respectively.

[8] Including the Waikato Regional Policy Statement, Waikato Regional Plan, HCC District Plan, WDC District Plan and Reserve Management Plans.

Figure 2-1 below shows the general catchment layout, including the main sub-catchment areas and surface water features. Also of note, the 'Rotokauri ICMP Boundary' forms part of the wider Ohote Stream Catchment as shown in Figure 1.1.

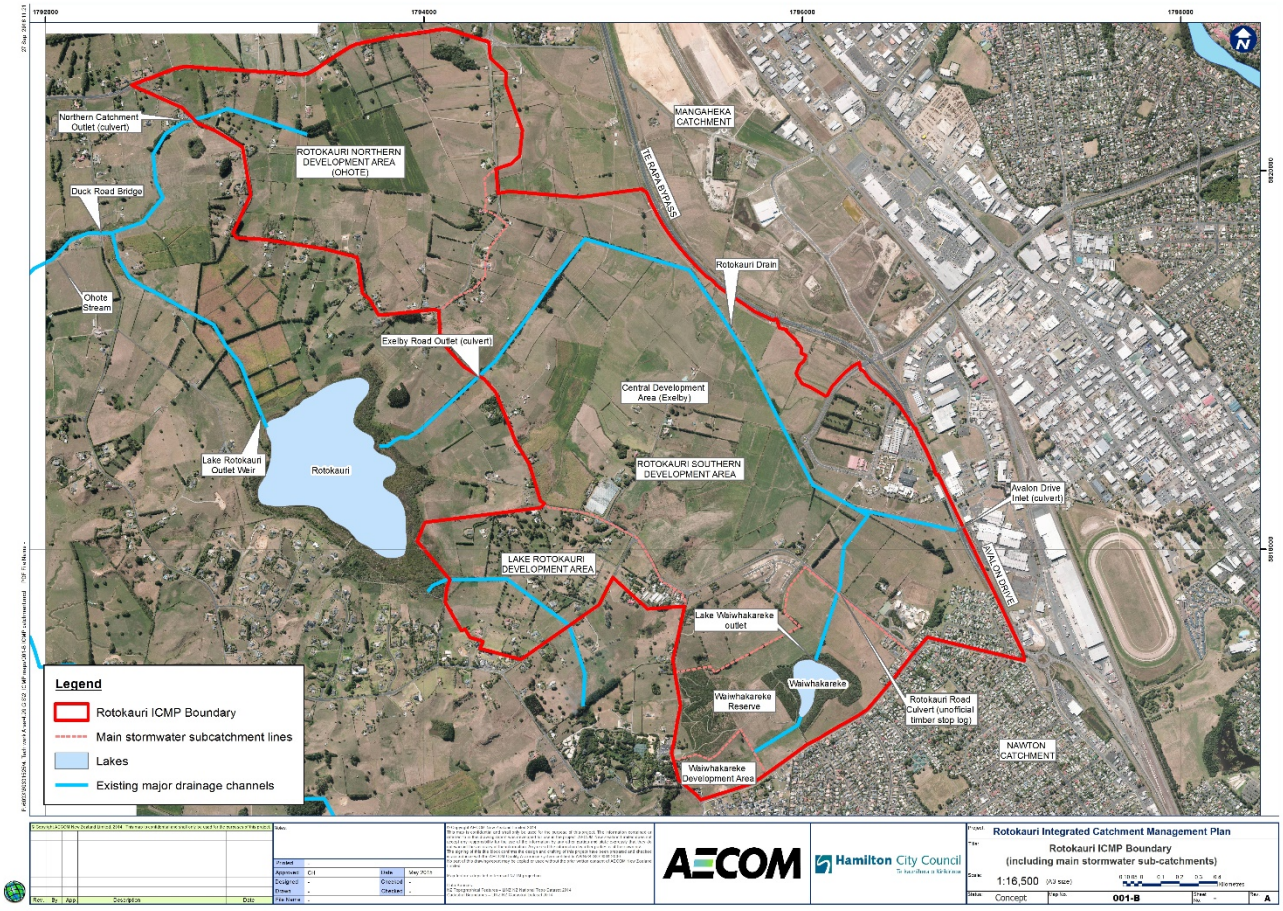

Figure 2-1: Catchment layout

2.2 Land-use

2.2.1 Historic and cultural land-use

In terms of pre-European historical land use, a cultural assessment undertaken by Nga Mana Toopu o Kirikiriroa (2001) shows that the wider catchment area was extensively occupied and provided raw materials to support everyday life. In this regard a number of iwi and hapu historically occupied the area, including Nga Iwi (an early pre Tainui Maori tribe), Ngati Ngamurikaitaua, Ngati Koura, Ngati Ruru and Ngati Mahanga.

The cultural assessment explains that 'Rotokauri' translates to mean 'Lake of Kauri Trees' in Te Reo Maori. Lake Rotokauri was given this name because of the many ancient Kauri logs which are buried in the bed of the lake and around its margins.

Around this time the hills and ranges overlooking the Rotokauri Catchment were also densly forested with a mixture of matai, miro, totara and tawa trees. By contrast, the forests of the peat swamps and low lying plains were dominated by kahikatea, titoki, rewarewa and pukatea trees, and Maire trees along the the margins of the swamps. Within these dense forest stands there was ground cover of ferns such as maheuheu, punga and mamaku along with several species of vines that were particularly significant for Maori in their application to various construction, crafting and implement manufacturing activities.

Within the immediate catchment, much of the area between Lake Waiwhakareke and Lake Rotokauri was wetland. The section nearest to Lake Waiwhakareke was bog, a wetland type characterised by low nutrient concentrations and rainwater inputs (Ausseil et al. 2010). The middle sections of the catchment would have been fen, a wetland type with intermediate nutrient concentrations. The steeper gully area in proximity to the existing Exelby Road catchment outlet, would most likely have been a stream due to the steeper topography in this location. Finally, the margins of Lake Rotokauri would have extended much further than they do today, and marginal swamps would have surrounded the lake (Kessels, 2016). These wetland characteristics are shown in Figure 2-2 below.

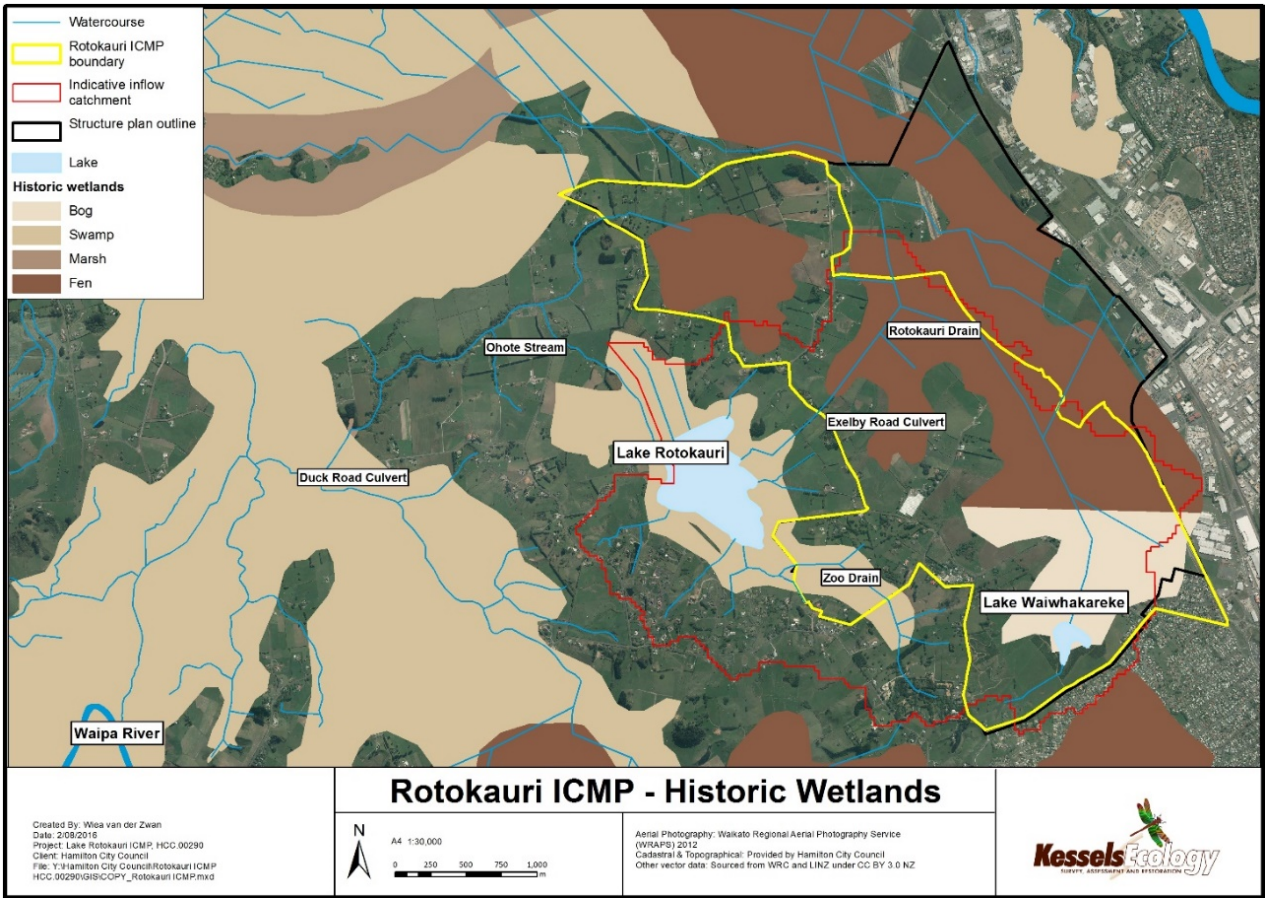

Figure 2-2: Map of historic wetlands

The Nga Mana Toopu o Kirikiriroa cultural assessment states that significant land use change began to occur around the 1820's when Ngapuhi forces, armed with muskets, invaded the region and set fire to many of the existing settlements and surrounding forests. Later, huge land clearances were directed by European Christian missionaries who are recorded as setting fire to many of the ancient forest reserves in the area. They apparently also encouraged Maori to clear forests and transform the land into European type farms. This had an enormously deleterious effect upon the natural resources of the area along with commercial trade which Tainui undertook prior to 1860.

2.2.2 Current land-use

In terms of current day land use, the Rotokauri Catchment is predominantly 'greenfield' and reflects the historical land clearances of the last two centuries. Extensive rural drainage networks have been established to enable agricultural grazing and cropping activities, and smaller lifestyle block activities exist in the southern lake fringe areas of the catchment. Small pockets of urban development have also emerged in the more central southern areas, as per provisions of the District Plan.

Figure 2-3 below shows current land use based on land cover which is predominantly high producing exotic grassland.

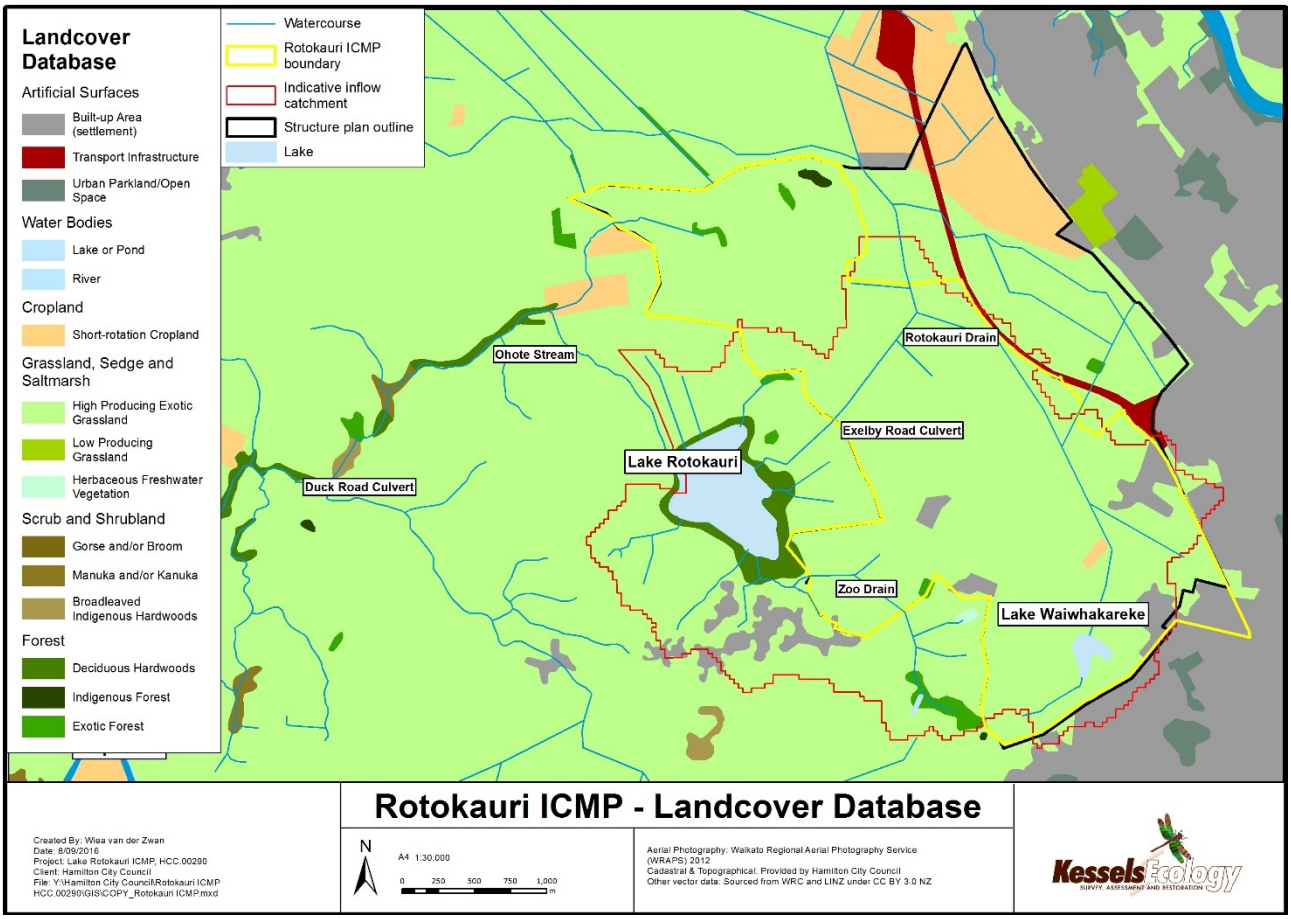

Figure 2-3: Map of existing landcover

In addition, Figure 2-4 and Table 2-1 below describes the land-use assumptions used in 3 Waters (water, wastewater and stormwater) modelling and generally aligns with land-use and growth expectations at the time.

At the time of catchment modelling the inputs included approximately 5.1 Ha of residential land use ('Block Residential') in the Waiwhakareke area (as shown in Figure 2-4). However, since then, Council (owner of the land) has resolved that this land will be used as reserve.

Two other notable changes are:

- An area of land (approximately 8ha) to the north of the proposed suburban centre that is being changed from an industrial (Rotokauri Employment) zone to medium density residential zone as the consequence of settling an appeal to the District Plan

- An area of land (approximately 4.5ha) that was rezoned from Major Facilities Zone (associated with the Waikato Institute of Technology (WINTEC)) to industrial.

It is considered that these differences have an inconsequential effect on overall modelling outcomes for the catchment given their nature and scale. They are therefore not considered further in this ICMP.

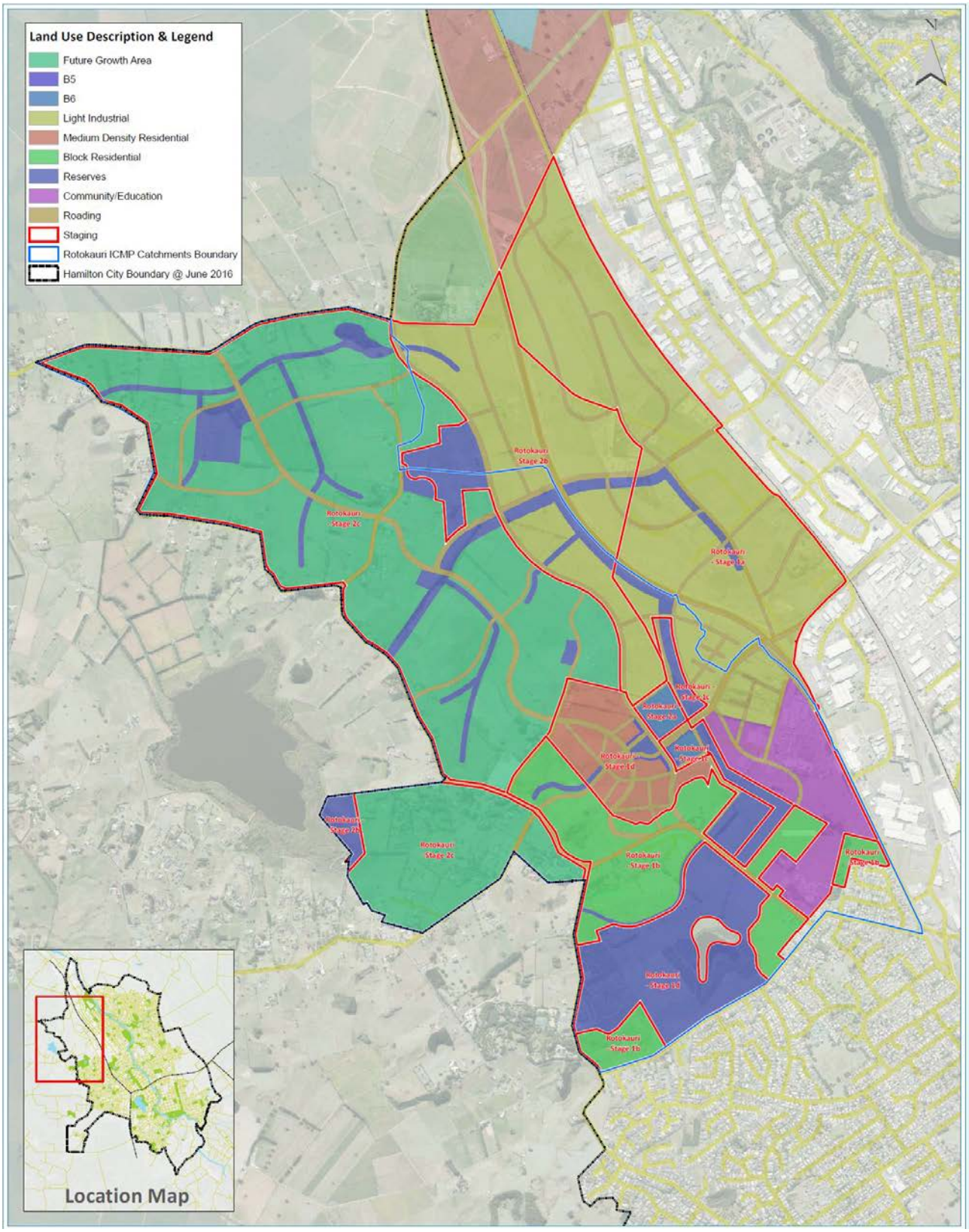

Figure 2-4: Land-use assumptions used in 3 Waters modelling

Lend	Development Stage name	Land use Description	Area (ha)	Dwelling density (Dwelling per ha)	Occupancy Rate (People per Dwelling)	Current Development Population	Projected Population Equivalent				Development		Maximum Impervious-ness
							2021	2041	2061	City Full	Start	End	
Rotokauri - Stage 1a	Rotokauri - Stage 1 - Industrial	Light Industrial	157.30	1	30	44	1825	4719	4719	4719	2014	2034	0.9
		State Highway	5.51	0	0	0	0	0	0	0	2014	2034	0.95
		Major Arterial Road	5.71	0	0	0	0	0	0	0	2014	2034	0.95
		Minor Arterial Road	0.45	0	0	0	0	0	0	0	2014	2034	0.95
		Collector Road	24.10	0	0	0	0	0	0	0	2014	2034	0.95
		Park Edge Road	1.86	0	0	0	0	0	0	0	2014	2034	0.95
		WINTEC	29.33	1	45	7	507	1320	1320	1320	2014	2034	0.2
		Community Facilities	11.90	1	45	7	208	535	535	535	2014	2034	0.2
		Drainage Reserve	5.57	0	0	0	0	0	0	0	2014	2034	0.1
		Lake	3.61	0	0	0	0	0	0	0	2014	2034	0.1
Rotokauri - Stage 1b	Rotokauri - Stage 1 - Lake Waiwhkareke	Block Residential	69.71	11	3	35	351	1405	2301	2301	2016	2058	0.6
		Minor Arterial Road	1.02	0	0	0	0	0	0	0	2016	2058	0.95
		Collector Road	5.10	0	0	0	0	0	0	0	2016	2058	0.95
Rotokauri - Stage 1c	Rotokauri - Stage 1 - Suburban Centre	B5 - Commercial	1.12	1	135	0	45	152	152	152	2019	2028	0.8
		B6 - Commercial	1.80	1	30	0	16	54	54	54	2019	2028	0.8
		Major Arterial Road	0.91	0	0	0	0	0	0	0	2019	2028	0.95
		Collector Road	11.68	0	0	0	0	0	0	0	2019	2028	0.95
		Drainage Reserve	3.74	0	0	0	0	0	0	0	2019	2028	0.1
Rotokauri - Stage 1d	Rotokauri - Stage 1 - Medium density	Medium Density Residential	23.36	25	2.6	5	5	631	1518	1518	2030	2058	0.5
		Collector Road	1.72	0	0	0	0	0	0	0	2030	2058	0.95
		Neighbourhood Recreational	65.35	1	1	0	0	27	65	65	2030	2058	0.1
		Drainage Reserve	1.28	0	0	0	0	0	0	0	2030	2058	0.1
ROTOKAURI STAGE 1 SUMMARY			**432.13**	**varies**	**varies**	**98**	**2958**	**8843**	**10664**	**10664**	**2014**	**2058**	**varies**
Rotokauri - Stage 2a	Rotokauri - Stage 2 - Suburban Centre	B5 - Commercial	0.59	1	135	0	0	31	80	80	2029	2061	0.8
		B6 - Commercial	3.87	1	30	0	0	46	116	116	2029	2061	0.8
		State Highway	4.99	0	0	0	0	0	0	0	2029	2061	0.95
		Collector Road	8.63	0	0	0	0	0	0	0	2029	2061	0.95
Rotokauri - Stage 2b	Rotokauri - Stage 2 - Employment	Light Industrial	82.89	1	30	15	15	585	2487	2487	2036	2061	0.9
		Minor Arterial Road	9.58	0	0	0	0	0	0	0	2036	2061	0.9
		Collector Road	22.04	0	0	0	0	0	0	0	2036	2061	0.95
		Neighbourhood Recreational	29.17	1	1	0	0	7	29	29	2036	2061	0.1
		Drainage Reserve	11.10	0	0	0	0	0	0	0	2036	2061	0.1
Rotokauri - Stage 2c	Rotokauri - Stage 2 - Low density	Future Growth Area	320.90	16	2.7	257	257	257	4792	13863	2056	2073	0.5
		Collector Road	3.12	0	0	0	0	0	0	0	2056	2073	0.95
		Neighbourhood Recreational	17.51	1	1	0	0	0	6	18	2056	2073	0.1
		Drainage Reserve	1.65	0	0	0	0	0	0	0	2056	2073	0.1
ROTOKAURI STAGE 2 SUMMARY			**516.05**	**varies**	**varies**	**272**	**272**	**926**	**7510**	**16592**	**2029**	**2073**	**varies**
ROTOKAURI DEVELOPMENT AREA SUMMARY			**948.17**	**varies**	**varies**	**369**	**3230**	**9769**	**18174**	**27256**	**2014**	**2073**	**varies**

Table 2-1: Land-use assumptions used in 3 Waters modelling

2.2.3 Proposed and potential land-use change

The wider RSP area has been identified for urban growth purposes since being brought into Hamilton through the 1989 local government reforms (Beca et al, 2001). A 'future urban' zoning was applied to most of this area when the RSP was incorporated into the District Plan (notified in 2007). The RSP served as a guide to the long term development of Rotokauri.

The future population of the area is estimated between 16,000 and 20,000 people and development to support this population is guided by the following RSP Vision:

> *"The sustainable expansion of the City into Rotokauri, through a coherent, integrated and people-focused mixed-use development based on best practice urban design principles."*

With regard to the Rotokauri Catchment, the RSP makes provision for approximately 485 Ha of General Residential zoning along with provision for Character Areas based upon Lake Waiwhakareke, the area's natural ridgelines and medium density development adjoining the proposed suburban centre. Immediately to the west of the Mangaharakeke Drive/Te Rapa Bypass is an employment area of approximately 100 Ha that is planned to transition from the industrial activity in the adjacent Managaheka Catchment. A suburban centre of approximately 6 Ha to the west of Gilchrist Street forms the main retail focus for Rotokauri, whilst Major Facilities at WINTEC remain an important part of Rotokauri.

In addition to the above land use zonings, the RSP identifies approximately 140 Ha of Reserves throughout the catchment. This includes the Waiwhakareke Natural Heritage Park, three sports parks, neighbourhood reserves and a neighbourhood green at the heart of the southern suburban centre. Multi-functional Green Corridors also extend throughout the area, providing landscape and amenity value, stormwater management and off road walking and cycling networks.

With regard to the proposed Central Green Corridor (discussed in Section 3) which follows the general alignment of the Rotokauri Drain, the RSP envisages this as being a major feature within the Rotokauri environment. The central north-south collector corridor also has a role in providing connectivity between reserve and recreation nodes, completing an overall concept of an open space network.

Clearly, these proposed land use changes will significantly increase the imperviousness and runoff characteristics of the catchment. This has been modelled and assessed as part of the technical investigations undertaken to support the ICMP (AECOM, 2016). The main findings of these investigations are presented and discussed in Sections 3 – 6 of this document, however, with reference to the future development scenarios defined in Section 2.2.2 above, it is noted that the investigations have extended to the following scenarios:

- The 'Maximum Plausible Development' scenario where the catchment with main drainage mitigation has been extensively modelled based on current planning limits and physical catchment constraints
- The 'Potential Development' scenario where city and sub-regional growth strategies have been reviewed to determine the likelihood of development that could occur but is not currently provided for[9], and

[9] The city and sub-regional growth strategies reviewed include the 'Hamilton Urban Growth Strategy' which sets out HCC's spatial vision for the City; 'Future Proof' which is the growth strategy for the combined Hamilton, Waipa and Waikato sub-region; and the 'Waikato District Development Strategy' which identifies the main growth areas of the District.

- The ‘Hypothetical Development’ scenario whereby contingency measures in the form of alternative drainage options for the catchment have been considered.

Figure 2-5 below shows future land use in the catchment based on the District Plan and projected land use zoning.

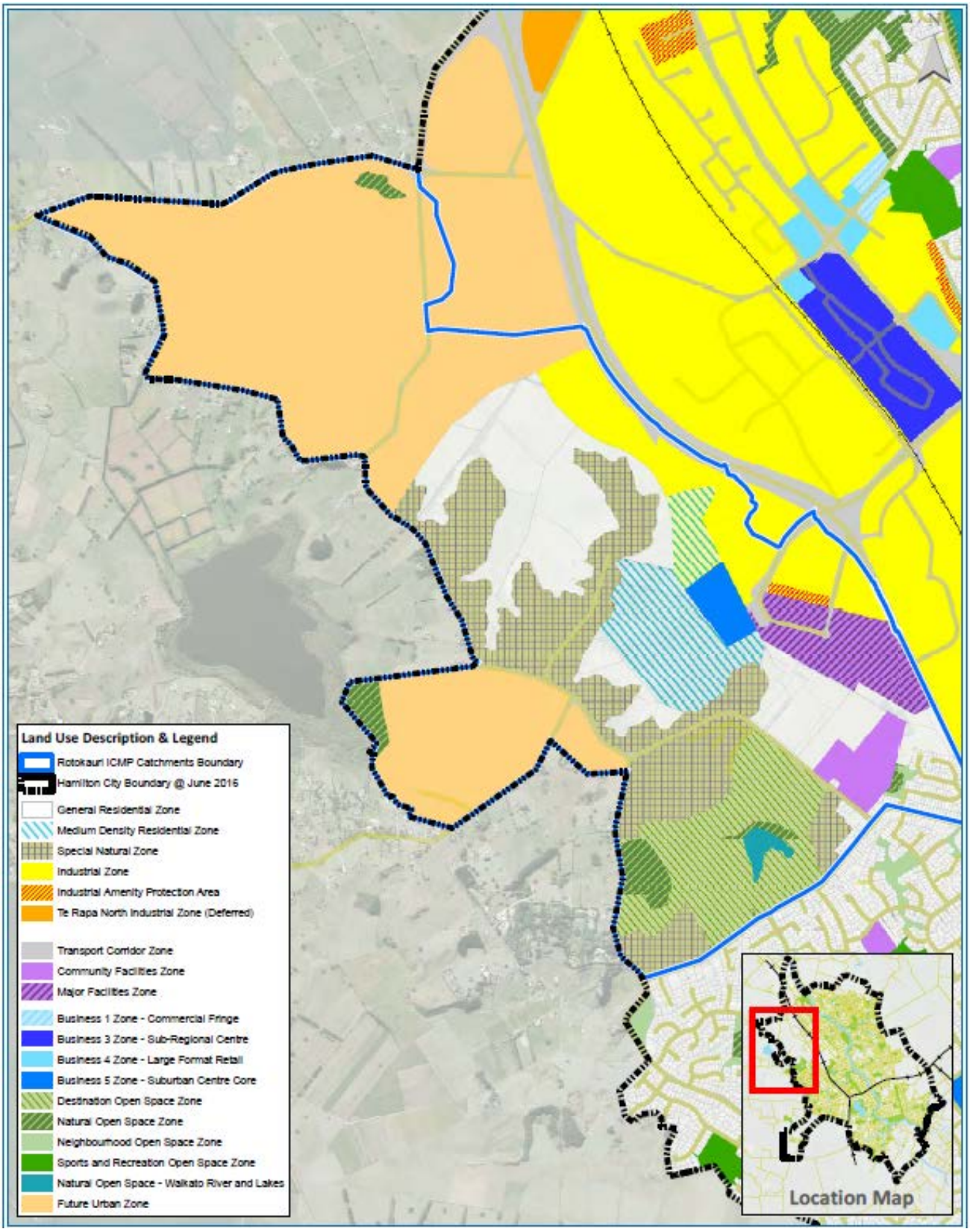

Figure 2-5: Map of future land-use based on the District Plan

It is noted that the land-use changes discussed in Section 2.2.2 above (e.g. an open space zone/reserve for the 5.1ha in the Waiwhakareke area) are not shown on the above map. At the time of writing this ICMP, these changes are still subject to further planning and related legal process.

2.2.4 Major transport links

In context to the wider structure plan area Section 3.6.2 of the District Plan proposes a multi modal transportation network based on a hierarchy, at the top of which are State Highways and the rail corridor providing for high volume inter-regional traffic and freight movements. Next in the hierarchy, the arterial transport corridor networks are designed to cater for high-volume traffic and provide the key connections with the wider City and regional network, including the Mangaharakeke Drive/Te Rapa Bypass which was completed in 2012.

The main industrial zone in the Mangaheka Catchment has a critical relationship to the City's arterial transport network. Te Rapa Road and Avalon Drive form part of State Highway 1. Both transport corridors are heavily trafficked and growth is anticipated as the route provides the spine to the City's industrialised 'western corridor' and direct access to key regional facilities such as the Central City, the hospital, educational campuses and the inland freight village at Crawford Street.

With regard to the Rotokauri Catchment (refer Figure 2-6 below), Section 3.6.3.2 of the District Plan states that roading upgrades will be required to service the specific residential growth cells adjacent to Baverstock Road, Brymer Road, Exelby Road, Rotokauri Road and Lee Road. Provision of the north/south minor arterial transport corridor will provide an eastern boundary to the residential zone north of the suburban centre and will form a spine to development south of it before it connects with and follows the southerly route of Rotokauri Road. Key works to be undertaken are anticipated in the following sequence:

- Upgrade of western end of Baverstock Road including the intersection of Brymer Road and north to the Hamilton Zoo entrance
- Upgrade of Rotokauri Road between the new residential arterial transport corridor and Brymer Road
- Upgrade of Brymer Road from Hamilton Zoo entrance, northwards to Lee Road
- Upgrade of Lee Road.

The RSP further indicates that future land releases will be serviced by the progressive development northwards of the north/south minor arterial to its point of connection to the existing Te Kowhai Road. Also by the progressive upgrading of existing transport corridors from south to north and east to west.

Treatment of stormwater runoff from the transport network will need to integrate with sub-catchment treatment concepts to ensure that treatment and associated infrastructure efficiencies are maximized. This is addressed in Sections 4 and 5 of the ICMP.

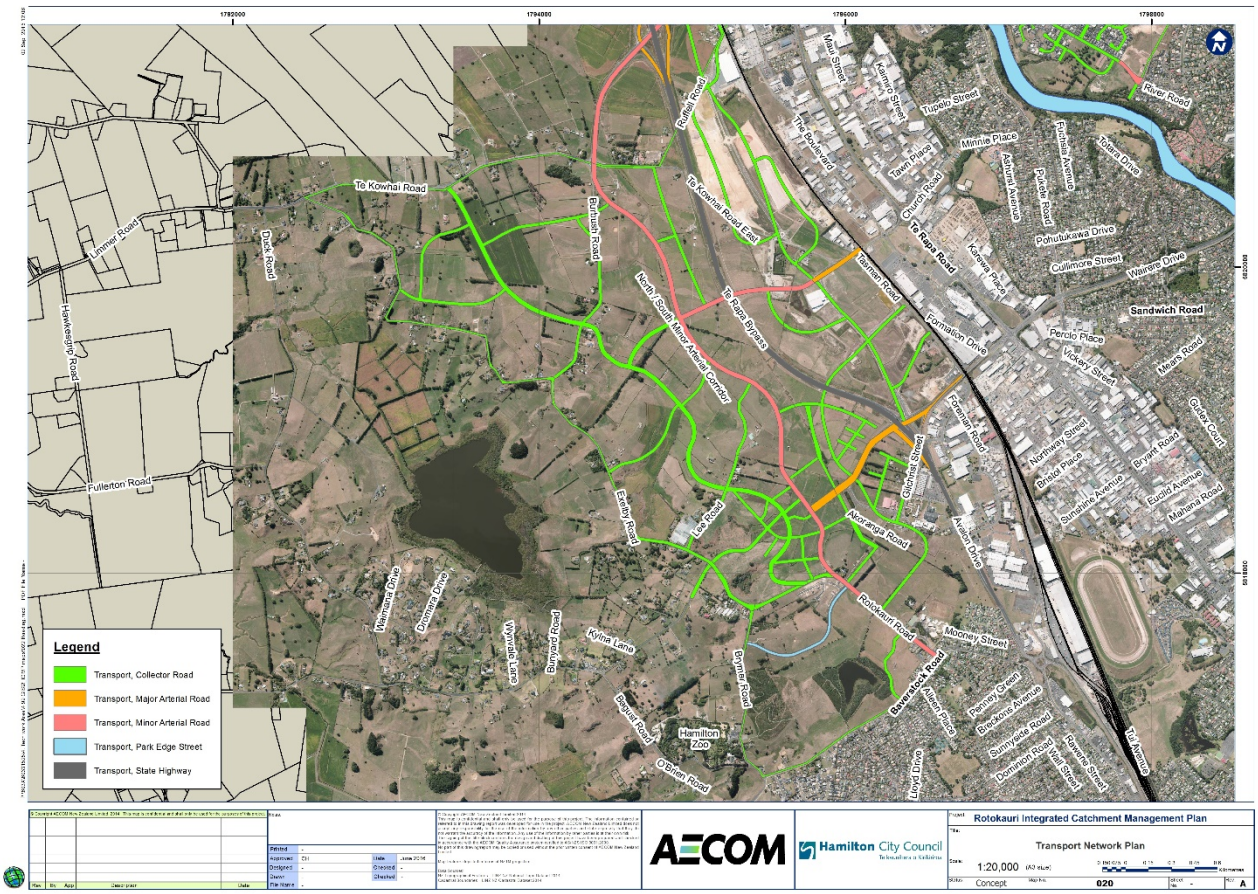

Figure 2-6: Map of transport network

2.3 Physical Environment

2.3.1 Topography

There are four main sub-catchments within the Rotokauri Catchment. These are shown in Figure 2-7 and described below.

- **Rotokauri North Development Area (RNDA)** - approximately 195 Ha and drains directly to the Ohote Stream. It is bounded by the Exelby Road/Hamilton jurisdictional boundary to the west, Te Kowhai Road to the north and the Mangaharakeke Drive/Te Rapa Bypass to the east. The RNDA is identified in the District Plan as a Stage 2 development area, with the release of land being subject to growth demand and the provision of major infrastructure.

- **Rotokauri South Development Area (RSDA)**. This area breaks down into three main sub-catchments:

    - **Waiwhakareke** - approximately 77 Ha and predominantly a Natural Heritage Park. This sub-catchment forms the upper headwaters of the RSDA and is bounded by Brymer Road/Hamilton jurisdictional boundary to the west, Baverstock Road to the south and Rotokauri Road to the east.

      Approximately 10 Ha of land in the south-west corner of the catchment is zoned for residential development, and is referred to in this ICMP as the **Waiwhakareke Development Area (WDA)**. The WDA drains directly to Lake Waiwhakareke and is identified in the District Plan as a Stage 1 development area (currently undergoing development).

- **Central Development Area (CDA)** – approximately 443 Ha and drains directly to Lake Rotokauri via the Rotokauri Drain and its network or rural drain tributaries. This sub-catchment is bounded by Exelby Road/Hamilton jurisdictional boundary to the west, Rotokauri Road to the south and the Mangaharakeke Drive/Te Rapa Bypass to the east. The southern area of the CDA is identified in the District Plan as a Stage 1 development area and is currently undergoing development.

  The CDA receives inflows from Lake Waiwhakareke and the upstream Nawton area. This area discharges to the Rotokauri Drain via the Avalon Drive culvert, however, the upstream pipe system also outlets to the Waikato River east through St Andrews Catchment. In lieu of detailed modelling of the St Andrews catchment, the Avalon Drive culvert has been modelled to discharge to its maximum capacity based on the topographical extent of the Nawton area (not network) draining to it.[10] Further details of this relationship are provided in the ICMP supporting documents (AECOM, 2016) (Appendix C).

  Other catchment inflows may occur along the eastern boundary of the CDA and adjacent Mangaheka Catchment. However, due to the flat topography of the area, the catchment boundary is not clearly definable. To be conservative, the topographical catchment to the east of the bypass was included for modelling purposes, although the size of this area is negligible in comparison to the balance of the catchment. Cross connection of the land drainage network remains following construction of the Mangaharakeke Drive/Te Rapa Bypass. This now forms a logical boundary between the two catchments.

- **Lake Rotokauri Development Area (LRDA)** – approximately 73Ha and drains directly to Lake Rotokauri via the existing rural land drainage network. This sub-catchment is largely bounded by the Waikato/Hamilton jurisdictional boundary to the south-west and north, and Exelby/Rotokauri Roads to the north-east. Similar to the RNDA, the LRDA sub-catchment is identified in the District Plan as a Stage 2 development area.

The topography of the catchment and main sub-catchments have been determined from LiDAR data (dated 2008), along with more recent data as relating to the Mangaharakeke/Te Rapa Bypass area (dated 2015).

[10] Stormwater network modelling for the Nawton area is likely to be undertaken as part of the St Andrews Catchment ICMP development project.

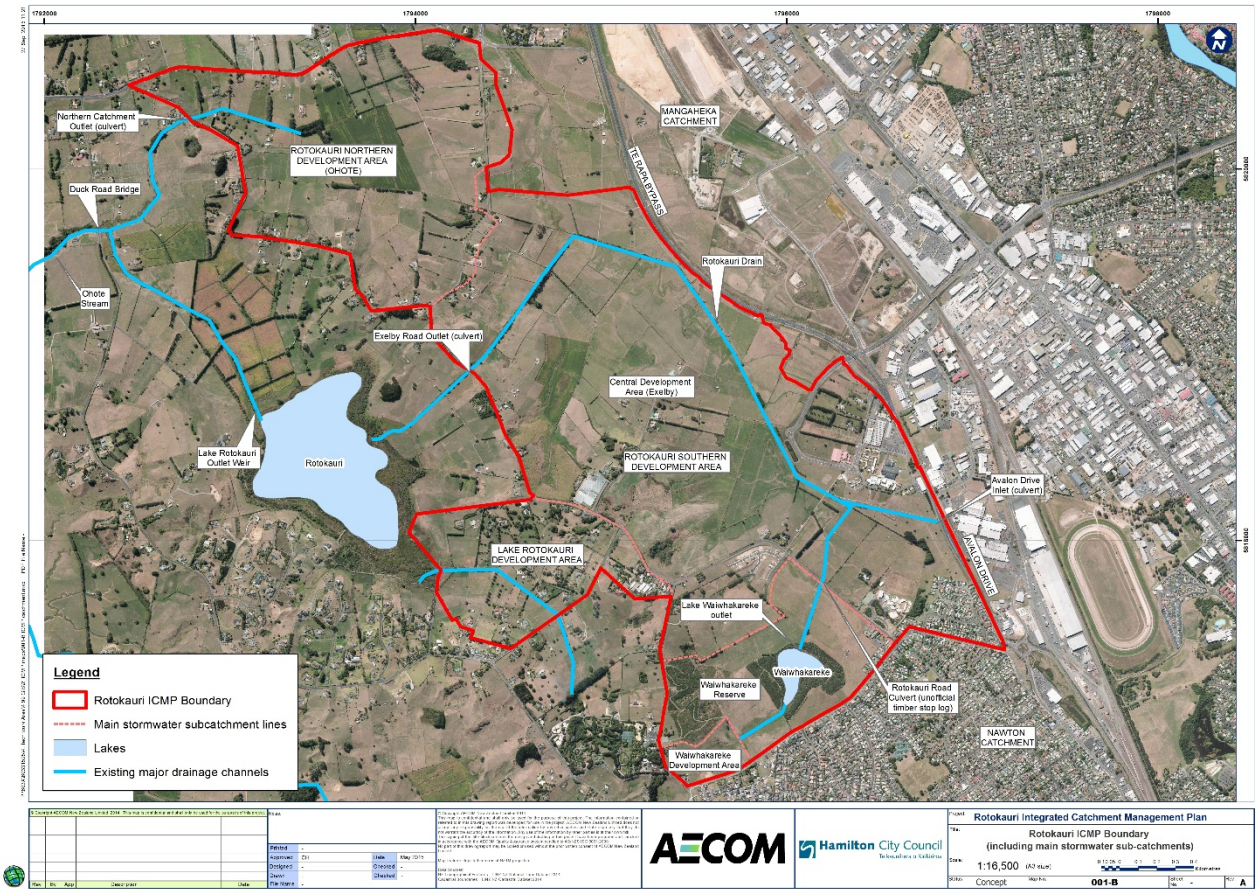

Figure 2-7: Topography and key features

2.3.2 Surface water classification and features

The Waikato Regional Plan (WRP) has established a water management classification that highlights the characteristics of rivers, streams and other watercourses for which they are valued so that these can be managed to protect or enhance these values. The classes which relate to the surface water features in the Rotokauri area include:

- *Significant Indigenous Fisheries and Fish Habitat Class* – valued for aquatic biodiversity and supporting indigenous fish species;
- *Contact Recreation Water Class* – valued for contact recreation; and
- *Surface Water Class* – relating to all surface waterbodies and valued for all other purposes.

The specific management objectives, policies and implementation methods that relate to these classes are documented in Section 3.2 of the WRP. Maps showing the surface water features of the Rotokauri area in relation to these classes, are presented in Figures 2-8 to 2-11 below.

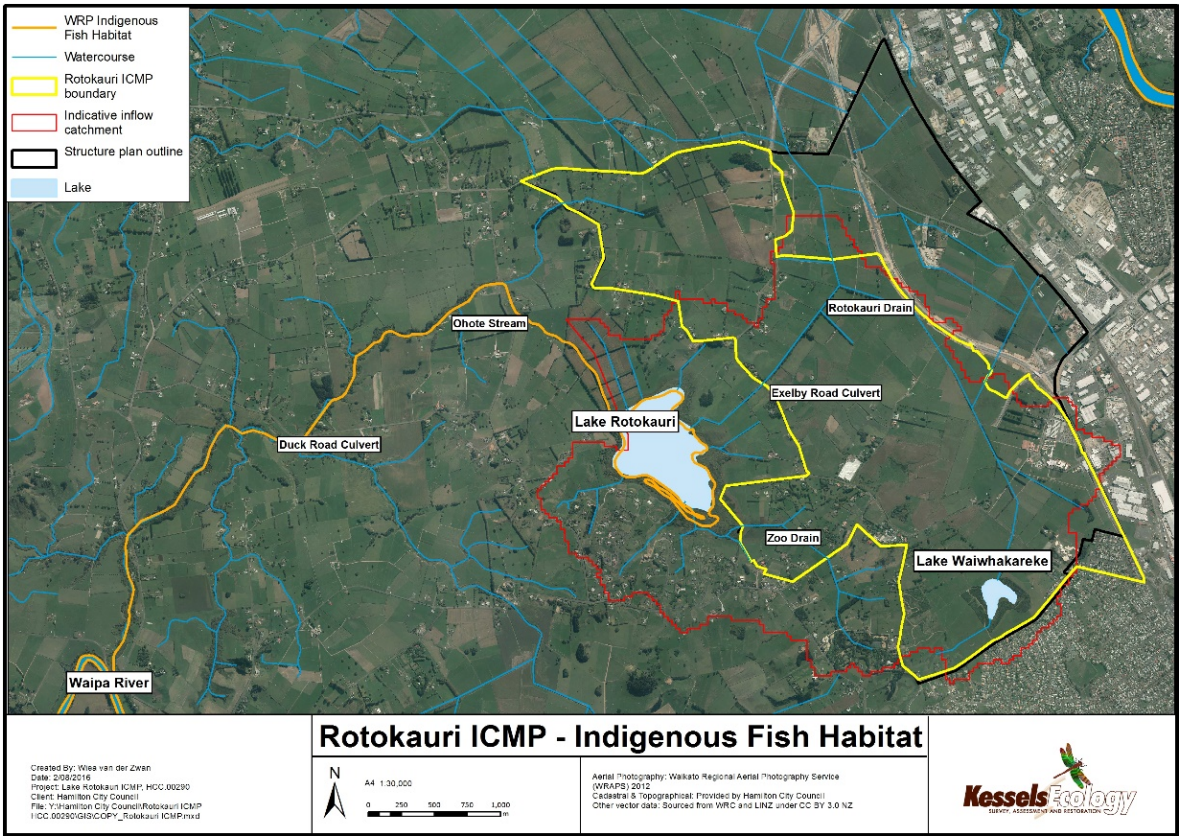

Figure 2-8: WRP Significant Indigenous Fisheries and Fish Habitat Class

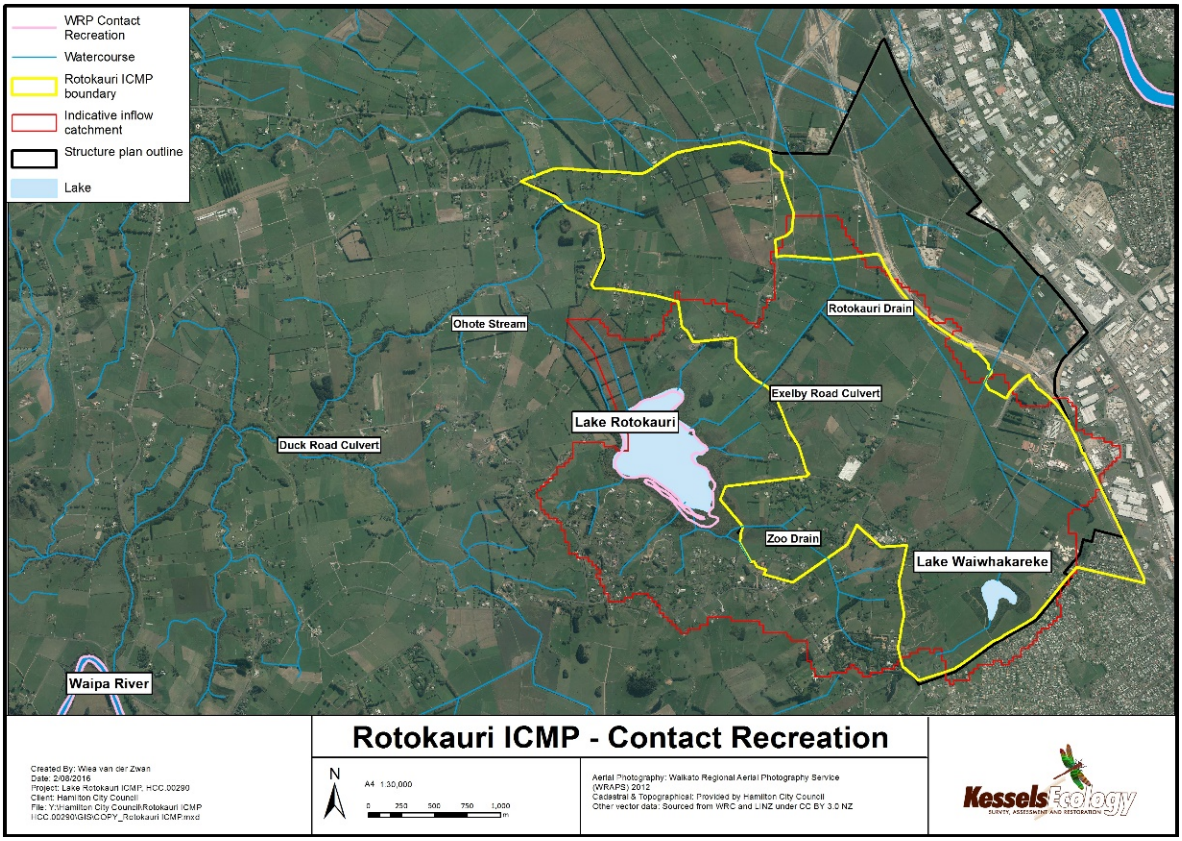

Figure 2-9: WRP Contact Recreation Water Class

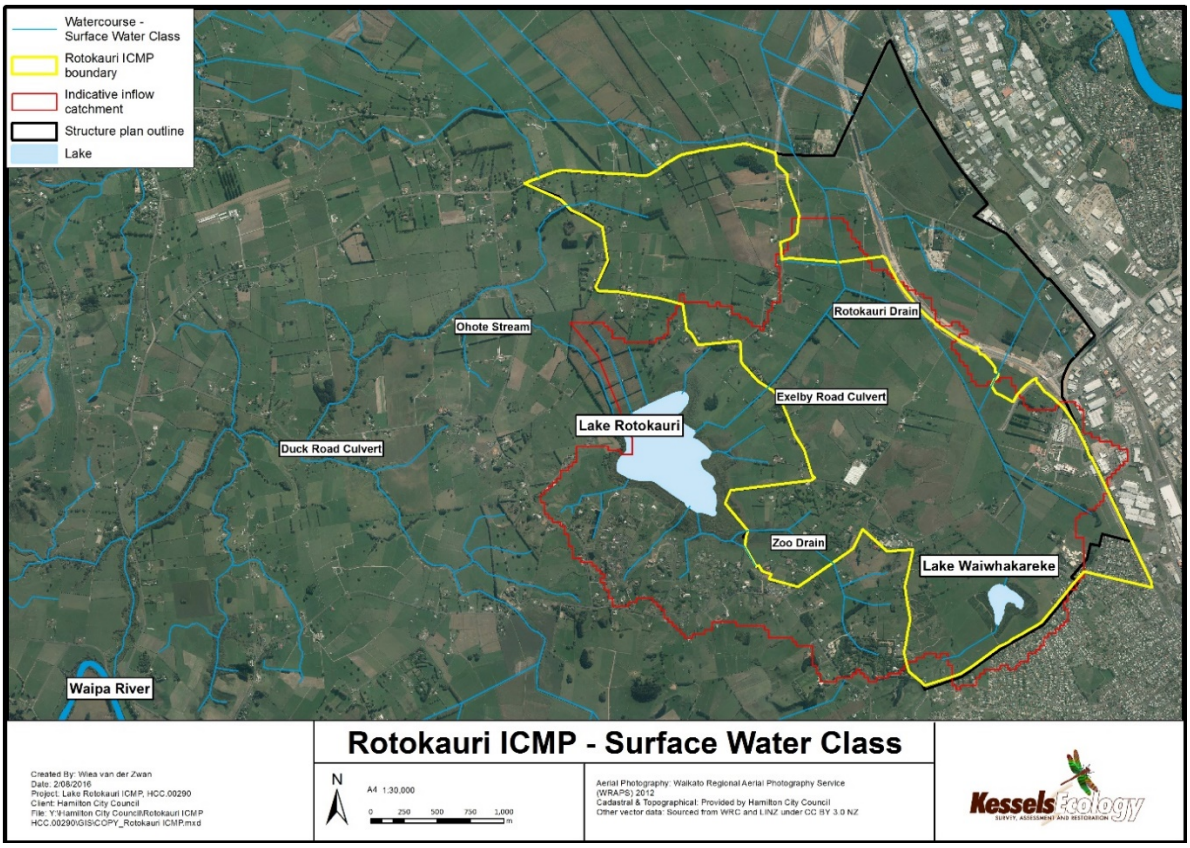

Figure 2-10: WRP Surface Water Class

In addition to the above water management classifications, the WRP differentiates surface waterbodies on the basis of the extent of modification. For ICMP purposes the descriptions applied in the WRP are generally used to further classify the surface water features in the general catchment vicinity.

Table 2-2 below presents key data for the main surface water features in and around the Rotokauri Catchment.

Table 2-2: Length of watercourse per surface water classification

Watercourse length *	**Ephemeral [m]**	**Perennial [m]**	**Unknown [m]**
Inside ICMP Boundary			
Natural watercourse			
Modified watercourse		4521	3141
Unclassified watercourse			199
Total		4521	3340
Inside RSP Boundary			

Natural watercourse			
Modified watercourse		73	5453
Unclassified watercourse			898
Total		73	6351
Lake Rotokauri Inflow Catchment			
Natural watercourse			
Modified watercourse		1973	5779
Unclassified watercourse			
Total		1973	5779
Ohote Stream			
Natural watercourse	342	5995	
Modified watercourse		529	
Unclassified watercourse			576
Total	342	6524	576
Grand Total	342	13,091	16,046

In accordance with the above data, Figure 2-11 below shows the corresponding main surface water features and classification status.[11]

[11] There are several unidentified watercourses within the main catchment and sub-catchments which are not shown in Figure 2-11. These are subject to future site surveys and are addressed in the sections below.

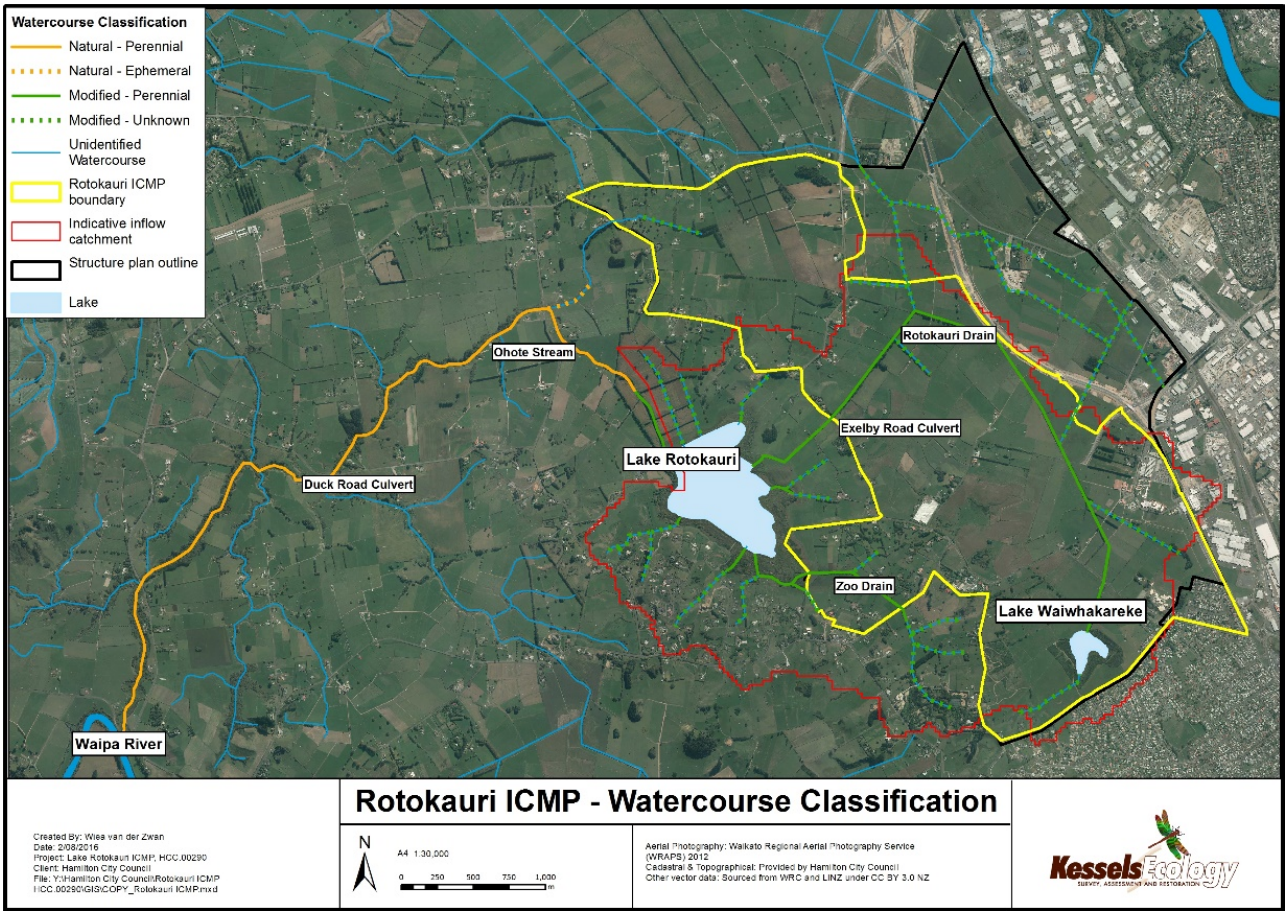

Figure 2-11: Main surface water features and ICMP Classification

2.3.2.1 *Description of Main Surface Water Features*

As part of the ICMP development programme Kessels and Associates Ltd (Kessels) undertook an ecological assessment of the main surface water features in the area, including the effects of urbanisation and development of ecological mitigation strategies (refer Section 3.2.5)[12]. The ecological assessment included a desktop review of previous site surveys and assessments (Champion et al. 2001, Kessels 2006, Price et al. 2014), along with a more targeted survey of the Rotokauri Drain to update the information set and address any gaps.

The ecological assessment report completed by Kessels (2016) is appended to this document for detailed reference purposes (Appendix C). A summary of the main surface water features as shown in Figure 2-11 and described in the report, is given below.

Lake Waiwhakareke

Located in the upper headwaters of the RSDA, Lake Waiwhakareke (also known as Horseshoe Lake) is a small but ecologically significant shallow peat lake with a maximum depth of 3m and a surface area of 3.42Ha (Figure 2-12). The lake has four small inflows and one outflow to the Rotokauri Drain.

Streamlined Environmental Ltd (2015) reported that the submerged vegetation in the lake has been surveyed on five occasions since 1977. During that time, the lake has transitioned from supporting a mix of native and exotic species to

[12] Kessels and Associates Ltd, 2016. *Ecological Assessment to Inform the Rotokauri Integrated Catchment Management Plan*. Prepared for Hamilton City Council.

being completely dominated by the exotic oxygen weed *Egeria densa* (1990-91). This vegetation subsequently collapsed and the lake was reported to have been without submerged vegetation in 1998. It remains this way today (Edwards et al., 2009). The lake has an extensive emergent plant zone that is dominated by raupo, and a reasonable diversity of native plants in the wetland zone. The emergent vegetation zone provides habitat for a range of wetland bird species and is buffered by a wide margin of willow and manuka scrub (Wildland Consultants, 2009).

Figure 2-12: Lake Waiwhakareke (Photo source: http://waiwhakareke.co.nz)

Rotokauri Drain

The Rotokauri Drain forms the main outlet to the catchment via the Exelby Road culvert, and runs between Lake Waiwhakareke and Lake Rotokauri. Aquatic ecology surveys have been carried out at the following sites (refer to Figure 2-13 for survey locations):

- Near the outlet of Lake Waiwhakareke (site 2N/1K), surveyed in 2001, 2006 and 2015;
- Near Lee Road (site 3N), surveyed in 2001 and 2015;
- Upstream of Exelby Road (site 4N), surveyed in 2001 and 2015; and
- Downstream of the Exelby Road culvert (site 5K/5N), surveyed in 2001, 2006 and 2015.

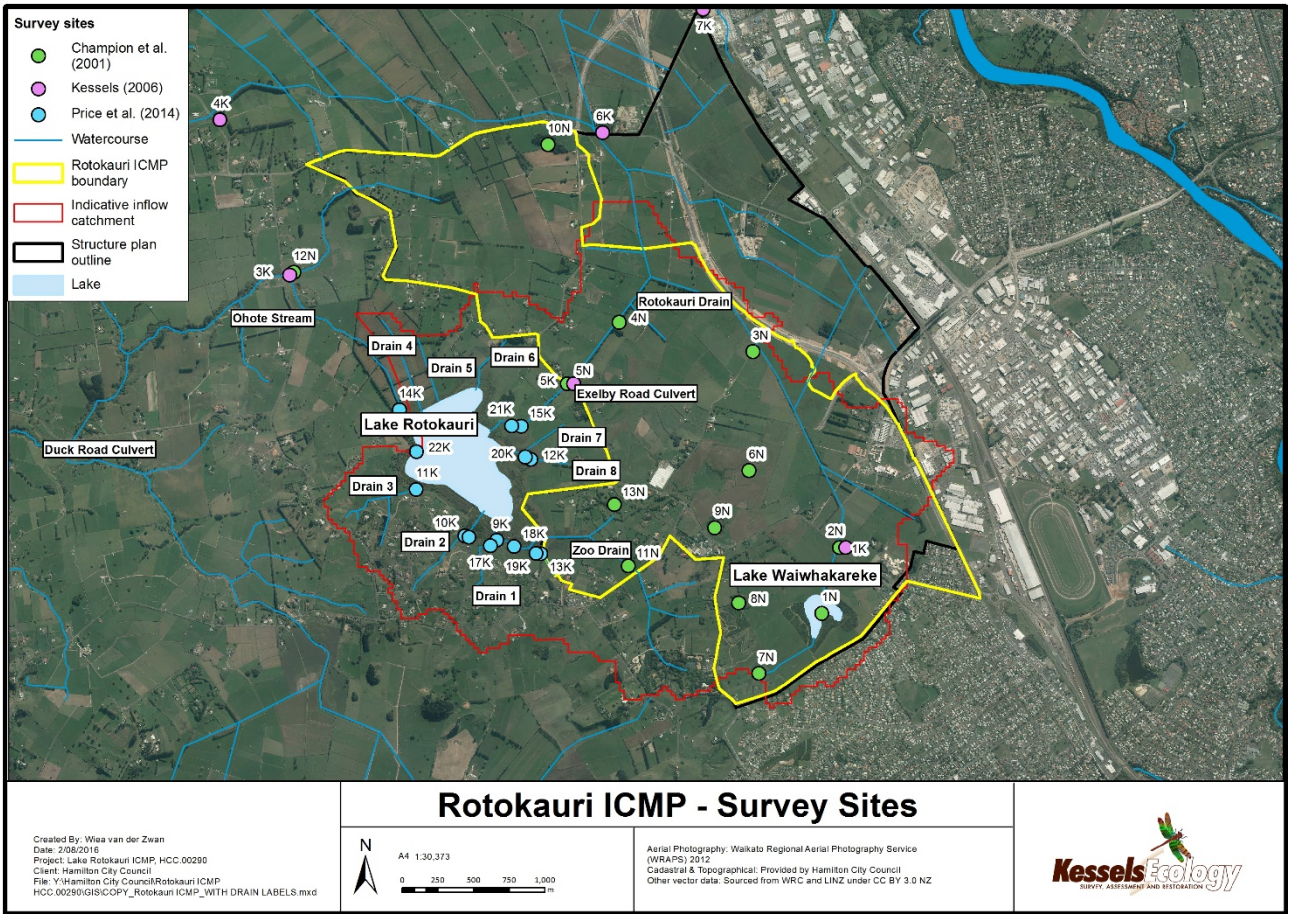

Figure 2-13: Ecology survey sites in general catchment vicinity

Survey Site 2N/1K (near Lake Waiwhakareke)

The Rotokauri Drain near Lake Waiwhakareke is an incised modified watercourse that was found to provide poor habitat quality for in-stream biota. Riparian vegetation is sparse and the immediate catchment is dominated by intensive pastoral agriculture. A line of mature Lawson's cypress follows the north bank and provides some shading and bank stability. The watercourse is fenced on both sides and where stock are unable to reach, the native plants swamp kiokio (Blechnum novae-zelandiae) and swamp carex (Carex secta) are found amongst exotic herbs and shrubs, including lotus major (Lotus pedunculatus), ring fern (Paesia scaberula), blackberry (Rubus fruticosus) and exotic grasses.

In 2006 the average wetted width was 1.8 m and the average watercourse depth was 0.6m. Only run habitat was present with no riffles or pools. The substrate consists of soft peaty muds/silts and small gravels overlaying a clay bed. The substrate consisted of 90% fine sediment (<2 mm) and 10% gravel (2-20 mm). Organic sediment was very abundant with 75% coverage of black muck/mud and 30% coverage of detritus such as sticks, wood and coarse plant materials. In 2015, the average wetted width was 1.87 m and the average depth was 0.26 m. Only run habitat was present. Substrates were composed of silt and sand.

Figure 2-14: Rotokauri Drain, near outlet of Lake Waiwhakareke (Kessels, 2006)

Survey Site 3N (Lee Road)

A survey in January 2001 found that near Lee Rd, the Rotokauri Drain was 0.7 m wide with run and pool habitat present (Champion et al. 2001). Water was only 0.05m deep and the temperatures exceeded 25°C in the afternoon. Bank vegetation was similar to that found further upstream near the lake outlet.

During the October 2015 survey at this site, conditions were slightly different to those found in 2001, likely due to the survey being carried out in spring rather than summer. The channel at this site was straight with abundant macrophyte cover and steeply incised banks (Figure 2-15). Riparian vegetation was limited to grasses, including pasture species and various weeds. The average water depth during the October 2015 survey was 0.37 m with an average wetted width of 2.01 m. Sediments were composed entirely of silt.

Figure 2-15: Rotokauri Drain, near Lee Rd (Kessels, 2015)

Survey Site 4N (upstream of Exelby Road)

Further downstream, Rotokauri Drain flows through a section containing riparian vegetation such as Cryptomeria, pines, Lawson's cypress and tree ferns (Champion et al. 2001). During the 2001 survey water depth varied from 0.1 to 1m and water temperature was 22°C. The substrate was soft, organic and muddy. Habitat conditions were similar during the 2015 survey with an average depth of 0.19m and an average width of 1.45m. The substrate was composed of organic matter and woody material overlaid with fine sediments.

Figure 2-16: Rotokauri Drain, upstream of Exelby Road (Kessels, 2015)

Site 5K/5N (downstream of Exelby Road Culvert)

Kessels (2006) found that habitat quality improved in the downstream reaches of Rotokauri Drain, with the section downstream of the Exelby Road culvert providing good quality habitat (Figure 17). The catchment immediately surrounding this section is rural/residential and pastoral agriculture. Champion et al. (2001) found that flow was greater at this site than the upstream sites, and the channel was cut into bedrock with silty substrates in the pools.

The October 2015 survey found that habitat conditions had changed little since the previous surveys. This site is characterised by very steep and incised banks which cut some 3m into the hill-slope. Despite the steepness of the bank slopes, no bank erosion or slumping was observed[13]. The waterway is fenced from stock with vegetation consisting of common pasture grasses and weeds, Spanish heath, blackberry, gorse and shaded by a line of mature poplar trees.

In 2006 the wetted width was approximately 1-1.5m, and depth in runs was 0.3m, pools 0.7m, and riffles 0.1m. Cobble (30% coverage) and gravel (30%) dominated the stream bed and when combined with the relatively steep grade created a run-riffle-rapid sequence. Small amounts of bedrock (20%), boulder (5%), and fine sediment (15%) were also present. Large amounts of sticks, wood and coarse plant materials provided ample coverage for stream fauna, with 40% of the bed covered. Less than 5% of the bed was covered by fine organic muck/mud.

The 2015 survey showed that habitat was largely unchanged at this site, however, substrate was composed of mainly compacted clay with boulders and sand. Sediment deposition was present in slower flowing pools. Habitat and water quality were slightly better at this site compared to the upstream sites surveyed.

[13] Refer to Section 3.2.3 for site specific erosion susceptibility assessment outcomes.

Figure 2-17: Rotokauri Drain, downstream of Exelby Road Culvert (Kessels, 2015)

Hamilton Zoo Drain

The Hamilton Zoo Drain is one of the larger modified watercourses flowing into Lake Rotokauri, emanating in the Waikato District and intersecting the western extent of the LRDA. It is a straight channelised watercourse flowing through open pasture approximately 0.5 m wide.

Figure 2-18: Zoo Drain (Champion et al. 2001)

Lake Rotokauri

Lake Rotokauri is one of the larger shallow peat lakes in the Waikato region with a surface area of 77 Ha including marginal wetland areas, and a maximum depth of 4m. It is situated immediately downstream of the Rotokauri Catchment within the WDC jurisdictional area, and is fed by several modified watercourses and drains, the two largest of which are the Rotokauri and Hamilton Zoo drains (refer to Figure 2-25).

The Lake Rotokauri reserve contains the largest area of wetland dominated by indigenous vegetation in the vicinity of the ICMP area. Lake Rotokauri has an extensive marginal vegetation zone which is important for the buffering of excess nutrients and sediments from land run-off and also supports a diverse range of waterfowl and other wetland birds (Hamilton City Council 2002). A further description of Lake Rotokauri is provided in Section 2.4.2 below.

Figure 2-19: Lake Rotokauri, viewed from Dromara Drive (Kessels, 2015)

Ohote Stream

The Ohote Stream forms the outlet to Lake Rotokauri, flowing from the north-western side of the lake through farmland for approximately 6.5 km before it reaches the Waipa River. It is an important ecological corridor between Lake Rotokauri and the Waipa River, serving as a migration pathway for indigenous fish species such as eels. The lower section of the stream also provides wetland habitat.

Lake Outlet to Duck Road

The Ohote Stream between the lake outlet and the Duck Road culvert is highly modified and flows through an incised, well-defined channel (Figure 2-20). A previous ecological assessment undertaken upstream of Duck Road found that the stream provided moderate habitat quality for stream biota (Kessels, 2006).

In terms of riparian features the banks of the Ohote Stream upstream of the Duck Road are steeply incised, providing some shading and stability to the quite broad and slow moving stream. The bank drops some 2m down into the stream and this formation continues for some way upstream, while immediately downstream of the bridge the stream flattens out into willow dominated stream wetland. On the true right bank several grey willows and blackberry provide dense cover, while on the true left bank rank grass and gorse provide less shading but quite good bank stability. On this side the exotic weed – bindweed (Calystegia sepium), is rapidly forming the predominant bank-side vegetation.

Average stream width and depth is 2m and 1.2m respectively with no riffles but occasional pools. The stream substrate consists of soft silts and sands (80% bed coverage) with numerous submerged logs and woody debris over a clay pan 'bed rock' (15%). Small amounts of gravel and organic muck/mud (5%) are present.

Figure 2-20: Ohote Stream, upstream of Duck Rd (Kessels, 2006)

Northern Tributary

The Northern Tributary is highly modified and partially ephemeral in nature, draining from the northern area of the catchment to the confluence with the main stream channel upstream of Duck Road. A complete description of this tributary is currently unavailable but will be provided via a detailed ecological assessment prior to development of the Northern Development Area (Figure 2-1).[14]

Duck Road to Waipa River

Downstream of Duck Rd, the Ohote Stream widens and flows through a series of gullies (Figure 2-21). Vegetation within the gullies is dominated by willow with a native understorey.

[14] Ecological and stream channel/erosion susceptibility assessments of the Northern Tributary are included as 'future actions' in Section 5.5.3 of this ICMP.

Figure 2-21: Gully section of Ohote Stream, between Duck Rd and Waipa River (Kessels, 2006)

Figure 2-22 below shows the confluence of the Ohote Stream with the Waipa River. This also demarcates the furthest extent of the ICMP study area.

Figure 2-22: Confluence of Ohote Stream with Waipa River (Kessels, 2006)

2.3.3 Hydrogeological setting

As part of the ICMP development programme, CH2M Beca undertook a hydrogeological investigation of the RSDA, inclusive of ground and groundwater conditions influencing stormwater design. This included a desktop review of previous investigations (Beca 2010a, Beca 2011) field studies and development of a groundwater flow model.

The hydrogeological interpretive report completed by CH2M Beca (2016) is appended to this document for detailed reference purposes (Appendix C). A summary of the hydrogeological and groundwater conditions as described in the report, is given below.

2.3.3.1 *Geological setting*

The relevant published geological maps (NZGS, 1966; Edbrooke, 2005) for the area show the site to be underlain by soils of the Piako Subgroup (Hinuera Formation) and Walton Subgroup (Figure 23).

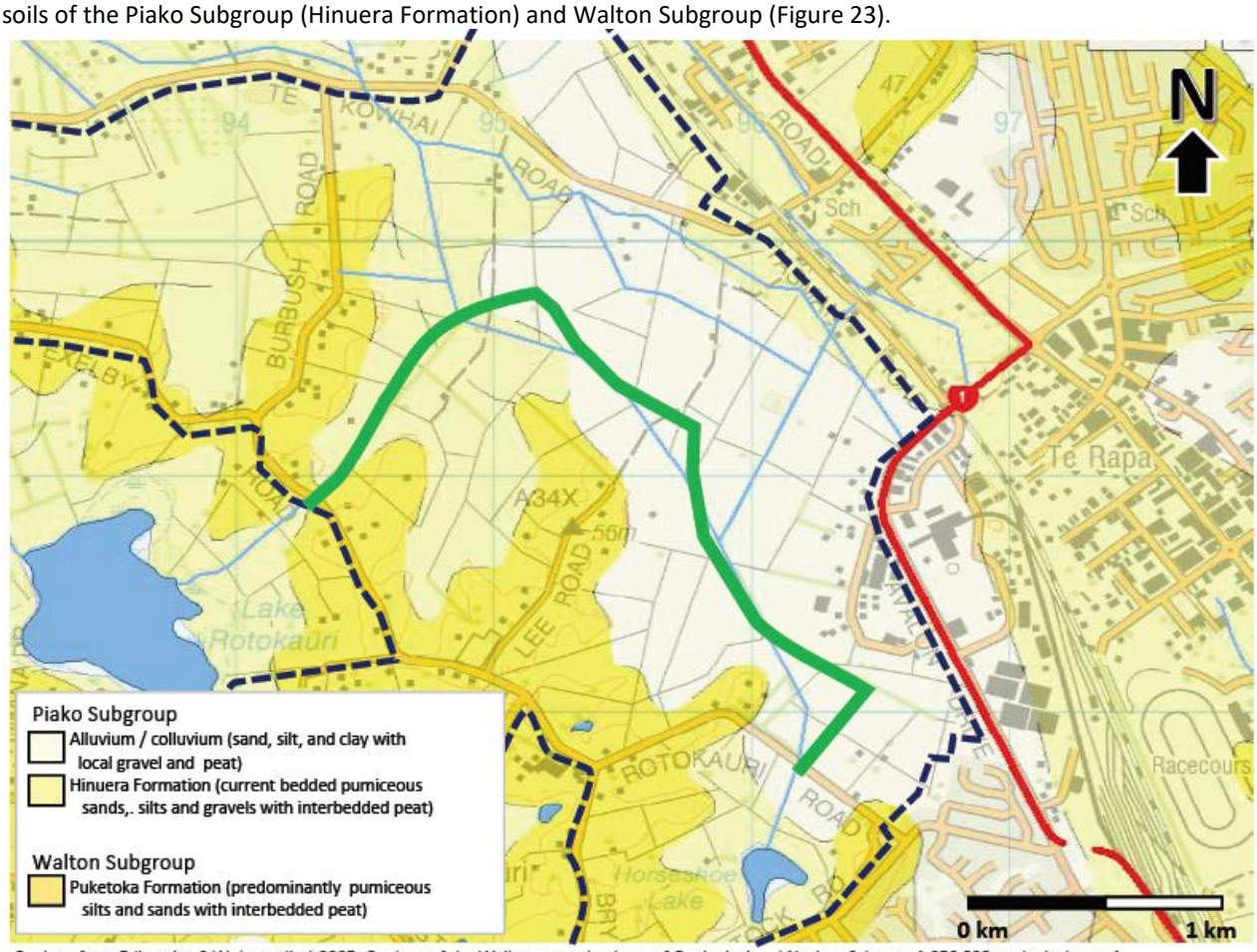

Figure 2-23: Underlying Soils of the Piako Subgroup (Hinuera Formation) and Walton Subgroup

The older (Late Pliocene to Middle Quaternary age) Walton Subgroup outcrops and forms the low lying hills in the western and north-western part of the site. The unit comprises interbedded lenses of pumiceous fine-grained sand and silt with interbedded peat, pumiceous gravelly sand and unwelded ignimbrites (GNS, 2005). The Hinuera Formation soils are of Late Quaternary age and comprise fluvial pumiceous gravel, sand and silt with minor peat beds. As they were deposited in a fluvial environment it is expected that individual layers will vary in thickness and extent. Peat is shown at the surface over the eastern part of the site, though investigations (Beca, 2010; Beca, 2015) have shown the actual extent to be much less significant than that mapped.

2.3.3.2 *Hydrogeological profile*

CH2M Beca (2016) determined the various soil layers and their corresponding hydrogeological properties as presented in Table 2-3, and described below.

Layers 2 and 4 are predominantly sands and gravels, and testing indicates a relatively high hydraulic conductivity (i.e. they readily transmit groundwater). Layers 6 and 8, whilst predominantly sand have a high fines content which will dominate the hydraulic behaviour and lowers the average / mean hydraulic conductivity relative to the upper coarser

layers. The remaining layers have an even lower hydraulic conductivity, again controlled by the fines component of the soils. Layers 1 and 3 are strongly anisotropic (that is, the layering in the alluvial soils means that flow occurs more rapidly in a horizontal direction than in a vertical direction, albeit slowly in both cases).

Given the fluvial nature of the soils, which vary in thickness and extent, there is also likely to be some variability in grain size and hence hydraulic conductivity in the vertical and lateral profile across the site.

Table 2-3: Summary of hydrogeological profile (CH2M Beca, 2016)

Unit	Layer	Description	Depth to top of layer (m bgl)	Thickness (m)	Range of Expected Hydraulic Conductivity (m/s)	K_v/K_h ratio
Piako Subgroup	1	Sandy silty CLAY/sandy SILT/Peat	0	0.1 – 3.5 (typical=1.3)	2×10^{-8} to 5×10^{-7}	0.1 – 0.3
	2	Fine to coarse SAND/ silty fine SAND/ gravelly SAND/SILT	0.1 – 2.5	1 – 15 (typical=4.1)	1×10^{-6} to 1×10^{-4}	1.0
	3	Sandy silty CLAY/sandy SILT/Peat	1.1 – 10.5	0.5 – 7.5 (typical=1.5)	2×10^{-8} to 5×10^{-7}	0.1 – 0.3
	4	Fine to coarse SAND/ silty fine SAND/ gravelly SAND/SILT	2.6 – 13.5	3.5 – 22 (typical=7.3)	1×10^{-6} to 1×10^{-4}	1.0
Walton Subgroup	5	Clayey SILT/ SILT/ silty CLAY/Peat	0 – 27.2	2.5 - 16.5+ (typical=9.5+)	3×10^{-7} to 4×10^{-6}	0.3
	6	Silty SAND	6.4 – 29	2.4 – 17.4+ (typical= 6.7+)	1×10^{-6} to 1×10^{-4}	0.3
	7	Clayey Sandy SILT	9.5 – 28	3 – 9.5+ (typical= 6.3+)	3×10^{-7} to 4×10^{-6}	0.3
	8	Silty SAND	10 – 27.5	10.5 – 22+ (typical= 14.9+)	1×10^{-6} to 1×10^{-4}	0.3

2.3.3.3 *Groundwater levels*

Upper Layers (Piako Subgroup)

Investigations and monitoring have shown that groundwater levels in the upper layers vary across the site from being at or close to ground surface (where adjacent to lakes) to depths of some 3 m below the ground surface. These upper layers are considered to represent a largely unconfined aquifer that is recharged directly from rainwater.

Monitoring from August 2010 to March 2011, and again from October 2015 to December 2015 in the upper layers indicate a difference of about 1 m between the highest and lowest levels, providing an indication of seasonal variation in groundwater level. This is based only on relatively short periods of monitoring and therefore the true seasonal variation is likely to be greater. Ongoing monitoring of the established piezometers will be important for confirming the full seasonal range.

Lower Layers (Walton Subgroup)

Investigations and monitoring have shown that groundwater levels in the lower layers are comparable, though generally slightly lower than those in the overlying Piako Subgroup. Groundwater levels are typically of the order of 2 m to 4 m below the ground surface, though in some places are as high as ground level (for example in proximity to Lake Waiwhakareke) or as deep as 5 m to 7 m below ground level.

Water levels in the lower layers are observed to vary seasonally by a smaller amount (0.25 m to 0.6 m) than the overlying layers, indicating that they have a less direct connection to rainfall. The Walton Subgroup layers are considered to act as a semi-confined aquifer in this area, recharged by leakage from the overlying sandier layers and confined to some degree by the lower permeability silts and clays in between.

A plot of interpolated average groundwater level (in RL m) in the upper aquifer is provided in Figure 24 below.

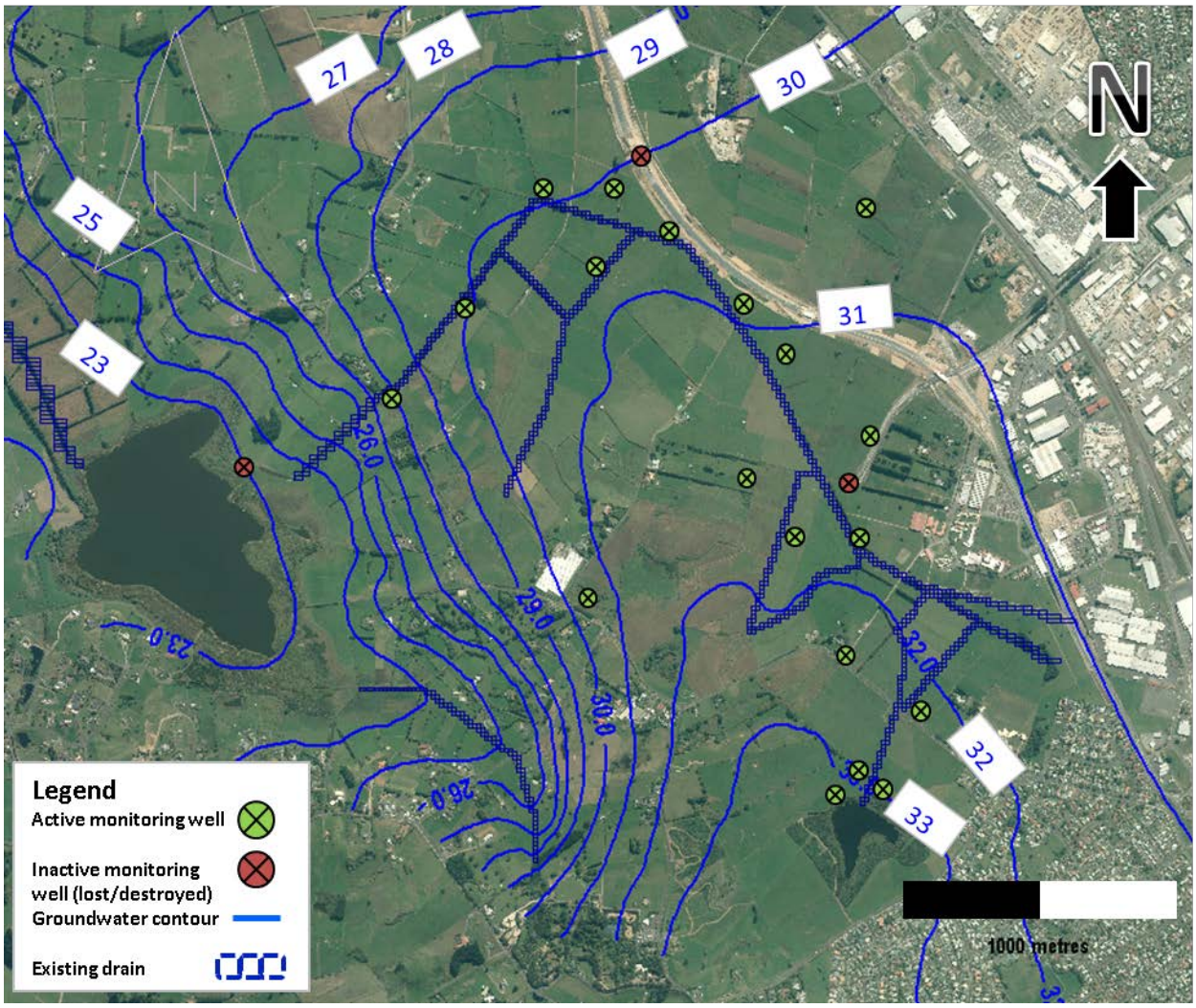

Figure 2-24: Interpolated groundwater contours (data from Beca groundwater monitoring 2010 – 2011, 2015 – 2016 interpolated in Groundwater Vistas). Contoured levels are in RL m. (CH2M Beca, 2016)

2.3.3.4 *Groundwater gradients*

In most locations there is a downward vertical gradient, indicating that the shallowest groundwater level is partially "perched" (or hung up) on lower permeability soil layers.

Where perched groundwater occurs as discrete lenses of water of finite extent, they can often be discharged with negligible environmental effects. However, the upper groundwater levels are relatively consistent across the study area indicating that the upper groundwater level is laterally extensive. This is considered further in relation to provision of major drainage infrastructure in Section 3 of this document.

In terms of use of soakage as a means of reducing stormwater volumes (post development), the relatively shallow depth to and presence of perched water levels across the site, and the occurrence of lower permeability silts and clays in the near surface is considered to be constraining. However, some soakage may be possible where near surface soils are sufficiently permeable and groundwater levels permit. This will need to be determined by developers on a site by site basis, and is further addressed in Section 3.2.2 of this document.

2.3.3.5 *Groundwater recharge and discharge*

Rainfall Recharge

Groundwater in shallow Waikato aquifers is generally considered to be recharged primarily from rainfall and discharged predominantly as base flow to incised streams (Hadfield, 2001). The results of the CH2M Beca investigation and monitoring suggests these assumptions are appropriate for the RSDA.

Furthermore, the results of recent monitoring indicate a relatively rapid response to rainfall events (within a day) in the upper layers, however, the presence of existing farm drains indicates that groundwater levels across the site are very high during winter and it is likely that a significant proportion of winter rainfall is discharged directly as runoff or indirectly via drainage, such that actual direct recharge to the aquifers from rainfall is somewhat less.

Groundwater – Surface Water Connection

In the absence of specific assessment, previous hydrogeological analysis has assumed that Lake Waiwhakareke is groundwater fed and therefore any changes in groundwater level in the vicinity will have an impact on lake levels. However, on the basis of the additional information obtained from the CH2M Beca investigation, it was concluded that there is a connection between groundwater and surface water in Lake Waiwhakareke.

In this regard, groundwater is likely to contribute a more significant component of baseflow during the dryer months (late spring, summer and early autumn) but may be less critical in wetter months when rainfall and stormwater runoff volumes are likely to exceed groundwater recharge. At this stage it is not possible to quantify the exact volumes of groundwater that are gained or lost from the lake; this would require long term baseflow records for the lake and surrounding drains (flow into and out of lake) as well as level monitoring records, and details of the manual weir operation.

Ongoing monitoring of levels will be important for assessing how the relationship between groundwater and surface water changes seasonally, and to confirm that the extent of changes in groundwater level due to provision of major stormwater in the catchment are within the expected range. This is further considered in Sections 3.2.2 and 8.2 of this document.

With regard to Lake Rotokauri, CH2M concluded that the overall water balance to the lake post development is not expected to change significantly. This is considered on the basis that groundwater diverted away from the lake will ultimately reach the lake via conveyance, and that Lake Rotokauri is weir controlled (which will maintain water levels).

2.3.4 Water quality and contaminants

As part of the ICMP development programme, Streamlined Environmental Ltd (Streamlined) undertook a broad-based water quality assessment as relating to the effects of urbanisation on natural water bodies within and beyond the Rotokauri Catchment.[15] This included a desktop review of previous water quality assessments (Cooke and Parkyn 2005, Story and Macaskill 2007, Diffuse Sources Ltd 2008, Sharma 2011), along with field studies to collect baseline data, a desktop study on nutrient yields, and simulation modelling of the potential effects of development and urbanisation on the trophic state of Lake Rotokauri.

The broad-scale water quality assessment report completed by Streamlined (2015), is appended to this document for detailed reference purposes (Appendix C). A summary of existing water and sediment quality baseline conditions as described in the report, is given below.

[15] Streamlined Environmental Ltd, 2015. *Rotokauri ICMP - Broad-scale Water Quality Assessment*. Prepared for Hamilton City Council.

Both Lake Rotokauri and Lake Waiwhakareke currently have degraded water quality, mainly because of nutrient enriched inflows from surrounding farmlands. Lake Rotokauri is currently classified as supertrophic whilst Lake Waiwhakareke is hypertrophic which is the highest trophic state (turbid, frequent algal blooms, very high levels of nitrogen (N) and phosphorus (P)). The Rotokauri Drain accounts for 60% of the inflow catchment of Lake Rotokauri and is a key source of sediment and other contaminants (nutrients, metals, organics) transfer into this lake. Cooke and Parkyn (2005) carried out a desktop study of nutrient inputs into Lake Rotokauri and identified the Rotokauri Drain as the single biggest source of nutrients.

Results from the field studies undertaken for Lake Rotokauri sediment quality, showed that metal concentrations are generally low. Zinc is the exception with moderately high levels (~250 mg/kg). Of the persistent organic pollutants analysed only one – 4,4-DDE (a breakdown product of 4,4-DDT) – was detected i.e. all others were below analytical detection limits. Streamline noted that 16 USEPA priority PAHs measured in 2014 were also below detection limits. Total PBDE concentrations were 2.8 ng/g, which is at the low end of reported studies. These data provide a useful baseline from which to monitor effects of urbanisation of these pollutants in the long term.

Streamlined also deployed passive samplers in both the main inlet (Rotokauri Drain) and outlet (Ohote Stream) to Lake Rotokauri. These passive samplers, which are specific to contaminant types (metals, polar wastewater markers), provide averaged dissolved contaminant concentrations over a sustained period (1 week - metals, 3 weeks - organics, in this case). Streamlined reported that metals in the inlet stream followed a similar pattern to metal concentrations in the sediment, with relatively high concentrations of the major elements in mineral soils (iron, aluminium, manganese) as well as zinc. Other heavy metals (copper, cobalt, nickel, lead) were present at minor concentrations (<0.1 - 0.8µg/L). Elevated concentrations of zinc in drainage waters from pastures around the peat lakes are relatively common, and are attributed to facial eczema treatments. Metals in the outlet stream were (with the exception of manganese) very much lower than the inlet, consistent with Lake Rotokauri sediments being a sink for heavy metals.

Of the 9 wastewater markers analysed, carbamazepine and FWA-1 (a fluorescent whitening agent) could not be reported due to analytical problems. Three of the remaining 7, paracetamol, caffeine and cotinine (nicotine breakdown product) could be quantified. Only caffeine showed a significant difference between inlet (5.5 ng/L) and outlet concentrations (2 ng/L). The presence of these wastewater markers is consistent with the presence of septic tanks (or other on-site wastewater treatment systems). Although urban development will mean a large population increase, it is expected that wastewater discharge to the lake will reduce in the long term as septic tanks are replaced with reticulated sewage systems. These current results provide a baseline to assess future development.

In terms of nutrient yields, Streamlined estimated N and P yields of 7.95 kg N/ha/y and 0.6 kg P/ha/y. These are broadly similar to the previous Diffuse Sources Ltd (2010) estimates derived from weekly measurements and continuous flow recording (6.5±1.3 kg/ha/yr for TN and 0.21±0.01 kg/ha/yr for phosphorus).

From the sediment chemistry and passive sampling (inlet/outlet water chemistry) undertaken, Streamlined found that the only contaminant currently above guideline values where an adverse ecological effect may be expected is zinc. Lake sediment zinc concentrations (250 mg/kg) were above ANZECC ISQG-Low guidelines (200 mg/kg), but below ISQG-High guidelines (410 mg/kg). Dissolved zinc concentrations in the lake inlet (Rotokauri Drain: 20.3 µg/L) were above the ANZECC guideline for protection of 90% of species (15 µg/L) but below that for protection of 80% of species (31 µg/L)1. Dissolved zinc concentrations in the lake outlet (Ohote Stream) were well below the same ANZECC guideline. All other contaminants measured were well below applicable guideline values.

The source of zinc inflows is thought to be from use of facial eczema remedies for stock (DSL, 2012). It is evident from the passive sampling results that moderately high concentrations of zinc (~20 µg/L) continue to be discharged to Lake Rotokauri.

2.4 Values

2.4.1 Legal status and management of key catchment features

Lake Waiwhakareke

Lake Waiwhakareke is the central feature of the Waiwhakareke Natural Heritage Park which was purchased by HCC in 1975 and remains within Council ownership. The park is classified as Local Purpose Reserve (Natural Heritage Park) under the Reserves Act 1977. It is subject to an Operative Management Plan (HCC, 2011)[16] and is managed in partnership with The University of the Waikato, WINTEC, Nga Mana Toopu O Kirikiriroa Limited Resource Management and Cultural Consultants (NAMTOK), Tui 2000 and HCC.

Lake Rotokauri

Lake Rotokauri, its bed, and much of the surrounding wetlands are part of a Crown reserve which is administered by WDC. The reserve includes two esplanade reserves and a paper road to the north and east of the lake. A small area of the lake's margin, near the outlet, remains in private ownership.

The WDC maintain the open drain network within the immediate lake reserve area, including silt traps which have been installed by WDC to assist water quality management of the lake (Figure 2-25). Beyond the reserve areas WRC/ICM maintain these open drains as part of the RDA, administered under the Land Drainage Act 1908. The main LOS to local landowners include water table management and the drainage of ponded surface water within three days (10 year ARI design storm event).[17]

An integral management component of the lake relates to minimum and maximum operating levels as controlled via the lake outlet weir. In this regard, the minimum lake operating level is set in the WRP to, primarily, protect ecological values and ranges between RL 22.5m – 22.8m (Moturiki datum). These levels also correlate with the RDA LOS and WRC/ICM subsequently hold consent to 'use and maintain' the outlet weir for lake level control purposes.[18]

The upper design flood level of the lake is set at RL 23.5m (Moturiki datum), and habitable floor levels of surrounding lake properties are constructed to no less than 300mm above this level[19].

Similar to Lake Waiwhakareke, Lake Rotokauri and the surrounding reserve areas are subject to an Operative Management Plan (WDC, 2000)[20] and are managed in partnership with the Lake Rotokauri Management Committee (LRMC). This is a special interest group made up of various stakeholder groups who have an interest in the lake.

Figure 2-25 below shows the two lake reserve areas, including silt traps on the inflowing open drains which are maintained by WDC.

[16] Waiwhakareke Natural Heritage Park Operative Management Plan 2011 (HCC, 2011)

[17] WRC TR 2014/13: *Managing land use change and Council's administered drainage areas* (Wainui Consulting Ltd)

[18] WRC Resource Consent #120860.

[19] WDC Consent Notice pursuant to Section 221, RMA, 1991, 25 March 1999.

[20] Rotokauri Lake Management Plan 2000 (WDC, 2000)

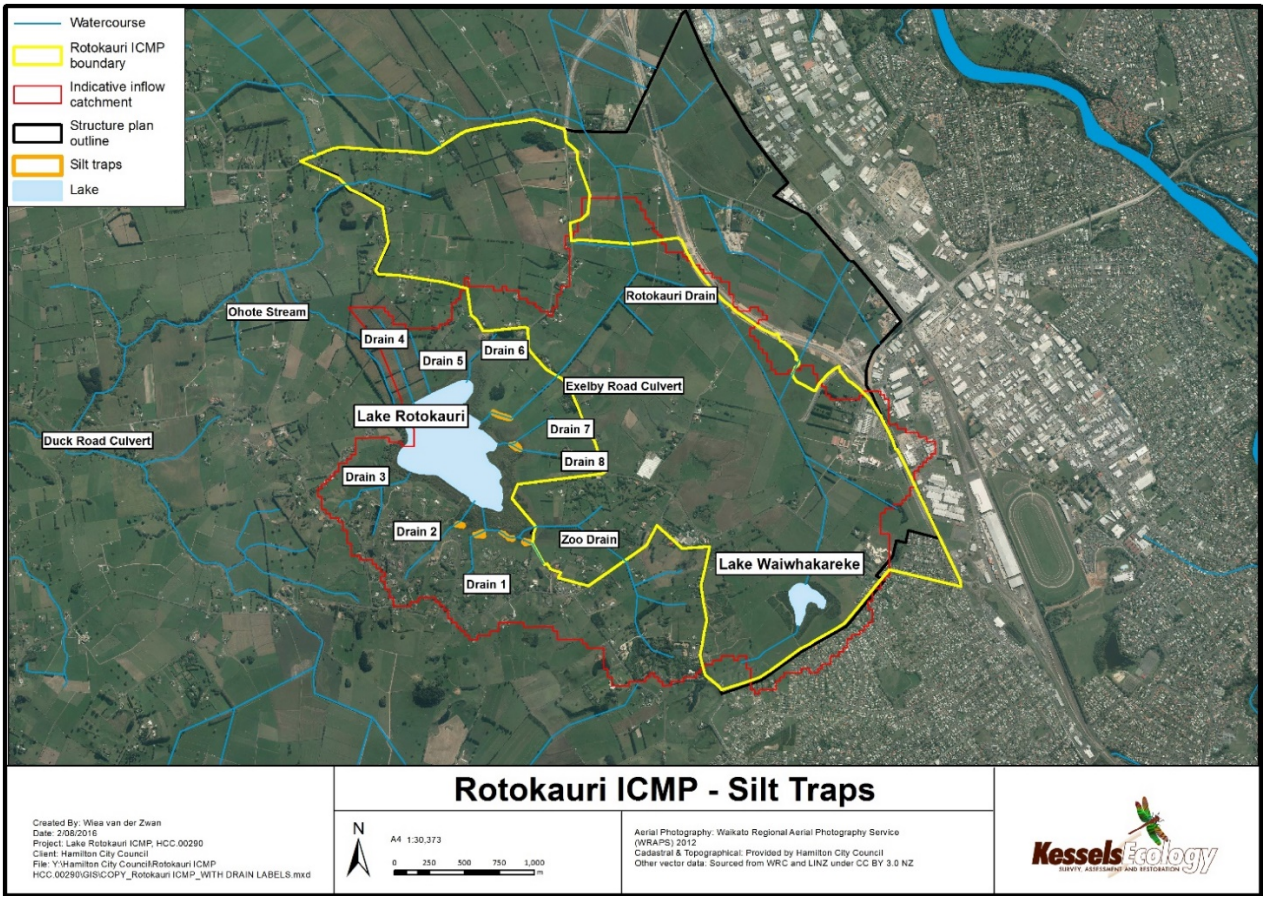

Figure 2-25: Lake reserve areas, including silt traps (Lake Rotokauri)

2.4.2 Aquatic, terrestrial and riparian ecology

A summary of the ecological values which are present in the general catchment vicinity and determined by Kessels and Associates Ltd (2016), is presented below. Further details are provided in the complete ecological assessment (Appendix C).

Aquatic Biodiversity Values

Many indigenous fish species are present in the general catchment vicinity with shortfin eel (Anguilla australis) and common bully (Gobiomorphus cotidianus) very common. The nationally At Risk giant kokopu (Galaxias argenteus) has been found within the Rotokauri Drain as well as in Lake Rotokauri. This species is often found in weedy, slower flowing habitats, and the discovery of an abundant giant kokopu in the Rotokauri Drain, spanning a range of sizes from juvenile to adult, suggests that the area provides important spawning and/or juvenile rearing habitat. Black mudfish (Neochanna diversus), also an At Risk species, have been found in various locations in the ICMP area, most recently in a tributary of the Rotokauri Drain near Lake Waiwhakareke. This was in conjunction with a separate ecological survey undertaken to support an urban development (Goldwater and McKay 2013).

Fish passage in the Rotokauri Drain past the Exelby Road culvert is likely restricted to climbing species at present, such as giant kokopu and eels. While non-climbing species such as common smelt (Retropinna retropinna) are likely to be unable to pass this culvert, it also appears to be restricting pest fish such as koi carp from the upper catchment and is therefore serving a beneficial purpose.

Several introduced fish species have been recorded within the general catchment vicinity such as rudd (Scardinius erythrophthalmus), koi carp (Cyprinus carpio), goldfish (Carassius auratus), brown bullhead catfish (Ameiurus nebulosus), brown trout (Salmo trutta) and gambusia (Gambusia affinis). Of these, goldfish, brown bullhead catfish,

and koi carp are listed as pests under the Waikato Regional Pest Management Strategy, while brown trout and rudd are classified as sports fish within the Auckland-Waikato Fish & Game region.

Aquatic macroinvertebrate communities in the various watercourses surveyed are dominated by species that are highly tolerant of poor water and habitat quality such as the true flies Tanypodinae, Tanytarsini and Chironomus, and the mudsnail Potamopyrgus antipodarum. Species characteristic of weedy, slow-flowing habitats are also common. Similar taxa are present in the Ohote Stream and an abundance of amphipod crustaceans indicate slow-flowing water.

Lake Rotokauri's benthic macroinvertebrate communities are numerically dominated by oligochaetes, which are very tolerant of poor water quality conditions and are often the dominant taxon in fine lake sediments. Aquatic plant communities in the upstream watercourses are dominated by exotic species with some common and widespread indigenous species present. An exception is the Rotokauri Drain where native macrophytes such as Nitella hookeri are abundant at some locations. Macrophytes in the Rotokauri Drain are likely to provide important habitat and cover for giant kokopu.

Lake Rotokauri does not contain any macrophytes, however, lakes Rotokauri and Waiwhakareke both contain a range of indigenous and introduced emergent macrophytes around their margins.

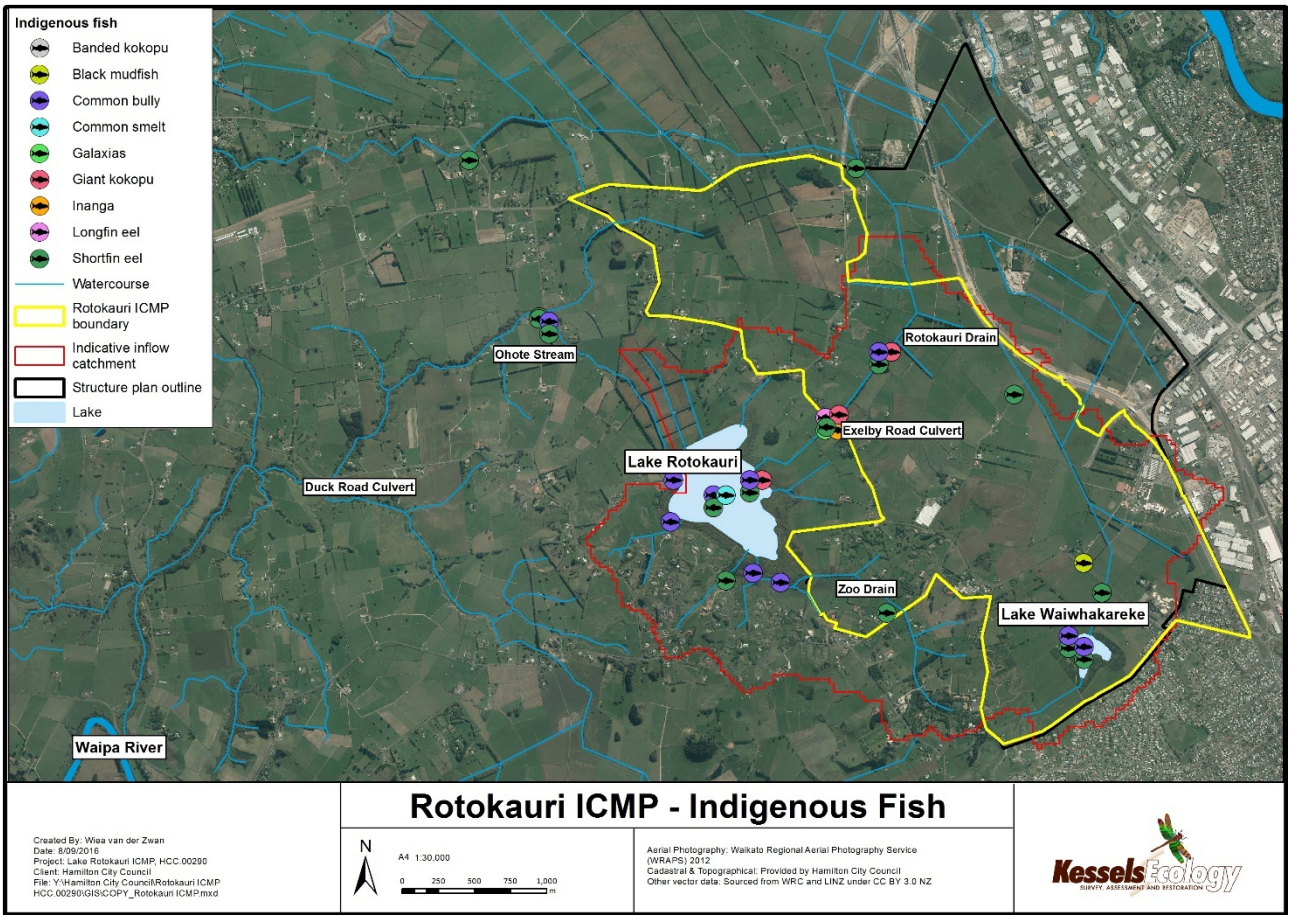

Figure 2-26: Indigenous fish recorded in the general catchment vicinity

Terrestrial Biodiversity Values

Kessels and Associates Ltd (2016) reports that restoration initiatives in Waiwhakareke Natural Heritage Park include reconstruction of kauri, tanekaha, rewarewa conifer-broadleaved forest; tawa, rimu broadleaved-podocarp forest; kahikatea, pukatea semi-swamp forest; and restoration of the existing peat lake margin including a restiad bog and swamp wetland, and peat lake/aquatic ecosystem.

Within Lake Waiwhakareke there are areas of open water with water lily, as well as baumea-raupo-kutakuta reedland. Alluvial plain and peat bog areas are dominated by kahikatea-manuka-flax shrubland. Within peat bog areas, cane rush-wire rush restiadland is the predominant vegetation type. On the hillslopes, manuka-kanuka-kohuhu-ribbonwood and kohuhu-kauri shrubland are present (Cornes et al. 2012). The area of the reserve that is planted increases each year as restoration continues (refer to Section 2.4.3 below).

Lake Waiwhakareke also provides habitat for many indigenous and introduced species. Notably, black shag (At Risk-Naturally Uncommon) and little black shag (At Risk- Naturally Uncommon) are present at the lake (OSNZ 2010).

With regard to the Lake Rotokauri reserve area, this contains the largest area of wetland dominated by indigenous vegetation in the vicinity of the ICMP area. The indigenous component of the wetland comprises an area of 34.8 ha (77.3%), while non-indigenous vegetation comprises 10.21 ha (22.7%). The reserve area also provides substantial habitat for several species of birds and waterfowl. Notable indigenous bird species include Australasian bittern (Threatened - Nationally Endangered), spotless crake (At Risk-Relict), black shag (At Risk- Naturally Uncommon) and little black shag (At Risk- Naturally Uncommon). Historical, unconfirmed records of marsh crake (At Risk-Relict) and North Island fernbird (At Risk-Declining) also exist (Reeves et al. 2011).

In addition to the above values, Kessels and Associates Ltd (2016) undertook an assessment of the main ecological features in the general catchment vicinity as per the criteria for determining 'significance of indigenous biodiversity' in the Waikato Regional Policy Statement. This found the Rotokauri Drain, Lake Rotokauri and marginal wetland areas, and the Ohote Stream to be 'ecologically significant'.

Regarding other natural values, the Waiwhakareke Natural Heritage Park, Burbush Road Forest (Pikihinau) and Mooney Street Reserve (Te Raukaka) are all classified as Significant Natural Areas (SNA) under the District Plan and shown in Figure 2-27 below.

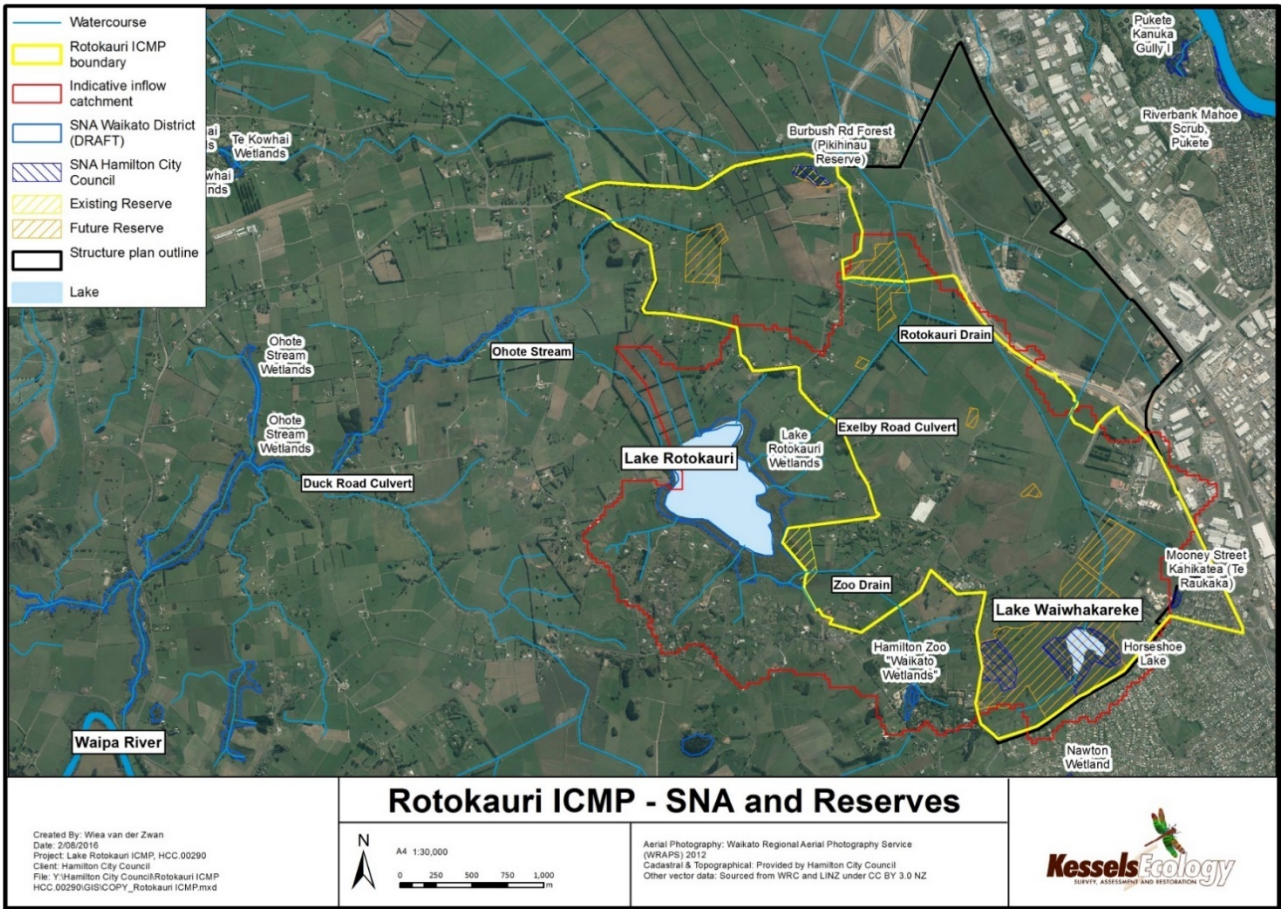

Figure 2-27: Significant Natural Areas (including sites of cultural significance)

2.4.3 Amenity, recreational and aesthetic values

The main amenity, recreational and aesthetic values of the general catchment vicinity relate to the Waiwhakareke Natural Heritage Park and Lake Rotokauri reserve areas. These values are briefly outlined below and further details can be found in the management plans for these areas (referenced below).

Waiwhakareke Natural Heritage Park

The Waiwhakareke Natural Heritage Park Operative Management Plan 2011 (HCC, 2011) states that the Park is adjacent to Hamilton Zoo and the Avalon Campus of WINTEC, thus providing unique opportunities for research and education. It is also one of the last opportunities within city boundaries for a large open space project including a water body. The project will increase the biodiversity and environmental values of Hamilton City and provide residents and visitors with increased recreation and tourism opportunities.

Initially conceived as a "Living Museum", the vision for the Park is to restore and recreate the native plant and animal communities that once existed within the Hamilton Basin and more specifically at the park site. It is further envisaged that the Park will take its place as one of Hamilton's most important parks, alongside Hamilton Gardens and Hamilton Lake Domain. The Park will serve as a focus for Hamilton's biodiversity restoration in and around its lakes, along the river banks and in the gullies and other parks with current or potential natural values. It will also include accessible walkways and cycleways to the public.

Lake Rotokauri Reserve

The Lake Rotokauri Management Plan 2000 (WDC, 2000) states that the Reserve is primarily being managed for its ecological, natural and historic values. However, recreational activities such as duck hunting have occurred for many

years and other recreational activities such as fishing, rowing and yachting are expected to increase with a growing local population.

In this regard, access to the lake has been enhanced in recent years via a boardwalk and jetty facility in proximity to local car parking. Walkways are also being created around the perimeter of the lake with the vision to eventually form part of a "green link" walkway network developed in conjunction with HCC.

2.4.4 Cultural value to Iwi and archaeological significance

The District Plan does not record any cultural or archaeological sites in Rotokauri. However, Lake Waiwhakareke and Lake Rotokauri are particularly valued and have historically held special spiritual and sustenance significance to local iwi (refer to Section 2.2.1). Other highly valued features within the catchment include Pikihinau Reserve (Burbush Road Forest), Te Raukaka (Mooney Street Kahikatea) and the wetland areas surrounding Lake Rotokauri where a number of taonga are likely to be buried. These features are shown in Figure 2-27 above.

Further background information on the cultural and archaeological significance of the catchment is provided in the cultural assessment undertaken by NAMTOK (2001).

2.4.5 Economic values

The current economic values of the catchment relate to existing land use, in particular the Waiwhakareke Natural Heritage Reserve and its inter-relationship with Lake Rotokauri, WINTEC, wide-scale pastoral productivity, and urban development which is emerging in response to the release of Stage 1 of the District Plan.

Immediately downstream of the catchment, WRC/ICM maintain the RDA. This is considered vital to ongoing pastoral productivity and for delivering agreed LOS for managing rural flood waters (refer to Section 2.4.1).

In terms of future economic values, these are significant and are widely reflected in the various growth strategies for the City and sub-regional growth areas (for example HUGS, Future Proof and Access Hamilton). With regard to HUGS (2008), this strategy indicates significant capital expenditure on provision of infrastructure services in the catchment. These services will support the variety of land uses that are indicated in the District Plan, inclusive of the approximate 100 Ha of Employment zoned land and 6,800 new dwellings. A suburban centre with an emphasis on retailing, a passenger transport facility and primary and secondary schools to service local residents, further add to the future economic values of the catchment.

Other economic drivers will relate to having more diverse future land uses than those associated with other City growth areas, along with potential links to Horotiu in the Waikato District as the two areas grow towards each other (HUGS, 2008).

2.5 Strategic Infrastructure

Development of the Rotokauri Catchment requires major new infrastructure services as indicated in the RSP and addressed in later sections of this document. The sub-sections below relate to the small areas of existing development and the 3 Waters infrastructure that currently service these areas.

Existing stormwater flows into and out of the topographical catchment are addressed in Section 2.3.1 above.

2.5.1 Stormwater

The small areas of existing development and the stormwater infrastructure that service these areas, is shown in Figure 2-28 below. This primarily includes:

- Stage 1 of the Rotokauri Rise residential subdivision, including a dry settlement pond ('Rotokauri Road Pond'), roadside planted swales and an online conveyance swale. This network infrastructure has been assessed by WRC to meet the requirements of the Auckland Council TP10 publication and achieve 75% removal of Total Suspended Solids prior to discharge to an open drain tributary of the Rotokauri Drain. Related resource consents include:
    - HCC 2013/5799
    - WRC AUTH130383.02.01.

- Stage 2-4 of the Rotokauri Rise residential subdivision (which is consented but yet to be developed), including pipe reticulation, an online conveyance swale and central treatment wetland[21]. As per Stage 1, this network infrastructure has been assessed by WRC to meet the requirements of the Auckland Council TP10 publication and achieve 75% removal of Total Suspended Solids prior to discharge to an open drain tributary of the Rotokauri Drain. Related resource consents include:
    - HCC 2015/6125
    - WRC AUTH136197.03.01.

- Te Wetini Drive and Akoranga Road pipe reticulation and associated treatment pond ('Akoranga Pond'). This pond is authorised under the HCC CSDC (105279) and has been assessed by WRC to meet the requirements of the Auckland Council TP10 publication and achieve 75% removal of Total Suspended Solids prior to discharge to the Rotokauri Drain.

- The Mangaharakeke Drive/Te Rapa Bypass attenuation ponds x 2, which are owned and operated by the NZTA. These ponds are authorised under resource consent WRC AUTH117710.01.01 and have been assessed to meet the requirements of the Auckland Council TP10 publication and achieve 75% removal of Total Suspended Solids prior to discharge to an open drain tributary of the Rotokauri Drain.

- The WINTEC treatment pond which is privately owned and provides an unspecified level of water quality treatment prior to discharge to an open drain tributary of the Rotokauri Drain.

With the exclusion of privately owned infrastructure, all new stormwater services will be designed and constructed in accordance with the HCC Infrastructure Technical Specification (ITS) to comply with the District Plan and meet Councils LOS agreements.[22] On becoming vested in HCC, these services are operated and maintained in accordance with Council's Activity Management Plan and the Stormwater Management Plan as relating to the HCC CSDC #105279 (following consent transferal and surrender in accordance with the administrative process set out in Appendix 2 of that consent).

[21] Stage 2-4 of the Rotokauri Rise residential subdivision and stormwater treatment system layout, is potentially subject to change prior to development. It is therefore not shown in Figure 2-28 below.

[22] It is also expected that all new stormwater services will be designed and constructed in accordance with regional guidelines and consenting requirements.

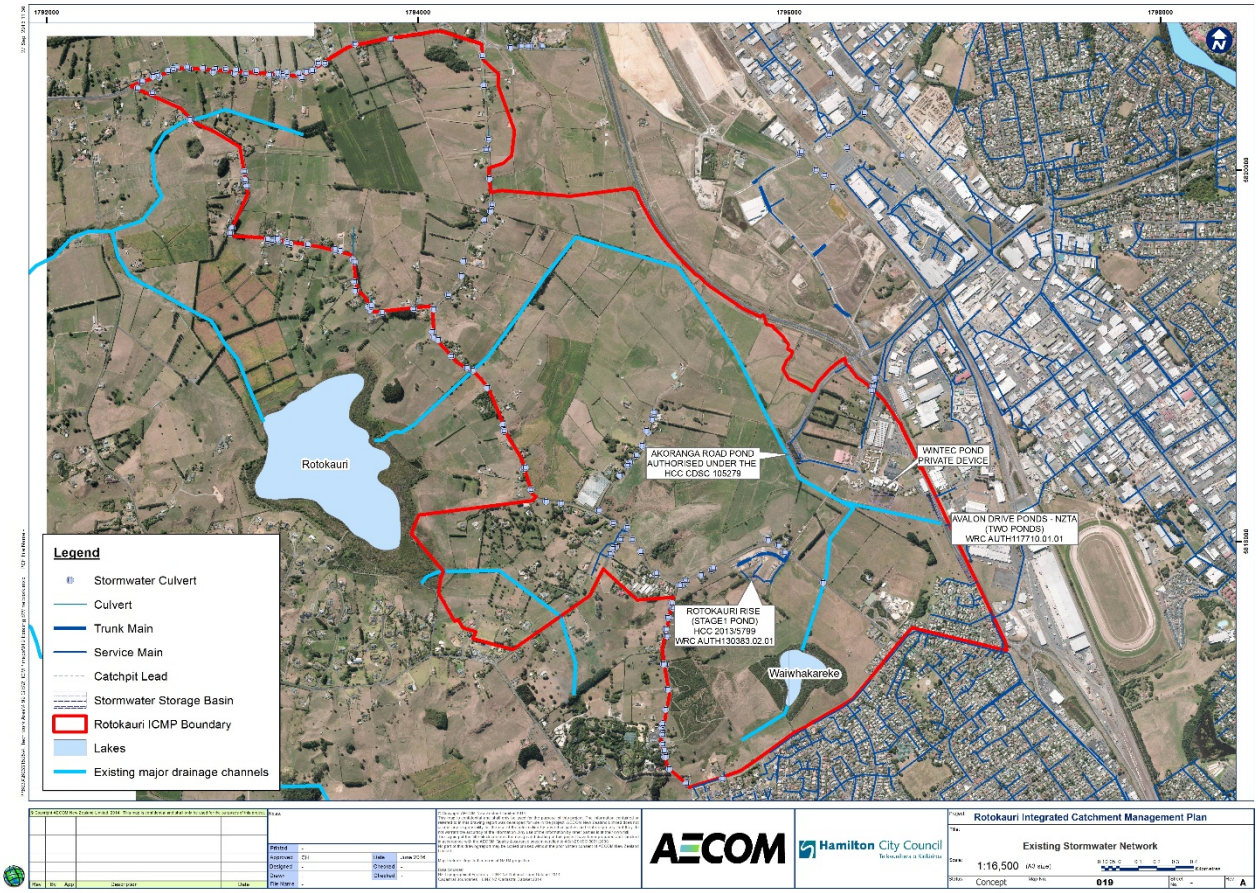

Figure 2-28: Map of existing stormwater infrastructure

In addition to above Table 2-4 shows some of the key data related to the stormwater primary infrastructure for this ICMP.

Table 2-4: Summary stormwater primary infrastructure

Stormwater Primary Infrastructure		
Length of public stormwater reticulation >=500mm	m	291
Length of public stormwater reticulation <500mm	m	1736
Number of public treatment devices	ea	5
Number of private treatment devices	ea	1

2.5.2 Wastewater

The current wastewater system in the Rotokauri catchment area is limited to reticulation of existing properties to the south of Lake Waiwhakareke which is conveyed by gravity to the south of this area. There is also a small reticulated area adjoining Rotokauri Rd to the north of Lake Waiwhakareke which is serviced by a temporary private pump station and associated rising main which discharges to manhole WWO12018 outside 109 Rotokauri Road. This arrangement is an interim solution, essentially in place to service the existing development area until the 1050mm diameter Far Western Interceptor (FWI) is constructed on the Te Rapa Bypass (State Highway 1), approximately 0.5km north of

Wairere Drive. Additionally, there is a small area on Baverstock Road which is serviced by gravity with the exception of Lot 1 being serviced by a private pump station and rising main that discharges into the gravity sewer on Baverstock Road.

The FWI is intended to convey wastewater from new growth areas in the Rotokauri Catchment by gravity to the existing Pukete Wastewater Treatment Plant. The FWI will be extended from the current upstream extent through the catchment and connect to the existing Western Interceptor. The FWI extension will relieve load on the Western Interceptor and enable servicing the Rotokauri development area. The layout of the strategic wastewater network and planned network, is shown in Figures 2-29 and 2-30 below.

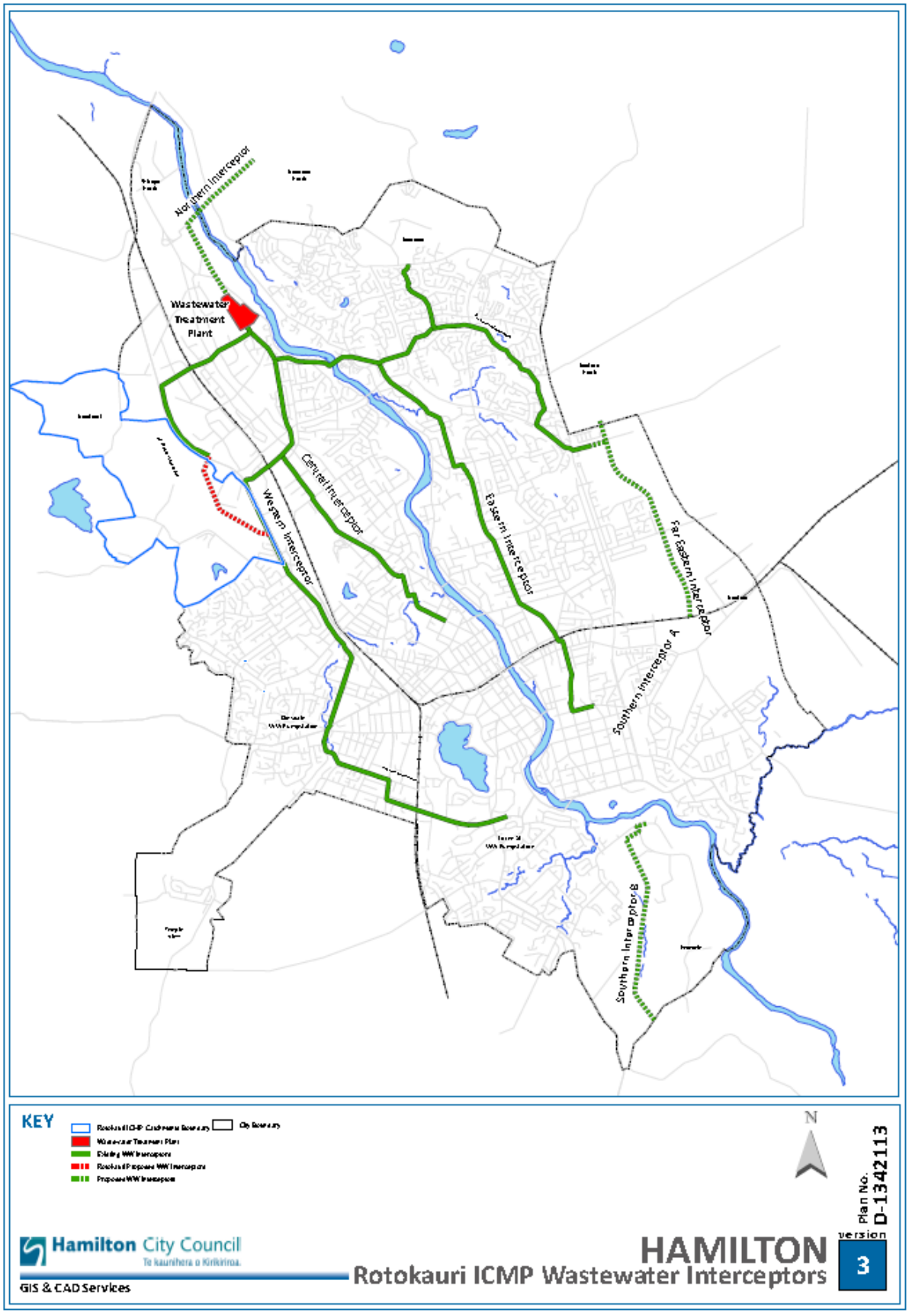

Figure 2-29: Wastewater interceptors

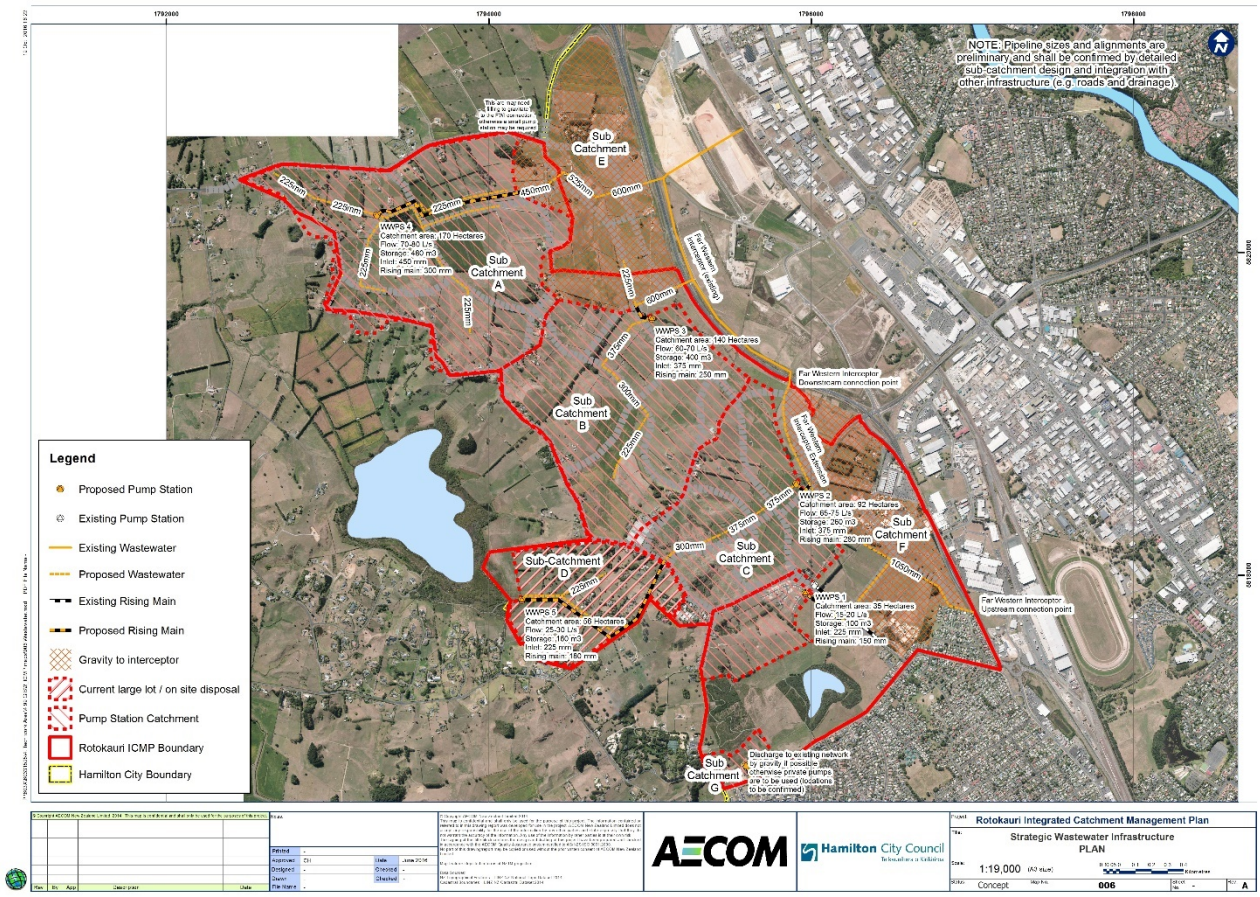

Figure 2-30: Existing and planned wastewater network

Table 2-5 shows some of the key data related to the wastewater network in this ICMP. Note that wastewater catchment boundaries are not the same as ICMP catchment or sub-catchment boundaries.

Table 2-5: Summary of existing wastewater network infrastructure

Existing Pumping station capacity/outlet capacity	**l/s**	**20.6**
Rising main capacity	l/s	n/a
Total storage (excluding in-line)	m^3	15.57
Length of public reticulation >=300mm	m	0
Length of public reticulation <300mm	m	894
Number of designated wet weather overflow locations	-	0
Number of connections	-	57
Number of properties not connected	-	0

2.5.3 Water Supply

The current water supply system in the Rotokauri Catchment is limited to reticulation of existing properties to the south of Lake Waiwhakareke and to a small reticulated area adjoining Rotokauri Rd to the north of Lake Waiwhakareke which is serviced by a 250mm diameter trunk main in Rotokauri Rd. An existing loop trunk main (150mm to 250mm) also services the area bounded by Gilchrist St, Akoranga Rd, Te Wetini Drive and Mangaharakeke Drive (State Highway 1). Maps showing the existing water supply pressure zones are presented below.

Figure 2-31 below shows the existing water infrastructure with existing pressure zone. Following on, Figure 2-32 shows the existing water infrastructure with network pressure deficiencies.

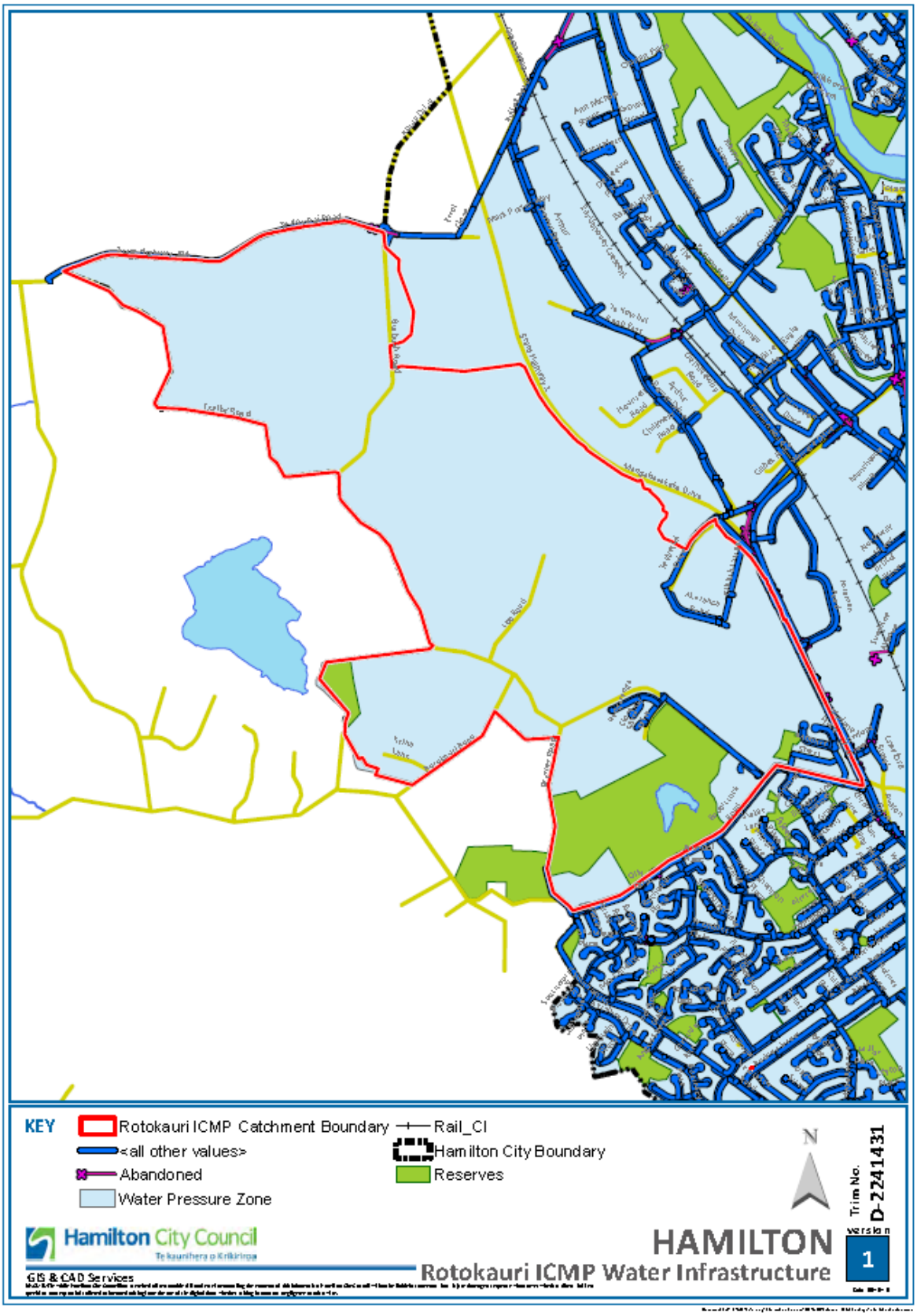
KEY
Rotokauri ICMP Catchment Boundary
<all other values>
Abandoned
Water Pressure Zone
Rail_Cl
Hamilton City Boundary
Reserves
N
Trim No.
D-2241431
version
1
Hamilton City Council
Te kaunihera o Kirikiriroa
GIS & CAD Services
HAMILTON
Rotokauri ICMP Water Infrastructure

Figure 2-31: Map of existing water supply pressure zone

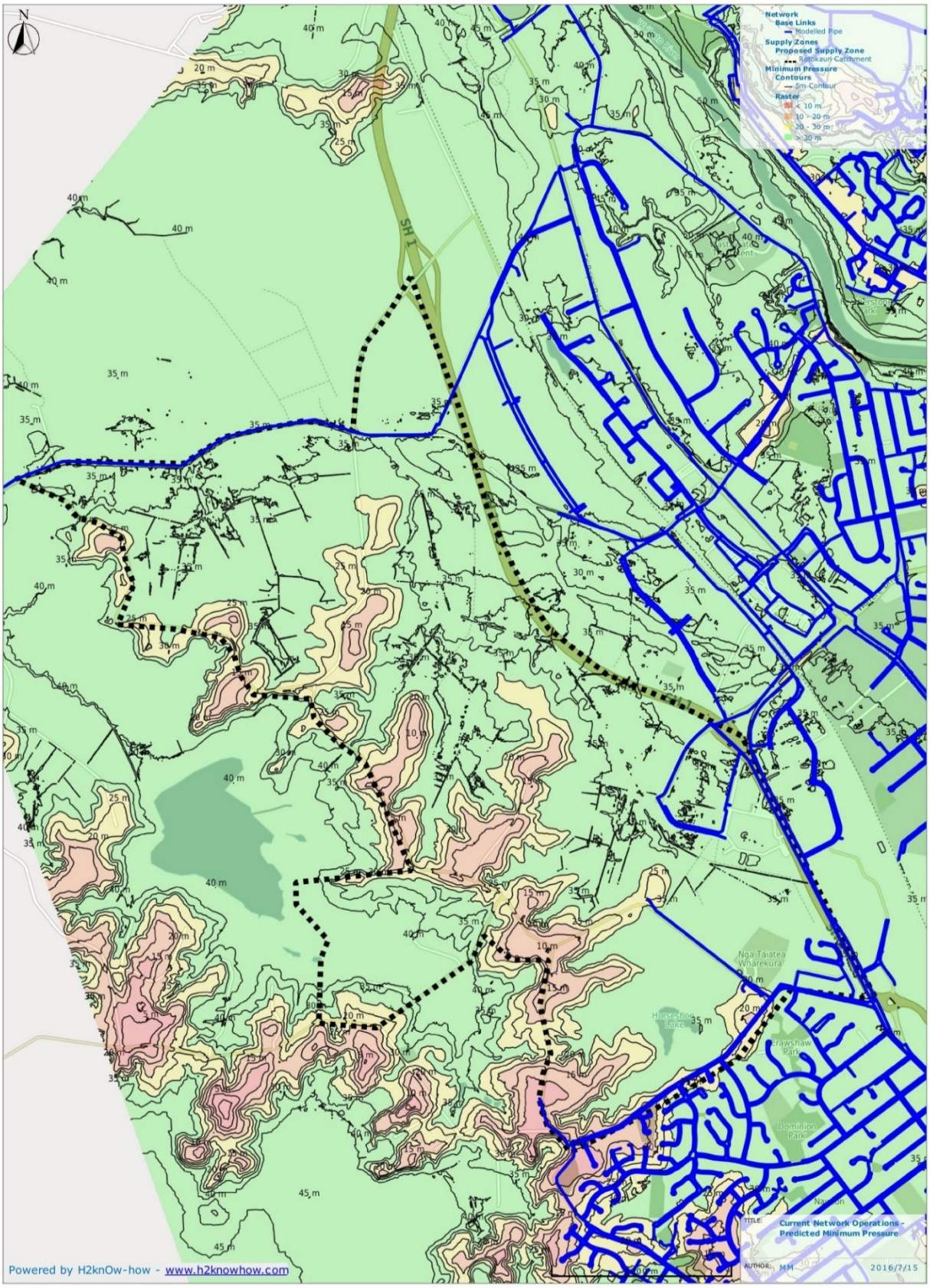

Figure 2-32: Existing water infrastructure with network pressure deficiencies

Table 2-6 shows some of the key data related to the water supply network in this ICMP. Note that water supply zones are not the same as ICMP catchment or sub-catchment boundaries.

Table 2-6: Summary water supply primary infrastructure

Length of public reticulation >= 150mm	**m**	**3064**
Length of public reticulation < 150mm	m	936
Number of connections		249
Number of properties using tanks only for drinking water		52

3 Outcomes and Issues

This section outlines the key outcomes and issues identified through the catchment specific technical investigations and assessment work undertaken, and reports on how existing and proposed three waters infrastructure performs against the objectives and targets listed in Section 1.7 of this document.

The main supporting information pertaining to this section, inclusive of the detailed methods and assumptions that were applied in generating the information, can be found in the technical documents in the attached appendices (Appendix C). The information below is therefore limited to a high level summary of the key outcomes and issues presented in these documents, to which the reader is referred if requiring further details.

It is further noted that:

- The Rotokauri Catchment is substantially greenfield
- The existing three waters infrastructure in the catchment is minor
- Provision for three waters major infrastructure has previously been investigated and, to some extent, advanced for the catchment (pre-ICMP development), and
- The focus of the technical investigations and assessments undertaken as part of the ICMP development process, has been on provision for growth, and avoiding or otherwise minimising issues related to growth.

Accordingly, the assessments in Sections 3.2 – 3.4 below incorporate proposed management solutions which generally align with the RSP and previous investigation work, and which have been further determined through this ICMP development process. Particularly where outcomes and issues relating to these solutions have been assessed.

3.1 Background Context

The Rotokauri Catchment has been subject to several historical investigations and assessments, including those undertaken in the early 2000s by Beca and others and recorded in the compilation report titled '*Rotokauri Structure Plan – Phase 1 Report*. *Environmental Constraints and Urban Needs Assessment*' (Beca et al, 2001).

As the title suggests, the assessments undertaken were aimed at supporting the development of the RSP and examined at a preliminary level, the opportunities and constraints to urban growth in the catchment. Of particular note, issues relating to culture, landscape, amenity, stormwater, geotechnical and ecological issues that might influence the form of development were examined.

Key outcomes from these assessments included the provision of high level design principles which were applied to early versions and indicative infrastructure solutions presented in the RSP. Other historical assessments which were subsequently undertaken to gain further understanding of the catchment, and to further inform the RSP / indicative infrastructure solutions, are listed in Table 3-1 below.

Table 3-1: Documents

Document Author and Title	TRIM Reference
Kessels and Associates Ltd, 2006. *Ecological investigations of the Rotokauri, Te Rapa and Te Kowhai catchments*	D-2230270
Diffuse Sources Ltd, 2012. *Effects of urbanisation of the Rotokauri catchment on nutrient loads. Phase 4 report: Predicted changes to nutrient loads after implementation of the Rotokauri Structure Plan*	D-1126695
Beca Infrastructure Ltd, 2014. *Preliminary Stormwater Investigation - Lake Rotokauri Catchment Development Area – Part 2*	D-1435587
MWH, 2009. *Rotokauri CMP – Preliminary Hydrogeological Impact Assessment*	D-594846

Beca Infrastructure Ltd, 2010a. *Rotokauri Development – Factual Geotechnical Report*	D-2006869
Beca Infrastructure Ltd, 2010b. *Rotokauri Development – Interpretive Geotechnical Report*	D-565518 D-565521
Beca Infrastructure Ltd, 2011. *Rotokauri Development – Preliminary Hydrogeological Assessment*	D-594846
Beca Infrastructure Ltd, 2013. *Rotokauri Growth Cell - Planning & Design Summary Report*	D-1009023
Beca Infrastructure Ltd, 2014. *Preliminary Stormwater Investigation Lake Rotokauri Catchment Development Area – Part 2*	D-1435587

3.1.1 Rotokauri Structure Plan

The RSP forms part of the District Plan. Development of the RSP has been guided by the following vision:

> *"The sustainable expansion of the City into Rotokauri, through a coherent, integrated and people-focused mixed-use development based on best practice urban design principles."*

To realise this vision the Rotokauri Catchment requires major new infrastructure services and an arterial transport network (not the subject of this ICMP). In this regard the District Plan refers to Council's Long Term Plan (LTP) in making provision for major infrastructure. It also states that controls on the release of land are necessary to ensure that development can be adequately serviced whilst not negatively impacting existing network services, or compromising the development potential of the remaining area. In particular Section 3.6.2.9 of the District Plan states:

> *"Constraints on the availability of infrastructure and network capacity limit the extent to which land can be released for development. Until capacity and services are available, it is essential the development potential of the remaining Rotokauri area is not compromised by interim development."*

The District Plan goes on to state (Section 3.6.3.1):

> *"Progressive development will be serviced by generally extending water supply, wastewater and stormwater services … subject to a full Integrated Catchment Management Plan as required for the development of a structure plan … to ensure the three waters are appropriately planned for."*[23]

Section 3.6.3.1(d) of the District Plan outlines the following principles to guide the formulation of the ICMP:

- *"Stormwater is managed in a manner that minimises the effects of urban development on downstream receiving waters*
- *Stormwater is managed to ensure that water being disposed of into Lake Rotokauri does not further degrade that water body*
- *Areas of significant indigenous vegetation, water features and habitats will be safeguarded and enhanced*
- *A combination of low impact stormwater design solutions and conventional piped drains will be utilised in an integrated manner to suit the soil and topographical characteristics of particular areas."*

[23] The RSP was developed without the benefit of an ICMP to help inform it, although several preliminary assessments were undertaken as discussed above.

The RSP further sets out an indicative concept for development and the management of stormwater, as follows.

Southern Development Area
A key part of the RSP concept is to provide constructed floodways through the Southern Development Area in recognition of the catchment constraints and opportunities previously identified. This includes overland-flow swales, wetlands and conventional piped drains to collect stormwater and discharge to the floodways. The floodways will be sized to store stormwater during storms with controlled release to Lake Rotokauri (via the Exelby Road culvert outlet). The flat topography will be characterised by shallow drains and high groundwater levels. Conventional piped stormwater drains will be used on the hill terrain discharging to the collector swales on the flatter land.

The Rotokauri Drain between Lake Waiwhakareke and Lake Rotokauri will serve as the main drainage feature, although it will be subject to some adjustment to its alignment to achieve an improved relationship to eventual land use. This floodway is referred to in the RSP as the 'Central Green Corridor' and is intended to be a component of an 'ecological corridor' between the two lakes, effectively linking the Waiwhakareke Natural Heritage Park with Lake Rotokauri. The ecological corridor will also provide planted open space, walking and cycling pathways. The RSP envisages that the improved drainage channel and ecological corridor will be formed as development takes place along its length. Also, that the floodway needs to have continuity of shape and alignment from one property to the next.

Northern Development Area
The RSP envisages that this area will be treated similarly to the Southern Development Area except its discharge location is to the existing culvert to the northern end of Exelby Road, draining directly to a tributary of the Ohote Stream (not Lake Rotokauri). An east-west green drainage corridor is also envisaged to run parallel to Te Kowhai Road and be sized to accommodate the fully developed Northern Development Area.

Helping to inform the implementation of the RSP and in particular the three waters infrastructure components of the plan, is central to the purpose of this ICMP. Due regard has therefore been given to the RSP in developing the ICMP, and this is reflected in the catchment specific management objectives and targets set out in Section 1.7 of this document.

3.1.2 ICMP development

The technical investigations and assessments undertaken to directly support this ICMP, were formulated following a literature review of the catchment and initial consultation initiatives with key stakeholders (including WRC, WDC, LRMC, WAG and the main development community). They were also designed to:

- Provide a more detailed and applied understanding of the constraints and opportunities pertaining to the catchment
- Enable the development of proposed three waters management solutions that:
    - Align with the RSP vision and indicative infrastructural concepts for the catchment
    - Are based upon BPOs and three waters integrated management solutions
    - Meet the objectives and targets outlined in Section 1.7 of this document
    - Where possible, accord with key stakeholder aspirations and wider management initiatives
- Inform design requirements for development and identify further actions which are necessary to implement the ICMP
- Meet the requirements of the HCC held resource consents for water, wastewater and stormwater activities
- Accord with the HCC ICMP Business Case.

Given the known catchment sensitivities and immediate development pressures, the technical investigations and assessments have largely focused on the Southern Development Area. However, the Northern Development Area has also been considered to sufficiently inform three waters management solutions for the area, and these are included in the sections below.

Table 3-2 below lists the main technical investigations and assessments that were undertaken to support this ICMP (and appended to this document).

Table 3-2: Documents

Document Author and Title	TRIM Reference
AECOM, 2016. *Rotokauri ICMP - Major Drainage: Options Report*	D-2230265
AECOM, 2016. *Rotokauri ICMP - Major Drainage: Preferred Option & Stormwater Management Solution Report*	D-2230077
AECOM, 2016. *Rotokauri ICMP – Three Waters Infrastructure: Integration Report*	D-2238224
CH2M Beca, 2016. *Rotokauri: Hydrogeological Interpretive Report to Support ICMP*	D-2230274
CH2M Beca, 2015. *Rotokauri - Additional Hydrogeological Investigations* (Factual Report)	D-2006869
Kessels Ecology, 2016. *Rotokauri ICMP – Ecological Assessment and Inputs*	D-2230270
Opus, 2015. *Pukete Reservoir Bulk Water Main – Conceptual Design Report*	D-1969497
Morphum Environmental Ltd, 2016. *Rotokauri Erosion Susceptibility Assessment*	D-2230277
Morphum Environmental Ltd, 2016. *Rotokauri ICMP - Water Quality Treatment Concept Development Report*	D-2200176
Mott MacDonald, 2015. *Rotokauri Water Supply Capacity Assessment*	D-2172097
Streamlined Environmental Ltd, 2015. *Rotokauri ICMP - Broad Scale Water Quality Assessment*	D-1998549

These reports are discussed in context to the key outcomes and issues summarised below.

3.2 Stormwater and Receiving Environment Assessments

As outlined above, the focus of the technical investigations and assessment work undertaken has been on provision for growth, and avoiding or otherwise minimising issues related to growth. Accordingly, the assessments below incorporate proposed management solutions which have been advanced through the RSP and this ICMP development process, particularly where issues relating to these solutions have been assessed.

This section presents stormwater and receiving environment assessments relating to:

- Flooding and overland flow
- Hydrogeological and geotechnical issues
- Stream channel erosion
- Water quality and stormwater treatment requirements, and
- Aquatic, terrestrial and riparian ecology.

3.2.1 Flooding and overland flow

Most of the information presented in this section is from the technical reports listed below. These provide complete information, including the detailed methods and assumptions that were applied in generating the information:

- AECOM, 2016. *Rotokauri ICMP - Major Drainage: Preferred Option & Stormwater Management Solution Report.* (Appendix C)
- AECOM, 2016. *Rotokauri ICMP - Major Drainage: Options Report* (Appendix C).

The general scope of the investigations and assessment work undertaken included hydrologic and hydraulic modelling, optioneering and concept design related to the planning of the major drainage system for the catchment. This included:

- Defining baseline (Existing Development) hydrology within the development area and wider Ohote Stream Catchment, in order to understand the potential hydrologic effects and impacts of development through-out the catchment.
- Testing various major drainage scenarios for the purpose of developing a concept design solution to meet the following objectives:
    - Meet downstream flood protection LOS (WDC and WRC)
    - Minimise flood storage and conveyance infrastructure requirements in the development area, and
    - Avoid as far as practicable and otherwise minimise, potential adverse hydrologic effects through-out the catchment, including the downstream Lake Rotokauri sub-catchment and Ohote Stream.

In relation to the methods applied, some key observations and tags relating mainly to the Southern Development Area of the catchment, include:

- The catchment is unusual in that its hydrology does not function in a manner that is typical of other catchments within Hamilton or normally seen around urban centres. Three main contributing factors include:
    - The catchment is very flat, long and large and retains a lot of runoff and discharges it at a slow rate
    - The downstream lake (Lake Rotokauri) has a significant storage and attenuation volume. Discharge rates from the lake are less than pre-development inflows through the Exelby Road culvert outlet (i.e. the controlling hydraulic structure discharging to the lake from the catchment)
    - For a period of time early on in large storm events, the lake outlet becomes an inlet from the lower Rotokauri Drainage Area (i.e. the Ohote Stream backflows into the lake). During that period the lake does not discharge.
- The combination of size, land use and flat topography means that the catchment is dominated by storage, it takes a very long time to fill in large storm events, and it also takes a very long time to empty. Where most urban catchments are prone to intense but short duration flooding, with water levels rising and falling quickly, in Rotokauri the timeframes are in the order of several days.
- The downstream LOS for land drainage and flood protection are primarily achieved by controlling the lake level within the following range:
    - Normal operating range: RL22.5m to RL22.8m (Moturiki datum)[24]
    - Design flood level: RL23.5m (Moturiki datum).
- Modelled scenarios included:
    - Existing Development (ED) 2, 10 and 100 year ARI events - without climate change
    - ED 100 year ARI event - with climate change
    - Maximum Probable Development (MPD) 2, 10 and 100 year ARI events - with climate change and optimised flood mitigation in place (Southern Development Area).

Figure 3-1 below shows the proposed major drainage infrastructure to mitigate flooding in the MPD / fully developed catchment situation. Of particular note, the 'main storage and conveyance channel' depicts the proposed central drainage corridor and the 'conveyance swales' depict the proposed primary drainage corridors.

[24] The normal operating range also relates to minimum lake level requirements to protect ecological values (WRP and WRC/ICM Resource Consent #120860). Lowering the lake outlet to increase flood storage capacity is not considered to be an option.

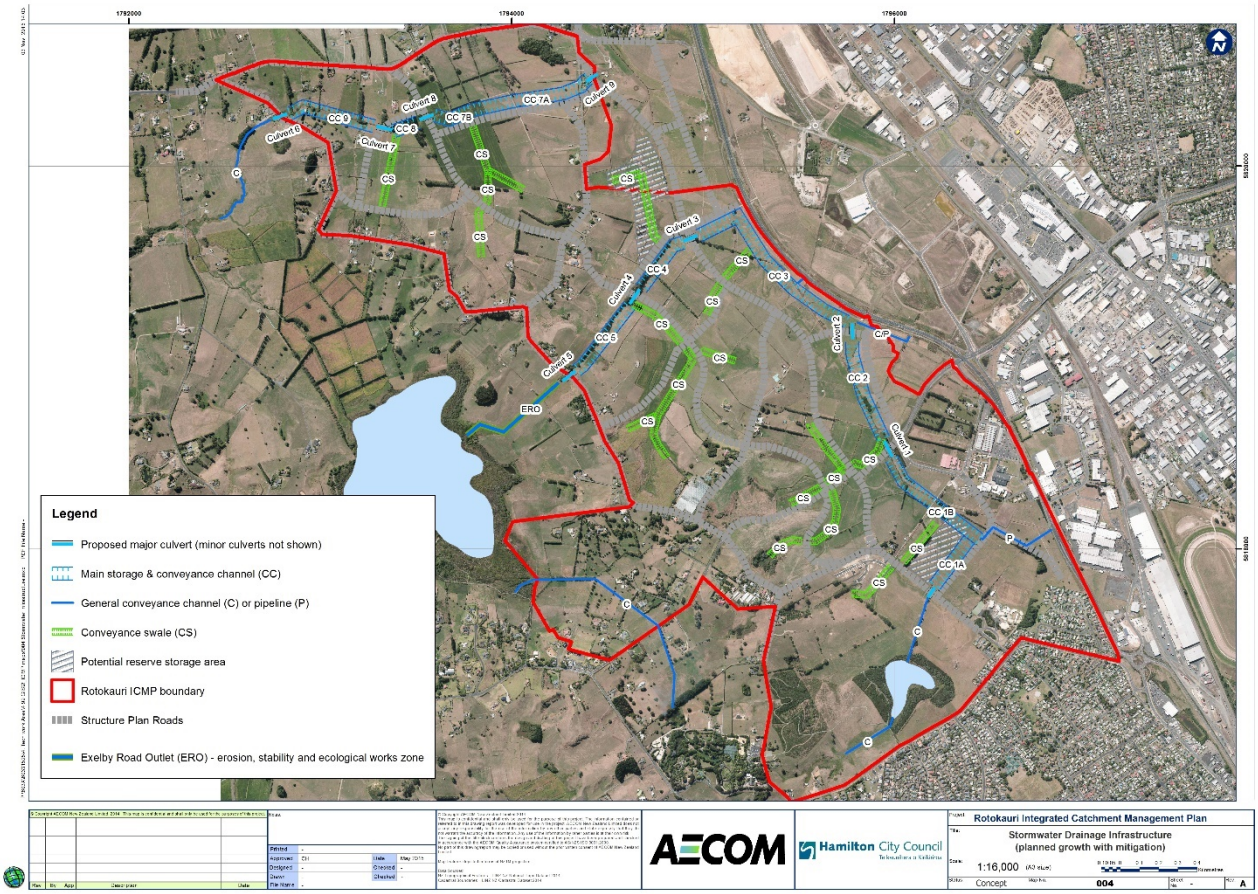

Figure 3-1: Flood mitigation – major drainage infrastructure (planned growth with mitigation)

Flood Extent Maps

The two maps below present two versions of the same map, the difference being that the depicted storm event overlays are ordered differently to show complete information. Both maps compare the ED 100 year (orange), ED 100 year with climate change (red), and MPD 100 year with climate change (blue) ARI events.

In Figure 3-2 (Map Version 1) below there is a considerable reduction in flooding through the central development area in the 'MPD with climate change and flood mitigation in place' scenario, compared with the two ED scenarios. There is also residual flooding in the catchment that will need to be addressed through provision of conveyance swales (not factored in the flood extent maps) and at the time of detailed design and implementation of the overall drainage system (further discussed below).

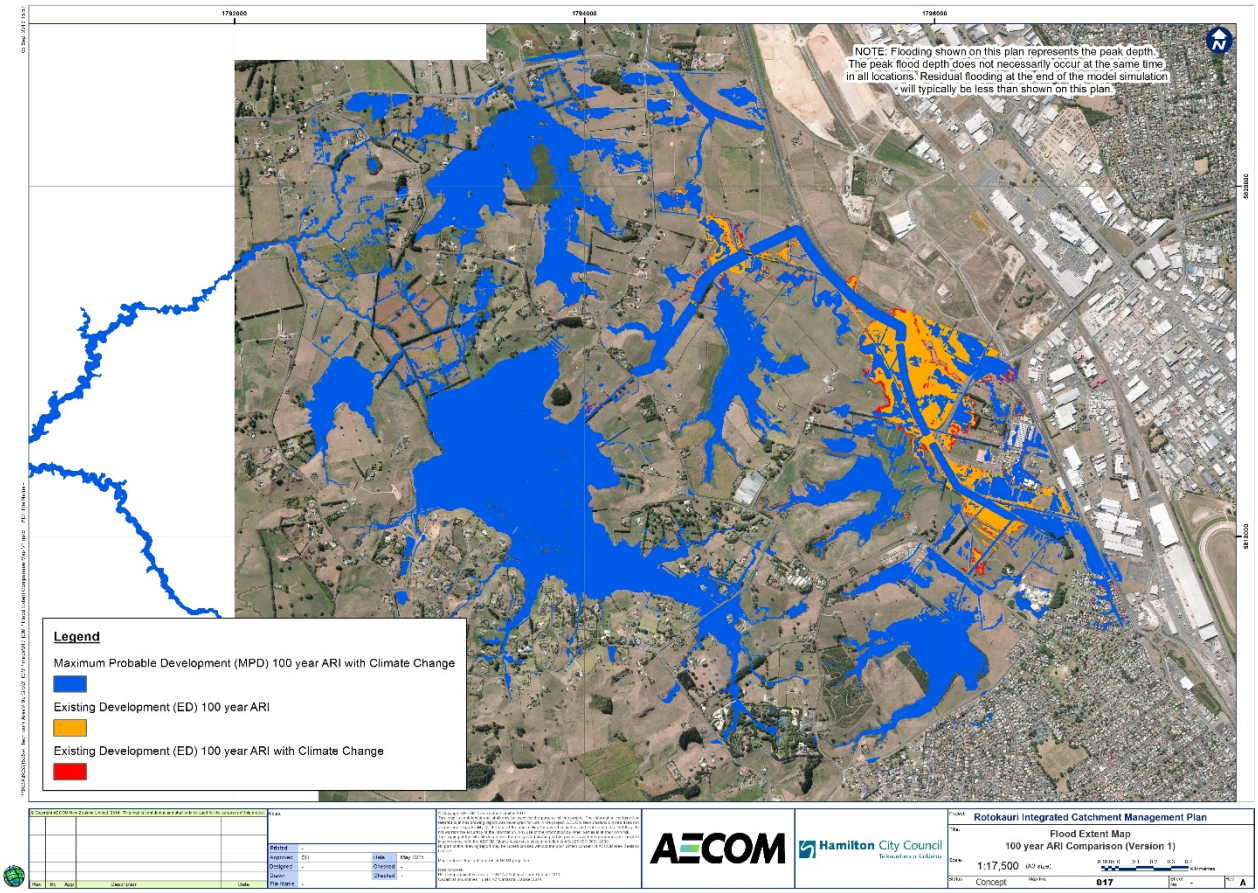

Figure 3-2: Flood extent map – 100 Year ARI comparison (Version 1)

With reference to the Lake Rotokauri sub-catchment in Figure 3-3 (Map Version 2) below, there is noticeably little difference between the 'MPD with climate change and flood mitigation in place' scenario compared with the 'ED with climate change' scenario. However, it is interesting to observe that climate change alone may bring about the most significant change in flood extents in the wider catchment area as shown in this figure.

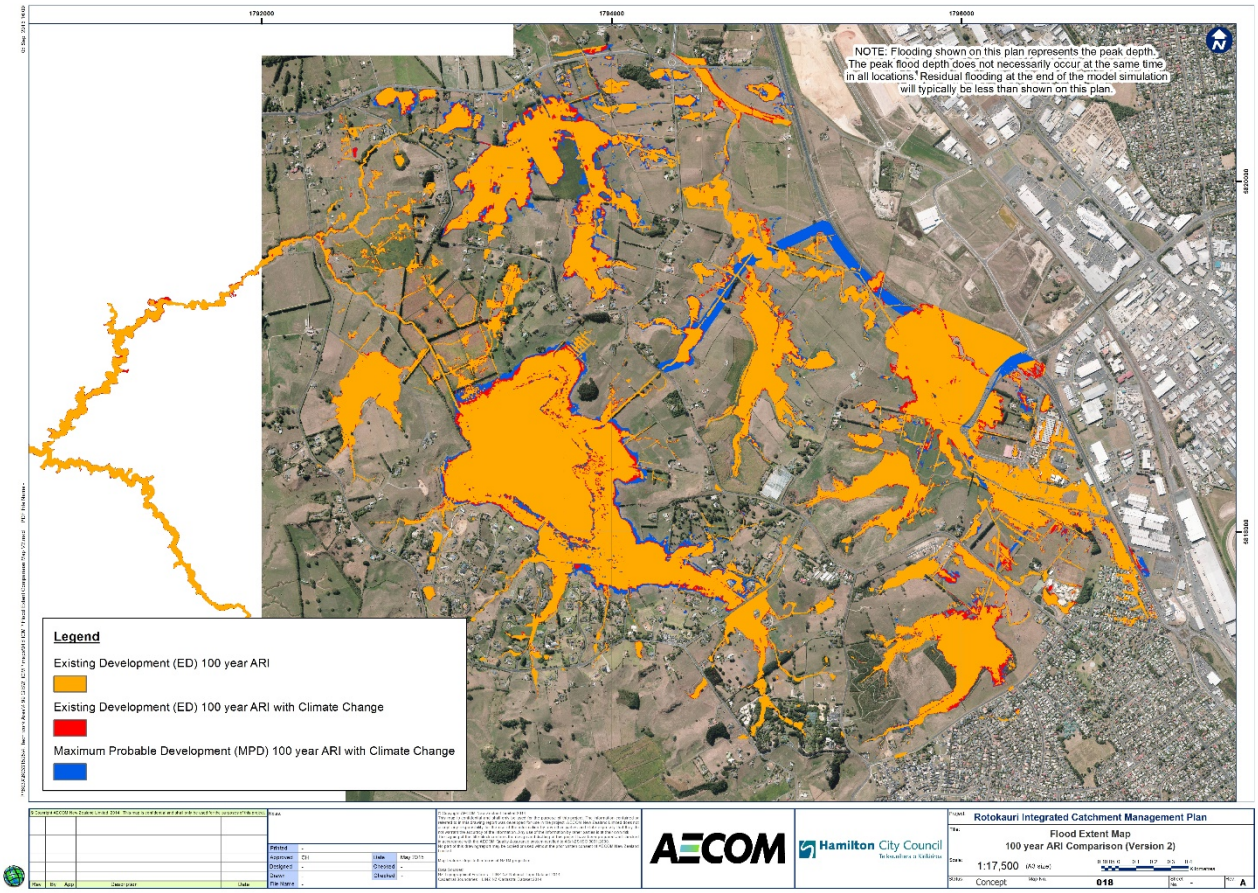

Figure 3-3: Flood extent map – 100 Year ARI comparison (Version 2)

Key outcomes and assessment against relevant objectives and targets (Section 1.7)

A high level assessment of the main investigation and assessment outcomes against the relevant O&Ts in Section 1.7 of this document, is presented in Table 3.3 below. This is followed by an overall summary of the main assessment outcomes which follow through to Section 5 of this ICMP ('BPO, Solutions and Implementation'), as necessary.

Table 3-3: Assessment of flooding issues against relevant O&Ts

Id	O&Ts	Assessment	Issue	Comment
SO2	Maintaining the natural hydrological cycle	This objective can be met through development design, minimising impervious surfaces where practicable, and through storage and reuse of rainwater in on-lot rainwater tanks and requiring soakage where feasible	Increased runoff volume and reduced groundwater replenishment due to widespread impervious areas causes several issues such as lowering the groundwater table / ground consolidation, increased base flow and peak flow fluctuations in receiving waterbodies, and greater infrastructure requirements	Widespread soakage in the catchment is not considered to be feasible but there may be opportunity for localised soakage on a case by case basis (subject to site specific testing). Storage and reuse of rainwater in on-lot rainwater tanks should be encouraged where possible

Id	O&Ts	Assessment	Issue	Comment
SO4	Stormwater management	This objective can be met through provision of flood storage capacity in the development area and via controlled discharge to the downstream lake catchment (Lake Rotokauri)	Unmitigated runoff due to development would cause significant catchment flooding and exceed existing LOS in the downstream lake catchment (WDC, WRC)	The proposed flood mitigation / major drainage solution would address this issue (to be finalised in design development)
SO9	Minimising infrastructure requirements	This objective can be met through utilizing the natural storage capacity of Lake Rotokauri whilst maintaining the existing lake level management regime	Significant flood storage requirements in the development area along with associated land area requirements and costs (capital and ongoing operation and maintenance costs)	Further optimisation of major drainage infrastructure in the development area may potentially be achieved through utilisation of planned reserve areas and/or reducing inflow from Avalon Dr/Nawton (subject to future assessment)
SO10	Hierarchy of preferred stormwater disposal options	This objective can be met through storage and reuse of rainwater in on-lot rainwater tanks and requiring soakage where feasible	Increased runoff volume and reduced groundwater replenishment due to widespread impervious areas causes several issues such as lowering the groundwater table / ground consolidation, increased base flow and peak flow fluctuations in receiving waterbodies, and greater infrastructure requirements	Widespread soakage in the catchment is not considered to be feasible but there may be opportunity for localised soakage on a case by case basis (subject to site specific testing). Storage and reuse of rainwater in on-lot rainwater tanks should be encouraged where possible
SO11	Resource consent compliance (HCC CSDC)	This objective can be met through avoiding or otherwise minimising, adverse flooding effects in the downstream catchment	Unmitigated runoff due to development would cause significant catchment flooding and exceed existing LOS in the downstream lake catchment (WDC, WRC) This would contravene the HCC CSDC and the requirements for catchment management plan approval	The proposed flood mitigation / major drainage solution would address this issue (to be finalised in design development)

Id	O&Ts	Assessment	Issue	Comment
SW1	Significant flood hazards	This objective can be met through provision of flood storage capacity in the development area and via controlled discharge to the downstream lake catchment (Lake Rotokauri)	Unmitigated runoff due to development would cause significant catchment flooding and exceed existing LOS in the downstream lake catchment (WDC, WRC)	The proposed flood mitigation / major drainage solution would address this issue (to be finalised in design development) Also, in conjunction with development, design of the primary conveyance swales, overland flow paths and landform changes will need to demonstrate that residual flooding can be adequately managed. Note, in context to 'significant flood hazard', residual flooding should not be an issue due to shallow depth and zero velocity
SW2	Network capacity	This objective can be met through provision of flood storage capacity in the development area and via controlled discharge to the downstream lake catchment (Lake Rotokauri)	Insufficient network capacity is limiting to development and risks flooding and associated LOS obligations in the development area	The proposed flood mitigation / major drainage solution would address this issue (to be finalised in design development)
SW3	Resilience	This objective can be met through development planning and design development of the major drainage infrastructure, including any necessary modifications to the Exelby Road culvert to address culvert block scenario	Risk of flooding and network failure	Development planning and design development of the major drainage infrastructure, including modifications to the Exelby Road culvert (or other engineered solution), would address this issue
CS1	Alignment with the Rotokauri Structure Plan	This objective can be met through provision of the proposed flood mitigation / major drainage solution, including central and primary conveyance drainage corridors	Potential inconsistency with the overarching vision, objectives, policies and guiding principles of the RSP	The proposed flood mitigation / major drainage solution is consistent with the RSP (to be finalised in design development)

Id	O&Ts	Assessment	Issue	Comment
CS5	Flood protection and downstream levels of service	This objective can be met through provision of flood storage capacity in the development area and via controlled discharge to the downstream lake catchment (Lake Rotokauri)	Unmitigated runoff due to development would cause significant catchment flooding and exceed existing LOS in the downstream lake catchment (WDC, WRC)	The proposed flood mitigation / major drainage solution would address this issue (to be finalised in design development)
CS7	Catchment development	This objective can be met through adequate provision of interim flood storage prior to construction of the proposed flood mitigation / major drainage solution	Unmitigated runoff due to development and prior to construction of the major drainage solution, would exacerbate existing flooding issues	Interim flood storage solutions will need to be developed to enable development prior to construction of the proposed flood mitigation / major drainage solution

Summary of Assessment and Observations

An overall summary of the main assessment outcomes is presented below.

Northern Development Area

Sufficient assessment of the Northern Development Area has been undertaken to define minimum requirements for this ICMP which can be implemented through future planning and design. A full concept solution has not been developed for this area, mainly because the Southern Development Area is currently planned to be developed first, and because the requirements to control downstream effects were sufficiently identified without concept design.

Proposed minimum requirements for this area include extended detention, attenuation of the 2 year and 10 year ARI event peak discharges, and a preliminary requirement to make the final discharge culvert to the Ohote Stream (at Exelby Road north) no larger than it is now to control discharges in events larger than 10 year ARI. This is to avoid adverse impacts on downstream flooding extents.

Southern Development Area

A viable concept solution has been developed to service the Southern Development Area as follows:

- Lake Rotokauri can be utilised for storage and attenuation without compromising the existing lake level operating regime. Lake Rotokauri forms the natural stormwater receiving environment for the catchment and represents an effective storage and attenuation mechanism. The effect of Lake Rotokauri is such that peak discharges to the Ohote Stream as a result of climate change and development will be attenuated and extended in duration.

- Lake Rotokauri will need to be supplemented with detention storage in the upstream development area to meet existing flood protection LOS and the operating level limitations of the lake (outlined above). The proposed solution has a number of limitations for which a number of mitigation measures and opportunities have been identified. Further work will be required to finalise the solution during design development (further discussed below).

The proposed solution generally aligns with the RSP and the concept of a central drainage corridor servicing the development area. A series of basins along the corridor can provide storage for the 100 year storm event with climate change, in conjunction with other functions such as water quality treatment, provision of ecological habitat and connectivity between the two lake sub-catchments, and public amenity.

The design flood level of Lake Rotokauri is fully utilised in the proposed solution (100 year storm event). Freeboard requirements are in place to control development around the lake. Habitable buildings need to be at least 300mm above the design flood levels and septic tank systems a minimum of 600mm.

It is also noted that local flood extents in the Rotokauri Drainage Area downstream of the lake are not defined by discharges from the lake. Flooding from direct runoff (not via the lake) is limited to within the Ohote Stream channel and there are no apparent potential adverse effects.

Notwithstanding the above, the proposed solution and the underlying assessment retain flexibility, and a number of opportunities to further mitigate have been identified. These could be incorporated into the final design as follows:

- Runoff to the lake may be further restricted to control lake levels lower than are currently planned. This could be achieved by further reducing the size of the Exelby Culvert
- Inflow from areas adjacent to the Southern Development Area may be able to be reduced through discharge restriction or diversion (subject to assessment)
- Storage in the basins could be offset or increased in offline storage areas such as lowered reserves.

These opportunities can also be investigated in more detail, particularly if required as an outcome of ICMP implementation and future development planning. However, the main point to acknowledge is that Lake Rotokauri is fully utilised in the proposed solution. There is also a degree of residual flooding in the flat terrain areas of the catchment. This will need to be accounted for in the design of the local stormwater network (channels and overland flow paths).

A holistic approach to the assessment, detailed design and implementation of the overall drainage system will be required because the detailed design of some elements will define other aspects of the solution. For example, the assessment of catchment inflows and residual flooding will influence the final sizing of the storage basins. Also, should implementation initiatives require a more conservative solution, or the opportunities to further mitigate prove insufficient, the following actions, or a combination thereof, may be required:

- Provision of increased storage capacity in the Southern Development Area
- Diversion of large event peak development flows to another catchment, away from Lake Rotokauri
- A reduction in the intensity or type of development within Rotokauri.

Key development considerations and future assessment requirements are fully outlined in the report titled *Rotokauri ICMP – Three Waters Infrastructure: Integration Report* (AECOM, 2016), (Appendix C). They are also included in the 'Future Actions' section of this ICMP (Section 5.5.3).

In addition to the above outcomes, matters pertaining to non-flooding issues associated with the proposed solution and major drainage infrastructure (Figure 3-1) are addressed in the sections below.

In summary there are significant flooding issues relating to growth in the catchment and these must be avoided, or otherwise minimised, through provision of adequate flood controls and major drainage infrastructure. The proposed solution provides a credible means of achieving this and, in doing so, meets the relevant O&Ts assessed in Table 3-3 above.

3.2.2 Hydrogeology and geotechnical

Most of the information presented in this section is from the technical report titled: *Rotokauri: Hydrogeological Interpretive Report to Support ICMP* (CH2M Beca, 2016), (Appendix C). This report provides complete information, including the detailed methods and assumptions that were applied in generating the information.

The general scope of the work undertaken included hydrogeological investigations and assessment. It focussed on understanding the hydrogeological conditions and the potential implications for stormwater management in the

Southern Development Area of the catchment[25]. In particular it assessed the hydrogeological implications of the proposed stormwater solution and the conceptual design of the central drainage corridor (referred to in this section as the 'central corridor').

In relation to the methods applied, some key observations and tags include:

- The conceptual design of the central corridor was undertaken by AECOM (discussed above) as detailed in the report titled *Rotokauri ICMP - Major Drainage: Preferred Option & Stormwater Management Solution Report* (2016), (Appendix C).
- The conceptual design of the central corridor varies in depth from 2 m to 4 m below ground level (bgl) and varies in width from typically 50 m to 70 m wide, but may be just 10 m wide in the upper part of the catchment near Lake Waiwhakareke. The central corridor also provides for a narrow low flow channel of approximately 0.5 m deep, making the overall corridor depth approximately 2 m to 4.5 m bgl
- Given that the central corridor will intersect the groundwater table over most of its length it is important to understand the implications of changes in groundwater level for the environment, design constraints, construction and long term operation
- The work undertaken included site investigation, analysis and groundwater modelling to understand the interaction between groundwater and the central corridor.

With regard to existing groundwater users which could potentially be affected by changes to the groundwater table, Figure 3-4 below shows the location of consented groundwater takes relative to calculated summer drawdown. This drawing with added water take authorisation details, is also appended to this document (Appendix A).

[25] As of 2015-16 when the hydrogeological investigations and assessment work was undertaken, there was not any foreseeable development being planned in the Northern Development Area.

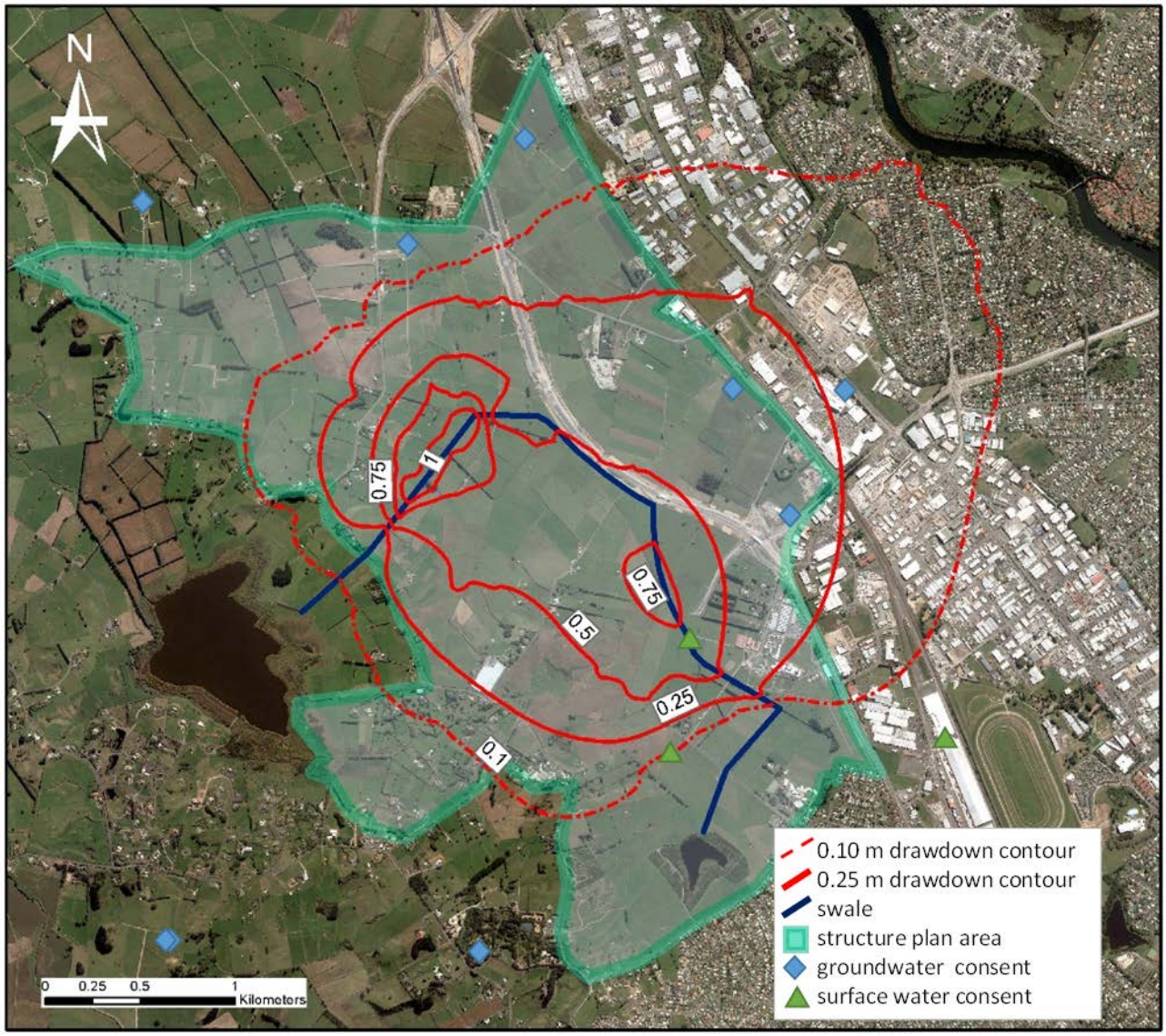

Figure 3-4: Location of consented groundwater takes relative to calculated summer drawdown (CH2M Beca, 2016)

Key outcomes and assessment against relevant objectives and targets (Section 1.7)

A high level assessment of the main investigations and assessment outcomes against the relevant O&Ts in Section 1.7 of this document, is presented in Table 3.4 below. This is followed by an overall summary of the main assessment outcomes which follow through to Section 5 of this ICMP ('BPO, Solutions and Implementation'), as necessary.

Table 3-4: Assessment of the hydrogeological and geotechnical issues against relevant O&Ts

Id	O&Ts	Assessment	Issue	Comment
SO2	Maintaining the natural hydrological cycle	This objective can be met through provision of soakage/infiltration systems for groundwater replenishment, where feasible	There is risk of consolidation settlement due to groundwater loss in the development area, due to the proposed central corridor	Widespread soakage is not considered to be feasible. However, localised soakage may be possible (subject to site specific investigations)

Id	O&Ts	Assessment	Issue	Comment
S10	Hierarchy of preferred stormwater management options	This objective can be met through provision of soakage/infiltration systems for groundwater replenishment, where feasible	Soakage is required where feasible to address multiple issues relating to three waters management, including groundwater replenishment	Widespread soakage is not considered to be feasible. However, localised soakage may be possible (subject to site specific investigations)
SO11	Resource consent compliance (HCC CSDC)	This objective can be met through avoiding or otherwise minimising adverse groundwater drawdown effects, i.e. on existing groundwater users and Lake Waiwhakareke	Groundwater levels in Waiwhakareke Natural Heritage Park must be protected to avoid adverse groundwater drawdown effects Adverse groundwater drawdown effects would contravene the HCC CSDC and the requirements for catchment management plan approval	Works below the groundwater level in proximity to the Waiwhakareke Natural Heritage Park must be kept to a practicable minimum to limit adverse drawdown effects. Note, effects on existing groundwater users are considered to be minor
SW2	Network capacity	This objective can be met by discharging (gravitating) groundwater inflows to the central corridor, downstream	The flood storage capacity of the central corridor must be maintained to avoid risk of flooding and network failure	During construction of the central corridor adequate allowance will need to be made for pumping and discharging the groundwater encountered
CS1	Alignment with the Rotokauri Structure Plan	This objective can be met through provision of adequate groundwater drawdown controls in proximity to the Waiwhakareke Natural Heritage Park	Potential inconsistency with the overarching vision, objectives, policies and guiding principles of the RSP	The proposed major drainage solution, inclusive of adequate groundwater drawdown controls in proximity to the Waiwhakareke Natural Heritage Park, is consistent with the RSP (to be finalised in design development)
CS2	Key stakeholder engagement	This objective can be met through ongoing engagement and collaboration with key stakeholders, in particular the members of the Waiwhakareke Advisory Group (WAG)	Ongoing consultation and collaboration with WAG is essential for ensuring that the values and management aspirations associated with the Waiwhakareke Heritage Park are protected / achieved	Consultation during design development of the central corridor, inclusive of adequate groundwater drawdown controls in proximity to the Waiwhakareke Natural Heritage Park, is essential

Id	O&Ts	Assessment	Issue	Comment
CS3	Ecological protection and enhancement	This objective can be met through provision of adequate groundwater drawdown controls in proximity to the Waiwhakareke Natural Heritage Park	Groundwater levels in Waiwhakareke Natural Heritage Park must be protected to avoid adverse groundwater drawdown effects	The proposed major drainage solution, inclusive of adequate groundwater drawdown controls in proximity to the Waiwhakareke Natural Heritage Park, would address this issue (to be finalised in design development)
CS4	Protecting groundwater levels in Waiwhakareke Natural Heritage Park	This objective can be met through provision of adequate groundwater drawdown controls in proximity to the Waiwhakareke Natural Heritage Park	Groundwater levels in Waiwhakareke Natural Heritage Park must be protected to avoid adverse groundwater drawdown effects	The proposed major drainage solution, inclusive of adequate groundwater drawdown controls in proximity to the Waiwhakareke Natural Heritage Park, would address this issue (to be finalised in design development)
CS8	Catchment monitoring and information gathering	This objective can be met through ongoing groundwater level and Lake Waiwhakareke water level monitoring, as well as observation monitoring of the central corridor excavation during construction as per the technical assessment recommendations	There are significant potential adverse effects associated with groundwater drawdown due to construction of the central corridor	Ongoing monitoring, as per technical assessment recommendations, will be essential in responding to any adverse effects during, and for a short time following, construction of the central corridor

Summary of Assessment and Observations

An overall summary of the main assessment outcomes is presented below.

High groundwater levels are encountered along the length of the central corridor with the winter groundwater level typically less than 1 m bgl. Over most of the site there is a downward vertical gradient with the shallowest groundwater level being perched on lower permeability horizons. The shallow, perched nature of the groundwater level has implications for design and environmental effects as follows:

- Groundwater inflows to the central corridor are likely to be of the order of 4 l/s in the long term and will need to be discharged down-stream to maintain the required storage capacity within the corridor. During construction, higher inflows can be expected that will require adequate provision for pumping and discharge. Inflows may impact locally on the stability of excavations during construction.
- Drawdown of 1.0 m to 1.5 m is calculated adjacent to the central corridor reducing to 0.25 m at a distance of 1.0 km to 1.5 km. Beyond the RSP area drawdown is unlikely to result in damaging consolidation settlement or impacts on existing groundwater users, however monitoring at the site boundaries in areas of greatest expected drawdown is recommended. Within the RSP area it would be prudent for developers to build some flexibility into permanent works to accommodate any settlements that do occur.

- Widespread soakage is not considered to be feasible. Localised soakage may be possible, but would be subject to site specific investigations confirming an appropriate thickness of high permeability soils near the surface and that the winter groundwater level is at least 1 m below the invert of any stormwater device.

With regard to Lake Waiwhakareke, the central corridor will result in some lowering of groundwater levels down gradient of the lake, and it is inevitable that there will be some small increase in the volume of lake water that seeps to groundwater. However, the volume of additional lake water that is lost to the ground is indicated to be small when compared to direct rainfall onto the lake and very small when compared to the total volume of water in the lake. Overall, any changes in lake level are expected to be very small (< 100 mm and < 12 % of rainfall recharge for a 4 m deep corridor, or, 20 % of rainfall recharge for a 4.5 m deep corridor). Nevertheless, this change should be considered against wider lake management and ecological objectives to assess if engineered mitigation measures are required.

Modelling has confirmed that early recommendations to maintain "as-is" the length of drain immediately down gradient of Lake Waiwhakareke remain appropriate.[26] Modelling has also confirmed that there is limited additional benefit, in terms of drawdown or effects on the Lake, to be gained by making small changes to the central corridor such as lining or raising the invert over discrete sections; though lining or raising over the full length would be expected to have greater benefit (in terms of both drawdown and inflows) and should continue to be evaluated as the detailed design is progressed and possible cost implications explored. It is also recommended that the analyses are updated as detailed design progresses to consider any changes in central corridor geometry and the results of ongoing groundwater level monitoring (which might indicate wider natural groundwater level variation).

With regards to monitoring, groundwater level and Lake Waiwhakareke water level monitoring should continue prior to, during and for a short time following construction of the central corridor to confirm that any changes in groundwater level are within the expected range. CH2M Beca also recommend that observation monitoring of the corridor excavation is undertaken during construction to help manage risks associated with groundwater inflows and slope stability.

The recommended groundwater level and Lake Waiwhakareke water level monitoring is further addressed in Section 5.5.3 (*Future Actions*) and in Section 8.2 (*Proposal for Catchment Monitoring*) of this ICMP.

In summary there are significant hydrogeological and geotechnical issues relating to growth in the catchment, and construction of the central corridor in particular. These issues must be avoided, or otherwise minimised, through provision of adequate groundwater drawdown controls in proximity to the Lake Waiwhakareke Natural Heritage Park. The assessment has also shown that some flexibility should be built into permanent development works to accommodate any consolidation settlements that occur.

Provided these issues are addressed through provision of adequate groundwater drawdown controls as proposed for the central corridor, and appropriate development design which further factors for consolidation settlements, the relevant O&Ts assessed in Table 3-4 will be met.

3.2.3 Stream channel erosion

Most of the information presented in this section is from the technical reports listed below. These provide complete information, including the detailed methods and assumptions that were applied in generating the information:

- AECOM, 2016. *Rotokauri ICMP - Major Drainage: Options Report* (Appendix C)
- Morphum Environmental Ltd, 2016. *Rotokauri Erosion Susceptibility Assessment* (Appendix C).

[26] Recommendations from the report titled *Preliminary Stormwater Investigation Lake Rotokauri Catchment Development Area – Part 2* (Beca Infrastructure Ltd, 2014).

The general scope of the work undertaken included erosion investigations and assessment of the main watercourses in the wider catchment area, and focussed on identifying existing stream channel erosion and susceptibility to further changes in flow regime as a consequence of development.

With reference to the catchment drawing below (Figure 3-5), the three main study areas included in the assessments were as follows.

Southern Development Area

- The Waiwhakareke Reserve and upstream 'Waiwhakareke Development Area'
- The Rotokauri Drain immediately upstream of Exelby Road outlet.

Lake Rotokauri sub-catchment

- Rotokauri Drain between Exelby Road outlet and Lake Rotokauri.

Lake Rotokauri outlet to Waipa River

- The southern tributary of the Ohote Stream between the lake outlet and Duck Road Bridge
- The Ohote Stream between Duck Road Bridge and the Waipa River.

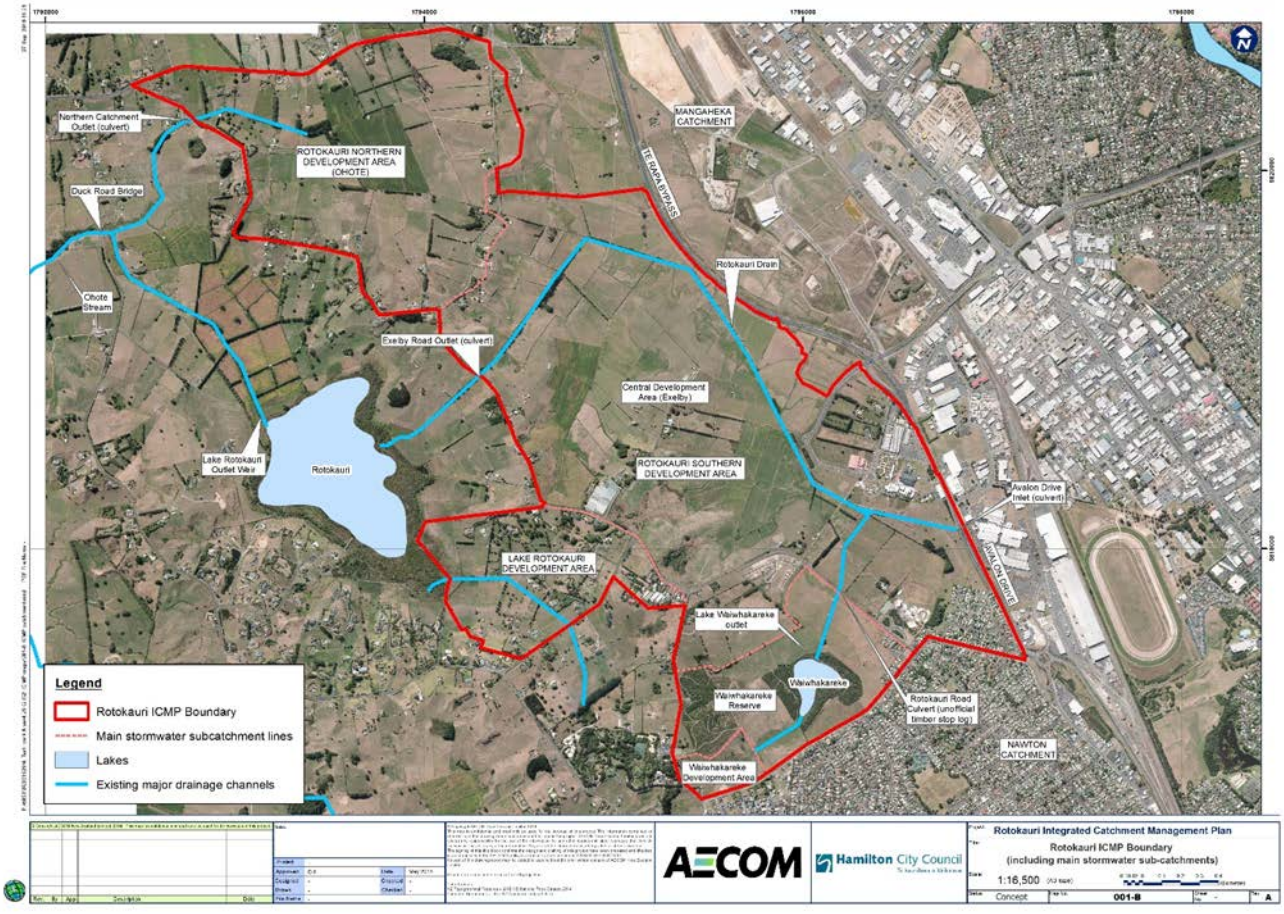

Figure 3-5: Catchment layout

In relation to the methods applied, some key observations and tags include:

- With the exception of the stream reach immediately upstream of Exelby Road, the Rotokauri Drain through the Central Development Area was not included in the erosion assessment. This is because it is subject to realignment in accordance with the RSP and the proposed central drainage corridor. The issues and outcomes

regarding this proposal, particularly in terms of the existing ecological values, are addressed in Section 3.2.5 below (A*quatic, terrestrial and riparian ecology*).

- The catchment area downstream of Exelby Road culvert, is within the jurisdictional areas of WDC and WRC/ICM who administer and maintain the Rotokauri Drainage Area.
- The erosion investigations and assessment work did not include the northern tributary of the Ohote Stream (Northern Development Area), due to there not being any development planned for this area in the foreseeable future[27].
- The work undertaken included:
    - Desktop studies of available geological and topographic maps
    - Site surveys and geomorphic mapping to confirm locations with high erosion susceptibility and where active erosion is occurring, and
    - Assessment of the future potential for erosion in the wider catchment as a consequence of development.

The figures presented below depict erosion susceptibility and active erosion areas ("hot spots") within the three main study areas. Mitigation options are also depicted where observed. The key assessment findings and mitigation options relating to these areas are also summarised below each figure for easy referral.

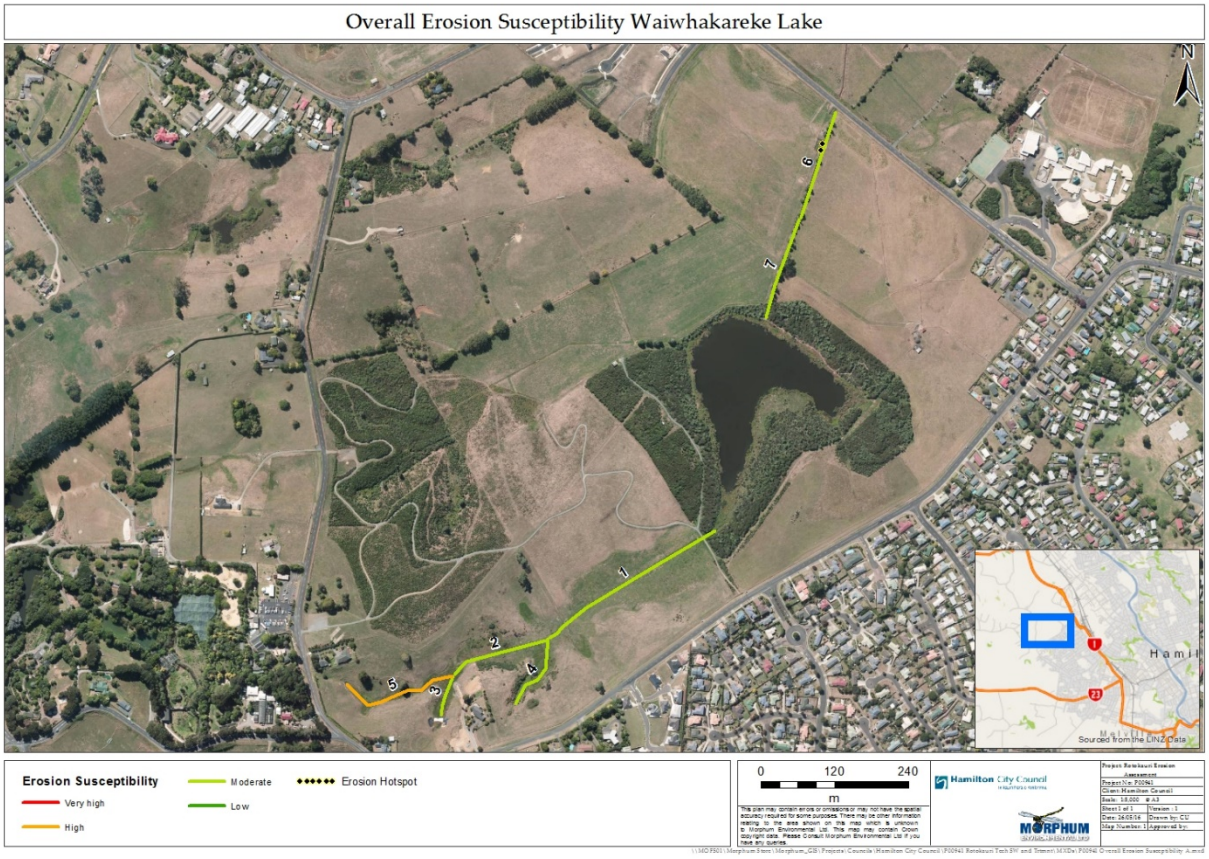

Figure 3-6: Lake Waiwhakareke Reserve and Waiwhakareke Development Area

[27] As of 2015-16 when the stream channel erosion assessment work was undertaken.

The key assessment findings for the Waiwhakareke Reserve and upstream 'Waiwhakareke Development Area', as determined by Morphum Environmental Ltd, are as follows:

- Reaches 1 and 2 have an overall upper bank stability score of 'good' and an overall erosion susceptibility score of 'moderate' - not requiring mitigation at this time. However, stock have access to both reaches and small sections of the streambanks are pugged with associated sediment mobilisation (further addressed in Section 3.2.4 – Water Quality).
- Reaches 3, 4, and 5 are the upper reaches of the catchment and described as headwater seepage wetlands with poorly defined channels. The overall upper bank stability of reaches 3 and 4 is 'good' and the overall erosion susceptibility score of these reaches is 'moderate'.[28] Reach 5 has a 'fair' overall upper bank stability score and a 'high' erosion susceptibility score. Mitigation to reduce the erosion susceptibility in reach 5 should therefore be determined prior to development in this area to ensure that potential erosion issues do not eventuate. This may be achieved through suitable riparian plantings subject to further investigation and design.

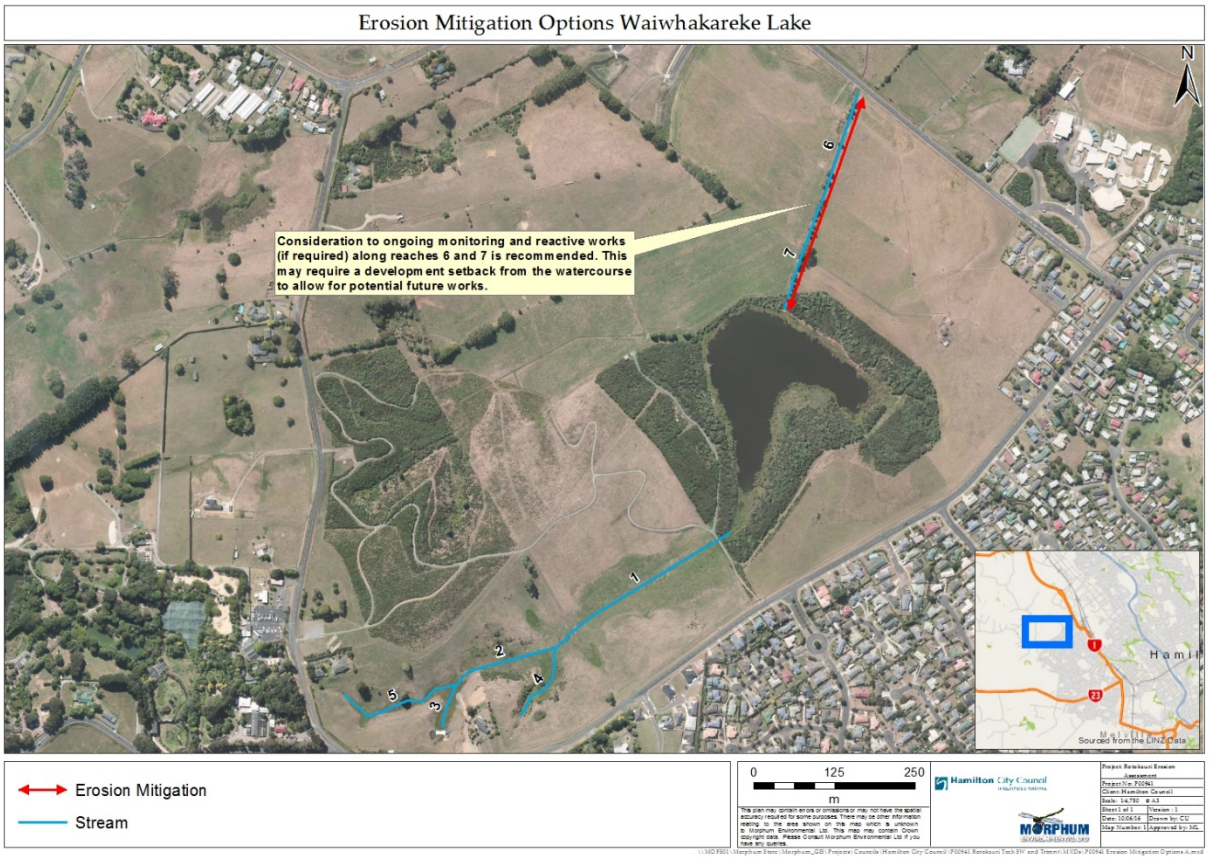

Figure 3-7: Lake Waiwhakareke Reserve and Waiwhakareke Development Area

Reaches 6 and 7 are straightened farm drains (modified watercourses) extending from Lake Waiwhakareke to Rotokauri Road. An erosion hotspot that is largely stabilised was identified along reach 6 (discussed below). Some minor historical mass wasting occurs in isolated locations along both reaches. The overall upper bank stability of these

[28] Section 3.2.4 (*Water quality and treatment*) identifies central wetlands for stormwater treatment purposes adjacent to reaches 2, 3 and 4. The proposed wetlands will provide multiple benefits, including improved bank stability and mitigation for potential erosion issues relating to development.

reaches is 'good' and the overall erosion susceptibility score is 'moderate'. Mitigation is not required at this time, however, ongoing monitoring and reactive remediation works (if required) are recommended.[29]

Figure 3-8: Rotokauri Drain between Exelby Road Outlet and Lake Rotokauri

The key assessment findings for the Rotokauri Drain immediately upstream and downstream of Exelby Road culvert to Lake Rotokauri, are as follows:

- Reach 8 is located immediately upstream of Exelby Road culvert. The angle of both banks is approximately 80 degrees. The TRB is approximately 6 m in height, while the TLB is approximately 4 m in height. Currently less than 20% of the banks exhibit erosion scarring. The dominant substrate is silt and mud, however, some gravel is present. The overall upper bank stability is 'fair' with the largest impact on this being the 'poor' land slope score. The watercourse is well shaded by both the high steep banks and the vegetation that is present. The overall erosion susceptibility is 'high'.
- Mitigation is not required at this time. However, this particular stream reach is located in the most downstream extent of the proposed central drainage corridor, and measures must be considered in development design to protect it from potential adverse effects. These relate to significant upstream earthworks, regular inundation and potential drawdown of water levels on the stream banks. Other potential effects relating to the ecological values of this reach are discussed in Section 3.2.5 below.

[29] Any future recommendations for reactive remediation works in reaches 1, 6 and 7 should take account of the WNHP Management Plan and any proposed developments in relation to these reaches.

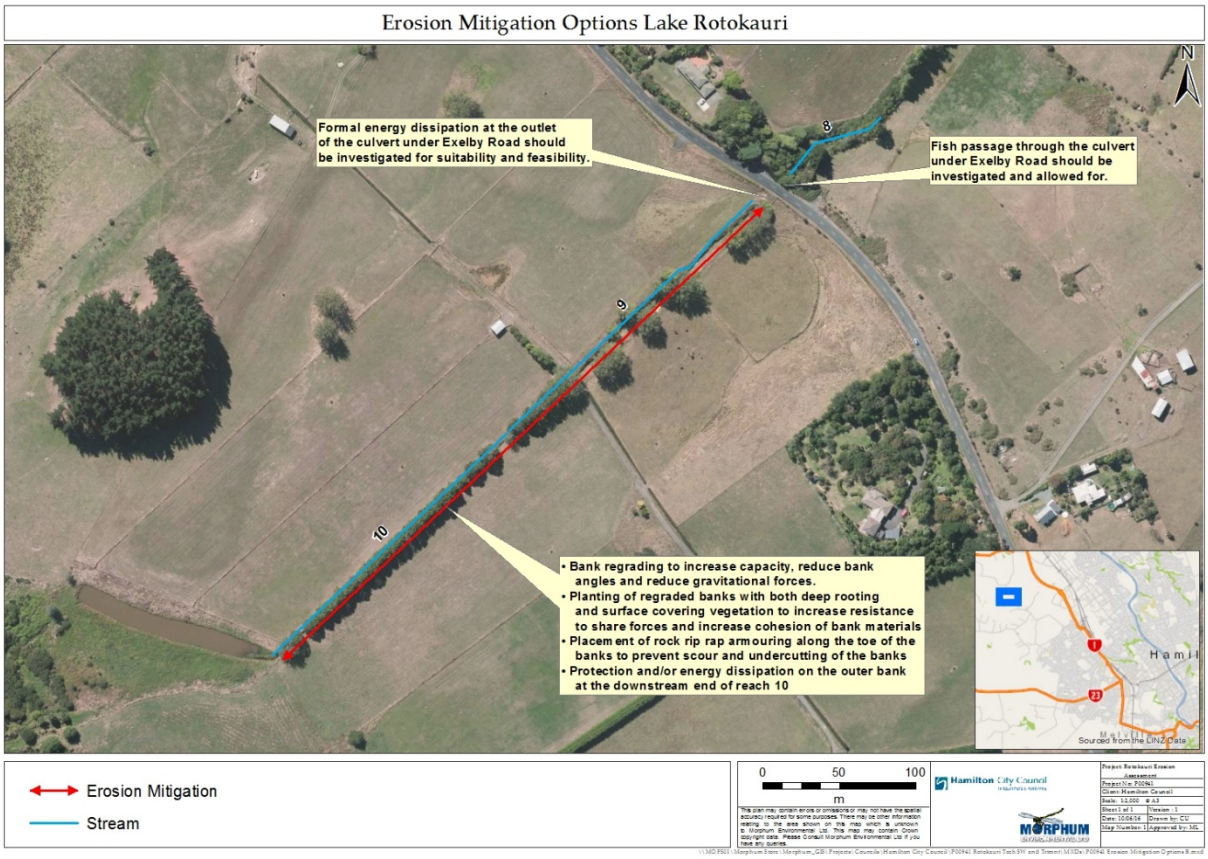

Figure 3-9: Rotokauri Drain between Exelby Road Outlet and Lake Rotokauri

- Reach 9 is located immediately downstream of Exelby Road culvert, part way to the lake reserve. Both banks are near vertical (80 – 90 degrees) and approximately 4 m in height. The banks are vegetated with pasture grasses, however, there is evidence of historic mass wasting and slumping along the reach. There are natural drops of approximately 150 mm along the reach and stable undercuts (up to 1 m) are present on both banks. Side cutting and sediment deposition is evident with the reach tending towards re-establishing more natural meanders in places.
- The dominant substrate is silt/mud, however, gravel and some artificial substrate (concrete waste) are also present. The overall upper bank stability is 'fair' with a 'poor' land slope score, 'poor' bank vegetation score and 'fair' mass wasting score. The overall erosion susceptibility is 'high'. An erosion hotspot was identified along the TLB of this reach and is approximately 14 m in length and 2.5 m in height. Evidence of historic slumping and mass wasting is visible on the TRB directly opposite this hotspot.
- Reach 10, immediately downstream of reach 9, exhibits similar characteristics such as the substrate composition, existing bank erosion and stable undercut banks. However, the major differences are the bank height (approximately 2 m, rather than 4 m) and the straightness of the reach which lacks the side cutting and sediment deposition processes evident along reach 9. Similar to reach 9, the banks are vegetated in pasture grasses, however, there is evidence of historic mass wasting and slumping along the reach. The overall upper bank stability of these reaches is 'good', which is largely limited by the 'poor' bank vegetation score. The overall erosion susceptibility score of both reaches is 'moderate'.
- The assessment concludes that the high, steep, undercut banks of reaches 9 and 10, coupled with the lack of dense, vigorous deep rooting vegetation and the composition of the bank soils and channel substrate, means that these reaches are considered highly susceptible to erosion. As such it is proposed that efforts to investigate and implement erosion mitigation and protection measures are focused on reaches 9 and 10.

Figure 3-10 below depicts the Southern Development Area which will benefit from the proposed central drainage corridor (i.e. the major drainage solution discussed in Section 3.2.1 above). It also shows the stream channel requiring erosion mitigation and protection works as outlined above.

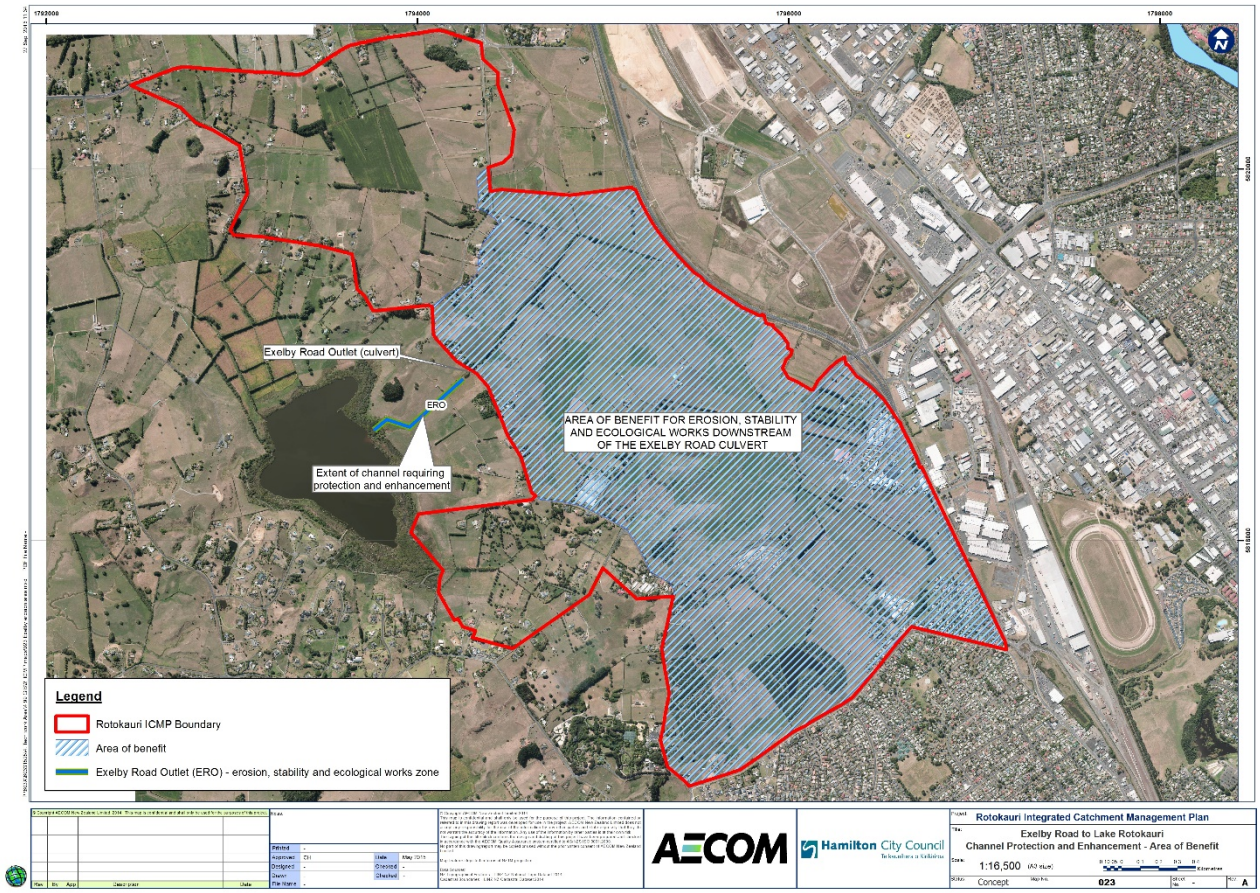

Figure 3-10: Rotokauri Drain between Exelby Road Outlet and Lake Rotokauri – 'Area of Benefit' for Mitigation Works

With regard to the Ohote Stream between Lake Rotokauri outlet and the Waipa River, AECOM (2016) found that:

- Active erosion within the Ohote Stream catchment generally relates to shallow retrogressive failure of the Hinuera formation slopes where vegetation has been removed as part of development of the farmland. Shallow slab type failures are common where the stream gully is narrow and the stream erodes its lower banks.
- Much of the observed slope failure and erosion is typical of tributary gullies of the Waikato River in the Hamilton Lowlands. Areas where gullies are narrow and slopes steep are likely to be more susceptible to erosion during periods of flooding and high discharge. Those areas are likely to be susceptible as increased flows undercut the toe of the steep slopes eroding support to the lower slopes.
- Instability of the upper slopes is typically surficial failure and creep, however, regressive translational failure encompassing large portions of the slopes has occurred in the past. Past full slope instability near the Waipa River confluence is evident where flooding of the Waipa River has led to stream flow eroding the toe of slopes resulting in enlargement of the gully.
- Narrow and deeper portions of the gully appear to be affected by velocity effects due to channel modification and narrowing.

AECOM (2016) concluded that the following matters should be considered in planning for development[30]:

- The existing stream system is stable overall but could be susceptible to increased erosion if flows increase markedly. The existing flow regime downstream of Duck Road should be maintained as far as practicable.
- The most evident areas of erosion are in locations where vegetation has been cleared and stock has access to the gully slopes and terraces. Restoration planting and the exclusion of stock would have a positive effect on long term stability and erosion in these areas.
- Physical works (i.e. engineered solutions) may be required in and around existing culverts and bridges to maintain stability and control erosion. Outside of these areas riparian planting would be the preferred mitigation subject to the onset of any actual effects.
- Widening in the lower gully system is primarily attributed to backing up from the Waipa River when it is in flood. This is considered to be a natural process over time which is not related to development in the catchment upstream.

Figure 3-11 below depicts the site survey findings in the southern tributary of the Ohote Stream between Lake Rotokauri outlet and Duck Road Bridge.

[30] Complete information is presented in Section 5 of the report titled *Rotokauri ICMP - Major Drainage: Options Report* (AECOM, 2016), (Appendix C).

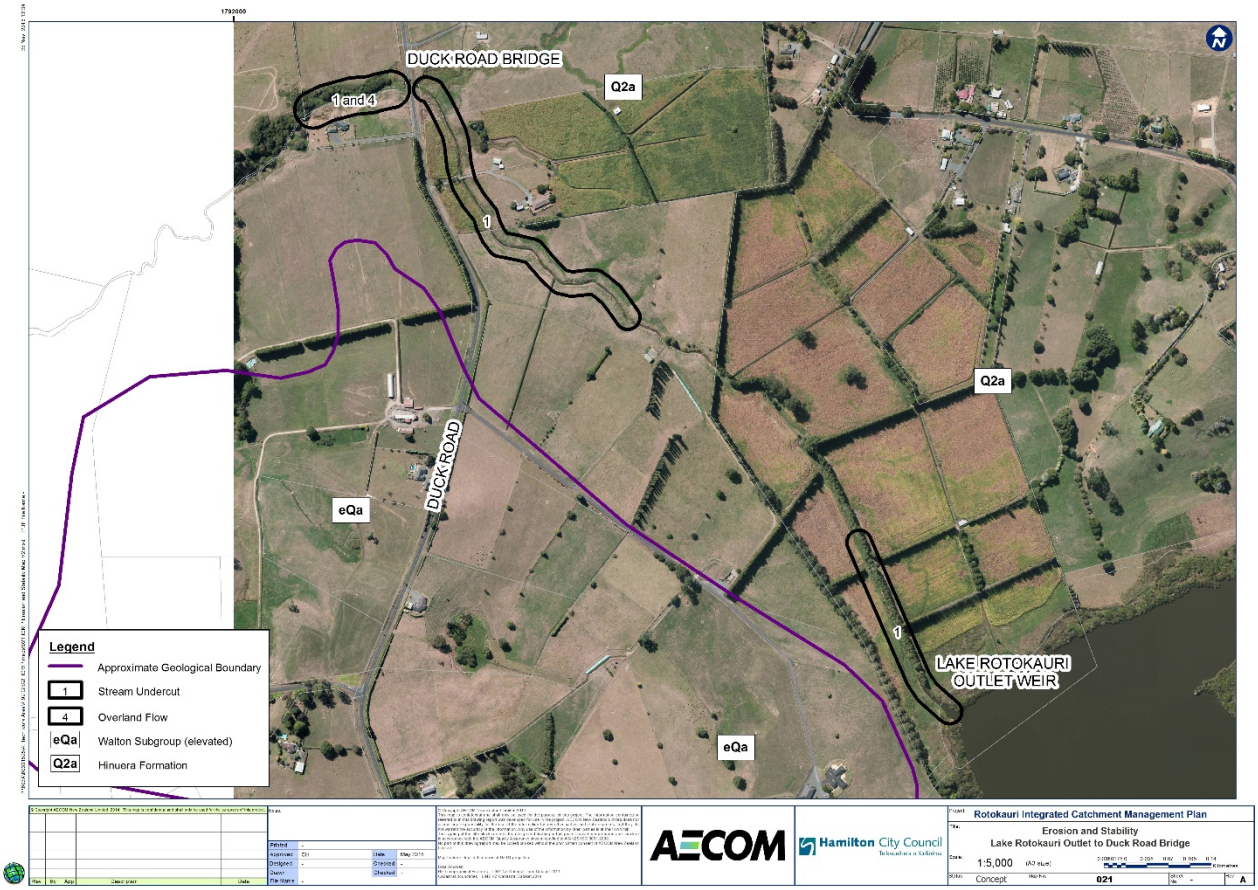

Figure 3-11: Ohote Stream between Rotokauri Lake Outlet and Duck Road Bridge

Subsequent assessment findings which specifically relate to the outcomes of the hydrologic modelling investigation and the proposed flood mitigation / major drainage solution, are also summarised below.

Key outcomes and assessment against relevant objectives and targets (Section 1.7)

A high level assessment of the main investigation and assessment outcomes against the relevant O&Ts in Section 1.7 of this document, is presented in Table 3.5 below. This is followed by an overall summary of the main assessment outcomes which follow through to Section 5 of this ICMP ('BPO, Solutions and Implementation'), as necessary.

Table 3-5: Assessment of receiving environment issues against relevant O&Ts

Id	O&Ts	Assessment	Issue	Comment
SO5	Mauri of the catchment and waterbodies	This objective can be met through ecologically sensitive stream channel remediation and protection works where required	Predicted erosion effects in the Rotokauri Drain due to increased runoff volume and duration. In particular between Exelby Road outlet and Lake Rotokauri Also, potentially, in the southern tributary of the Ohote Stream between Lake Rotokauri and Duck Road Bridge (subject to ongoing monitoring and remediation works if required)	The proposed stream channel remediation and protection works between Exelby Road outlet and the lake reserve would address the main area of concern (to be finalised in design development) Remedying existing erosion hot spots will also improve water quality and overall stream health through reducing suspended solids and associated adverse ecological effects
SO6	Stormwater effects on receiving environment	This objective can be met through ecologically sensitive stream channel remediation and protection works where required	As per above	As per above
SO11	Resource consent compliance (HCC CSDC)	This objective can be met through avoiding or otherwise minimising adverse scour, erosion and sedimentation deposition effects. Also through undertaking measures to remedy or mitigate these effects where identified	As per above This would contravene the HCC CSDC and the requirements for catchment management plan approval	As per above
CS1	Rotokauri Structure Plan	This objective can be met through ecologically sensitive stream channel remediation and protection works where required	Potential inconsistency with the overarching vision, objectives, policies and guiding principles of the RSP	The proposed stream channel remediation and protection works between Exelby Road outlet and the lake reserve, is consistent with the RSP (to be finalised in design development)

Id	O&Ts	Assessment	Issue	Comment
CS2	Key stakeholder engagement	This objective can be met through ongoing engagement and collaboration with key stakeholders	Consultation and collaboration with private landowners, WDC, WRC/ICM and WRC/RUD is essential for gaining access to monitoring and erosion hot spot areas. Also for coordinating remediation and protection works, and securing funding mechanisms	Engagement with the landowner between Exelby Road outlet and the lake reserve, as well as WDC/ICM and WDC/RUD is required to establish administrative mechanisms for addressing the observed erosion issues
CS3	Ecological protection and enhancement	This objective can be met through ecologically sensitive stream channel remediation and protection works where required	Predicted erosion effects in the Rotokauri Drain due to increased runoff volume and duration. In particular between Exelby Road outlet and Lake Rotokauri. Also, potentially, in the southern tributary of the Ohote Stream between Lake Rotokauri and Duck Road Bridge (subject to ongoing monitoring and reactive remediation works if required)	The proposed stream channel remediation and protection works between Exelby Road outlet and the lake reserve would address the main area of concern (to be finalised in design development) Remedying existing erosion hot spots will also improve water quality and overall stream health through reducing suspended solids and associated ecological effects
CS7	Catchment development	This objective can be met through ecologically sensitive stream channel remediation and protection works where required	As per above	As per above
CS8	Catchment monitoring and information gathering	This objective can be met through ongoing stream channel monitoring as per technical assessment recommendations	There are significant potential adverse effects associated with increased runoff volume and duration, particularly between Exelby Road outlet and the lake reserve. The southern tributary of the Ohote Stream also needs to be monitored and reactive remediation works undertaken if required	Ongoing monitoring, as per technical assessment recommendations, will be essential in responding to any adverse erosion effects

Summary of Assessment and Observations

In addition to the above assessment findings, a summary of the remaining findings relating to stream channel erosion and potential volumetric effects is presented below. These specifically relate to the hydrologic modelling investigation and the proposed flood mitigation / major drainage solution discussed in Section 3.2.1 above (AECOM, 2016).

Following implementation of the stormwater management solution the effects on the Ohote Stream, as a result of development in line with the solution, are expected to be no more than minor. Peaks flows from development will be reduced to a larger extent than would otherwise be required if Lake Rotokauri were not present. Similarly, extended detention and release of flows will occur in the lake and preceding storage system to a greater extent than would have otherwise been provided by conventional 24 hour extended detention.

The most notable potential effect of climate change and development will be an increase in runoff volume and duration. Lake Rotokauri is an efficient storage basin and attenuator so the Ohote Stream already receives significantly attenuated flows over long durations, if not constantly. In this case, increased volumes will result in an increase in the overall discharge rate.

The Ohote stream may therefore experience some changes in form due to increased runoff volume. This is unlikely to occur as result of increased volume and active scour due to development, because the lake's attenuation removes the peaks from development discharges. Possible changes are more likely to be due to higher base flows than the stream is currently subject to, from multiple factors, which may change the channel forming flow.

The stream is understood to be in stable condition and changes in stream form may not necessarily occur quickly enough for adverse effects to be evident (i.e. slow channel form changes and vegetation adaptation). Ongoing monitoring and assessment to determine concept level projects to mitigate potential adverse effects, and prepare the stream for cumulative volume effects where necessary, is therefore recommended throughout catchment development.

Possible methods to reduce runoff volume are to store it for other uses, or dispose of it by soakage. Widespread soakage in the catchment is not considered to be feasible (Beca, 2016), but there may be some opportunity for localised soakage on a case by case basis. Storage and reuse of rainwater in on-lot rainwater tanks may also be encouraged but typically cannot be relied on to affect the overall scale of the drainage solution. Unless comprehensive soakage is available, increased runoff volume is a typical outcome of any development.

In summary there are some significant stream channel erosion issues which currently exist in the wider catchment area. These issues will be exacerbated if not adequately addressed through stream channel remediation and protection works. In this regard the Morphum Environmental Ltd assessment has made various recommendations, particularly in relation to the observed channel erosion and susceptibility between Exelby Road outlet and the lake reserve (reaches 9 and 10). These recommendations, inclusive of ecologically sensitive design requirements, are considered to reflect the BPO/management solution and are carried forward to Section 5 of this ICMP, along with proposed measures to resource this solution from within the upstream 'area of benefit' (Southern Development Area).

It is also concluded that soakage where feasible, and storage and reuse of rainwater in on-lot rainwater tanks, should be encouraged. However, these measures will not affect the overall scale of the proposed major drainage solution as discussed in Section 3.2.1 above.

Provided the existing stream channel erosion issues are addressed through adequate remediation and protection works, and the areas which are susceptible to erosion addressed through ongoing monitoring, assessment and protection works where necessary, the relevant O&Ts assessed in Table 3-5 will be met.

Ongoing stream channel monitoring and assessment, as recommended through the technical assessments, is further addressed in Section 5.5.3 (*Future Actions*) and in Section 8.2 (*Proposal for Catchment Monitoring*) of this ICMP.

3.2.4 Water quality and treatment

Most of the information presented in this section is from the technical reports listed below. These provide complete information, including the detailed methods and assumptions that were applied in generating the information:

- Streamlined Environmental Ltd, 2015. *Rotokauri ICMP - Broad Scale Water Quality Assessment* (Appendix C)
- Morphum Environmental Ltd, 2016. *Rotokauri ICMP - Water Quality Treatment Concept Development Report* (Appendix C).

The general scope of the investigations and assessment work included a broad-based water quality assessment relating to the effects of urbanisation on natural water bodies within and beyond the Rotokauri Catchment. This included a desktop review of previous water quality assessments (Cooke and Parkyn 2005, Story and Macaskill 2007, Diffuse Sources Ltd 2008, Sharma 2011), along with field studies to collect baseline data, a desktop study on nutrient yields, and simulation modelling of the potential effects of development and urbanisation on the trophic state of Lake Rotokauri.[31] This work was undertaken by Streamlined Environmental Ltd.

The first objective was to predict potential deterioration in water quality from urban development without any mitigations in place. From a comparison with current state data, realistic water quality targets and contaminant load limits were then determined for the main receiving waterbodies - Lake Rotokauri, Lake Waiwhakareke, the Rotokauri Drain and the Ohote Stream. These water quality targets and contaminant load limits were then used to inform stormwater treatment and infrastructure design requirements. In particular through identifying which contaminants are most limiting and the likely quantum of treatment required, in order to ensure the limits are not breached and the targets met.[32]

This work was followed by developing a stormwater quality treatment concept to meet the targets and contaminant load limits identified, and to integrate with the proposed major drainage and central corridor solution. In this regard a central wetland treatment concept was initially developed by the ICMP project team to generally align with the RSP concept of a 'Central Green Corridor' and catchment specific O&Ts (Section 1.7). This concept was then advanced by Morphum Environmental Ltd who worked up the detail of the concept, inclusive of upstream source controls (on-lot and sub-catchment) to achieve an overall treatment solution for the catchment.

In relation to the methods applied to the water quality assessment (Streamlined Environmental Ltd, 2016), some key observations and tags include:

- Three catchment scenarios were considered – the 'existing baseline', the 'developing catchment situation' and the 'mature catchment situation' (i.e. the fully urbanised situation).
- The 'existing baseline' relates to the current water quality status of the main receiving waterbodies and, from a national and regional policy perspective (and HCC CSDC perspective), it informs what must be protected i.e. not further degraded as a consequence of development and new stormwater discharges in the catchment. Note, this is not optional or relative to other contributors in the wider catchment area. It is the baseline from which to determine the impact of future stormwater discharges in the catchment.

[31] Simulation modelling was undertaken for Lake Rotokauri only. Desktop modelling, using a variety of information sources, was undertaken for Lake Waiwhakareke to predict nutrient loads from the upstream development area (Streamlined Environmental Ltd, 2016).

[32] These water quality targets and contaminant load limits relate specifically to urban development and new stormwater discharges within the catchment. In particular they are to ensure that new stormwater discharges do not result in a further deterioration of water quality in receiving water bodies, and contribute to restoration and protection of these waterbodies over time (as per the statutory, policy and planning provisions outlined in Section 1.3 and the O&Ts in Section 1.7).

- The 'developing catchment situation' relates to subsoils being exposed during development. In this situation contaminants such as Total Suspended Solids (TSS) and the nutrient Phosphorous (P), the most limiting contaminant for the two lake receiving waterbodies (discussed below), are mobilised and exported to receiving waterbodies if not treated via appropriate erosion and sediment control measures. These measures may include sediment retention ponds and flocculation systems which are applied during bulk earthworks, or appropriate on-lot controls during housing construction.
- For the 'mature catchment situation' an assessment method applicable to urban nutrient sources was applied (refer to Section 7.3 of the technical report). This involved obtaining the latest estimates of Nitrogen (N) and P exports from mature (fully urbanised) catchments which were sourced from the new edition of the NIWA 'Urban Runoff Data Book' (i.e. estimates derived from 454 national and international data sets). These estimates were expressed as 10%ile, 50%ile and 90%ile loads and predictions made of resulting phytoplankton (chlorophyll a) concentrations in the lake to determine sensitivity.
- Sources of P in urban catchments include (but are not limited to) phosphates in soaps and detergents (for example vehicle wash down areas), lawn and garden fertilisers, inadvertent wastewater network connections and activity specific 'hot spots' in commercial and industrial areas where P loads often measure the highest.[33]

The water and sediment quality targets determined for the catchment are presented in Table 3-6 below. These targets relate to the main contaminants of concern, i.e. copper (Cu), zinc (Zn), N and P, and reflect a treatment efficiency that is necessary to avoid further degradation of water and sediment quality in the main receiving waterbodies.

Table 3-6: Summary of water and sediment quality targets

Parameter	Units	Cu	Zn
Water quality targets			
USEPA CMC (acute, stormwater)	µg/L	4.3	42
ANZECC (chronic, baseflow)	µg/L	1.4	8
Sediment quality targets			
ISQG Low (baseflow)	mg/kg	65	270
ISQG High (baseflow)	mg/kg	200	410
Nutrient treatment targets			
Phosphorus	Removal rate > 70 (%)[34]		

With regard to the proposed central sub-catchment wetlands (Morphum Environmental Ltd, 2016), some key observations and tags include:

- Wetlands are located within the central drainage corridor where possible for efficiency of land use (integrating with the flood storage and conveyance footprints), aesthetics, amenity and ecological linkages.
- Wetlands are off line to main catchment drainage flowpaths to ensure phosphorous removal (in addition to other contaminant removal) is achieved before discharge to a central base flow watercourse.
- Wetlands are to be specifically designed for enhanced phosphorus removal. This includes average wetland normal water depths of 300 mm, and protection (wetlands offline) up to the predicted 2 year ARI flood level

[33] As per Hamilton specific stormwater characterisation datasets from 1999 and 2015/16.

[34] Phosphorous is considered to be the main nutrient to target (Streamlined, 2015).

to ensure stable shallow water levels and low velocities for enhanced phosphorous performance and plant health.

- Provision of wetland treatment for 100% of the water quality flows from the contributing catchments. This will achieve an estimated 50% phosphorus removal catchment wide, with the remaining treatment to be achieved upstream at source.[35] This solution will also meet all other water and sediment quality targets for the catchment.
- The central wetland treatment solution has included consideration of the following integrations:
    - Balancing modelled flood storage requirements so that the same or greater flood storage cross-section is available beneath design flood levels with wetlands
    - Flexibility to adjust sub catchment wetland locations along the central corridor to fit with development patterns.

With regard to upstream source controls (on-lot and sub-catchment) to achieve full treatment requirements for the catchment, a 'means of compliance' solution has been developed with the following considerations:

- A toolbox approach with several compliant scenarios available as a treatment hierarchy.
- Utilisation of rain water harvesting and non-potable water reuse.
- Utilisation of conveyance swales where catchment size is small enough to achieve residence time and treatment credit.
- A preference for bio-retention rain gardens or wetlands to achieve a high level of phosphorous removal from higher load areas.[36]
- Provision for alternative 'means of compliance' to achieve an average 40% phosphorous removal upstream of wetlands integrated with development form.[37]

It is considered that the proposed solutions will contribute to an overall integrated solution that can achieve the water quality targets for the catchment whilst providing for multiple outcomes through development of the catchment.[38]

Figure 3-12 below depicts indicative central sub-catchment wetlands integrating with the central drainage corridor (Southern Development Area). It also shows central sub-catchment wetlands upstream of the central corridor where these are otherwise constrained by space limitations. Central treatment within the Waiwhakareke Development Area and the Lake Rotokauri Development Area are also shown.

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[35] This will require a further 40% phosphorous removal prior to discharges reaching the wetlands. The calculation of the residual 40% requirement is based on the treatment train formula presented in the NZTA *Stormwater Treatment Standard for State Highway Infrastructure* (2010). This makes allowance for the reducing effectiveness to remove pass down loads through devices in series, and the dilution of accumulating clean and dirty water reaching the downstream device.

[36] Where bio-retention raingardens are applied, these will need to be designed to withstand the relatively high groundwater constraints of the catchment and be located to target high contaminant load areas over lower load areas as priority.

[37] If/when treatment is provided at source through lot scale treatment devices, these can be mandated as part of the lot titles and covenants will need to be legally binding in the instance that they are part of the overall stormwater management treatment suite. This will need to include maintenance obligations to ensure that long term performance is maintained. It is further noted that any water quality improvements which are legitimately attributable to lot scale treatment devices will need to be represented through calculations.

[38] Soakage/infiltration systems are not included as a method of treating stormwater due to known catchment constraints and receiving water sensitivities. These include a combination of high groundwater levels, groundwater flows and the existing nutrient enriched trophic status of both lakes.

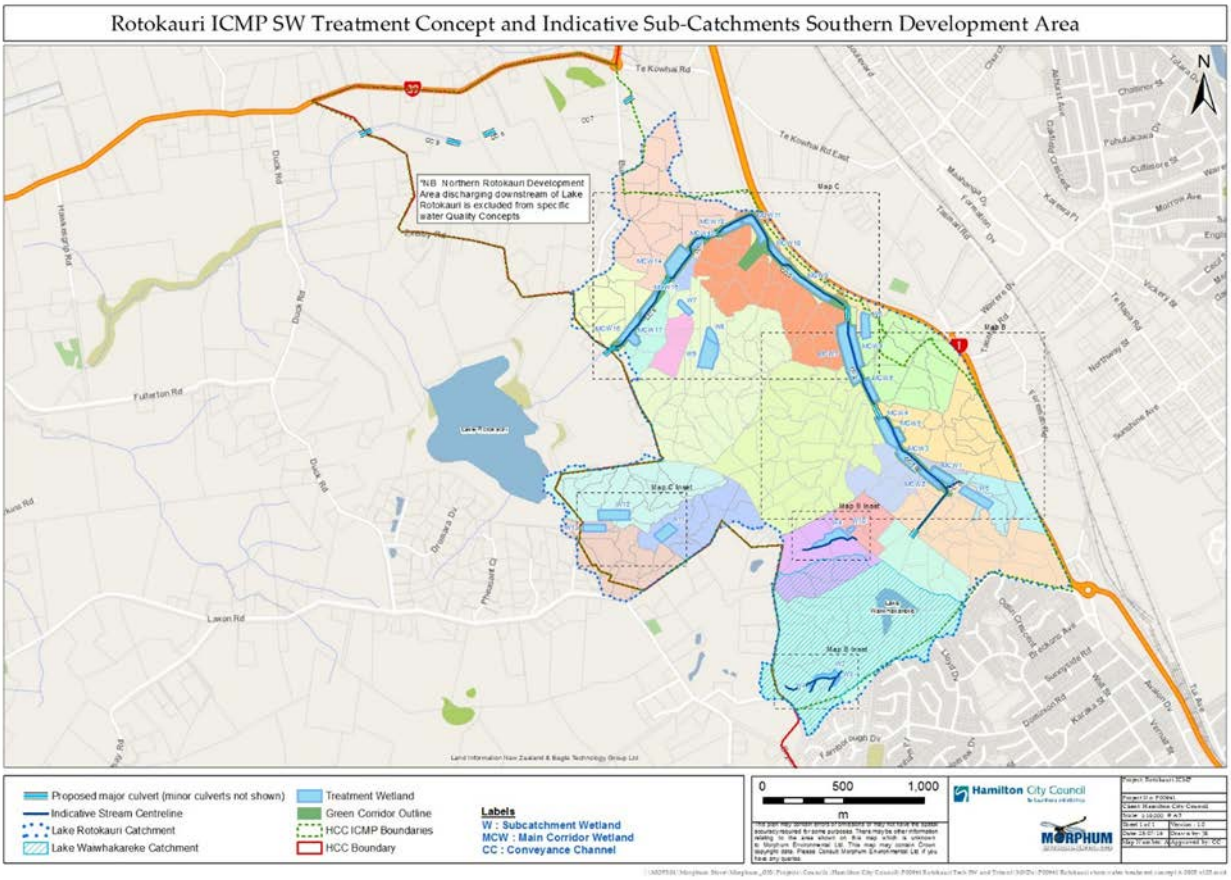

Figure 3-12: Central sub-catchment treatment wetlands - Southern Development Area

In addition to the above figure, Figure 3-13 indicates the integration concept of balancing flood storage volume lost below the two year ARI water level and compensating for new storage above.

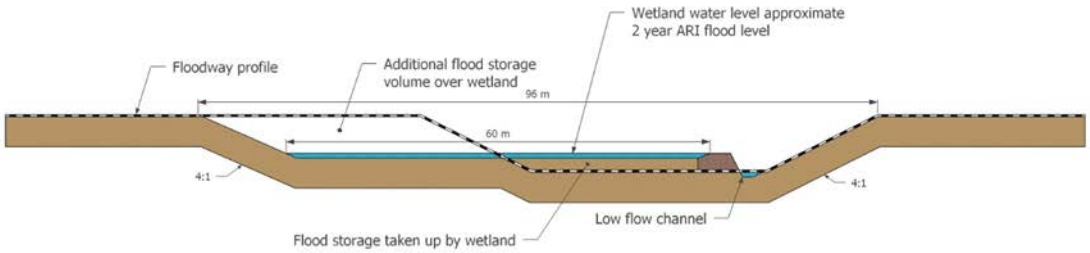

Figure 3-13: Central corridor wetland concept section (Morphum Environmental Ltd)

Key outcomes and assessment against relevant objectives and targets (Section 1.7)

A high level assessment of the main investigations and assessment outcomes against the relevant O&Ts in Section 1.7 of this document, is presented in Table 3.7 below. This is followed by an overall summary of the main assessment outcomes which follow through to Section 5 of this ICMP ('BPO, Solutions and Implementation'), as necessary.

Table 3-7: Assessment of water quality issues against relevant O&Ts

Id	O&Ts	Assessment	Issue	Comment
SO1	Application of natural systems in the urban form	This objective can be met through establishing the proposed stormwater treatment solution, in particular through integrating central sub-catchment wetlands with the flood conveyance footprints to create a central green corridor and linking primary drainage/green corridors	Historically, natural systems have not been applied in the urban form and this has resulted in significant, and often irreversible, decline in the natural environment and the mauri of waterbodies (e.g. biodiversity values, loss of stream habitat and degradation)	The proposed stormwater treatment solution, inclusive of central sub-catchment wetlands and creation of an open space green corridor network, would address this issue (to be finalised in design development)
SO3	Quality of discharges to the existing stormwater network	This objective can be met through design development of the proposed stormwater treatment solution, inclusive of adequate source controls and central sub-catchment wetlands. High risk facility sites must further be assessed on a site/activity specific basis and appropriate controls determined through relevant resource/building consents and industry codes/best practice	Stormwater discharges include a variety of contaminants that, in sufficient concentration and/or exposure, can adversely impact human and ecosystem health. Discharges from high risk facility sites, or accidental and/or deliberate discharges of contaminants to the stormwater network, increase this risk	Design development of the proposed stormwater treatment solution, and addressing high risk facility sites on a site/activity specific basis, would address this issue (to be finalised in design development)
SO5	Mauri of the catchment and waterbodies	This objective can be met through establishing the proposed stormwater treatment solution and meeting the catchment specific water and sediment quality targets	A deterioration in the water and sediment quality of receiving waterbodies is predicted to occur without adequate stormwater treatment in place and if the catchment specific water quality targets are not met	The proposed stormwater treatment solution, inclusive of central sub-catchment wetlands and upstream source controls, would address this issue (to be finalised in design development)
SO6	Stormwater effects on receiving environment	As per above	As per above	As per above

Id	O&Ts	Assessment	Issue	Comment
SO9	Minimising infrastructure requirements	This objective can be met through establishing the proposed stormwater treatment solution and integrating central sub-catchment wetlands with the flood conveyance footprints (central drainage corridor)	Significant treatment requirements in the development area along with associated land area requirements and costs (capital and ongoing operation and maintenance costs)	Integrating central sub-catchment wetlands with the flood conveyance footprints will help to minimise infrastructure requirements along with associated land area requirements and costs (capital and ongoing operation and maintenance costs)
SO11	Resource consent compliance (HCC CSDC)	This objective can be met through establishing the proposed stormwater treatment solution and meeting the catchment specific water and sediment quality targets	A deterioration in the water and sediment quality of receiving waterbodies is predicted to occur without adequate stormwater treatment in place and if the catchment specific water quality targets are not met This would contravene the HCC CSDC and the requirements for catchment management plan approval	The proposed stormwater treatment solution, inclusive of central sub-catchment wetlands and upstream source controls, would address this issue (to be finalised in design development)
SO12	Network design for planned and unplanned events	This objective can be met through considered development planning and design development of the proposed stormwater treatment solution, inclusive of adequate source controls and central sub-catchment wetlands. High risk facility sites must further be assessed on a site/activity specific basis and appropriate controls determined through relevant resource/building consents and industry codes/best practice	Risk of accidental or deliberate contaminant spills to the stormwater network, for which treatment systems are either not designed to treat or exceed system capacity. These incidents can adversely impact on the network/treatment systems and the receiving environment which must ultimately be protected	Development planning, design development of the proposed stormwater treatment solution, and addressing high risk facility sites on a site/activity specific basis, would address this issue (to be finalised in design development)
SW3	Resilience	As above	As above	As above

Id	O&Ts	Assessment	Issue	Comment
CS1	Rotokauri Structure Plan	This objective can be met through establishing the proposed stormwater treatment solution, meeting the catchment specific water and sediment quality targets, and integrating central sub-catchment wetlands with the flood conveyance footprints to create a central green corridor and open space network	Potential inconsistency with the overarching vision, objectives, policies and guiding principles of the RSP	The proposed stormwater treatment solution and integrating this with the flood conveyance footprints, is consistent with the RSP (to be finalised in design development)
CS2	Key stakeholder engagement	This objective can be met through ongoing engagement and collaboration with key stakeholders	Consultation and collaboration with private landowners and developers is essential in coordinating central sub-catchment wetlands and integrating with the flood conveyance footprints	HCC and the development community will need to work together to coordinate, design and establish the proposed stormwater treatment solution in combination with the central drainage corridor and other 'green corridor' design elements as required (e.g. boardwalks, footpaths, cycleways)
CS6	Protecting water quality	This objective can be met through establishing the proposed stormwater treatment solution, inclusive of central sub-catchment wetlands and upstream source controls to meet the catchment specific water and sediment quality targets	A deterioration in the water and sediment quality of receiving waterbodies is predicted to occur without adequate stormwater treatment in place and if the catchment specific water quality targets are not met	The proposed stormwater treatment solution, inclusive of central sub-catchment wetlands and upstream source controls, would address this issue (to be finalised in design development)

Id	O&Ts	Assessment	Issue	Comment
CS7	Catchment development	This objective can be met through establishing adequate site controls during development, i.e. for bulk earthworks, provision of services and during housing construction. Best practice erosion and sediment controls, inclusive of flocculation systems, will be required to meet the catchment specific water and sediment quality targets	A deterioration in the water and sediment quality of receiving waterbodies is predicted to occur without adequate site controls in place during development, and if the catchment specific water quality targets are not met.	The establishment and ongoing maintenance of best practice site controls will be required throughout the development stages of the catchment
CS8	Catchment monitoring and information gathering	This objective can be met through ongoing water and sediment quality monitoring both during and post development, as per the technical assessment recommendations	A deterioration in the water and sediment quality of receiving waterbodies is predicted to occur without adequate stormwater treatment in the development area and if catchment specific water quality targets are not met	Ongoing monitoring, as per technical assessment recommendations, will be essential in gauging the effectiveness of stormwater treatment systems in protecting receiving water quality. Also, undertaking regular inspections and maintenance of treatment systems to sustain performance

Summary of Assessment and Observations

An overall summary of the main assessment outcomes is presented below.

Key water quality assessment outcomes:

- Water quality targets need to reflect national and regional policy settings, including the 'Vision and Strategy for the Waikato River' (RPS) which is to restore and protect the Waikato and Waipa Rivers and their tributaries. Further degradation of waterbodies, or even maintaining the current state, is not consistent with the Vision and Strategy.
- N and P are the principle contaminants of concern in relation to urbanisation in the catchment. Based on model outputs, N and P (particularly P) are the main contaminants that will require mitigation both during and post-development. Phytoplankton concentrations in Lake Rotokauri will increase both during the development phase and as a result of runoff from the urbanised catchment without adequate site controls (during development) and stormwater treatment (post development) respectively. The modelling suggests that a treatment efficiency of > 70% will be necessary to avoid further degradation. Any improvement on this efficiency could lead to a modest improvement of water quality (less phytoplankton), which would satisfy the policy intent.
- Changes in nutrient load inputs are predicted to have a greater effect on lake water quality than changes in catchment hydrology. The modelling sensitivity analysis has shown that phytoplankton levels are relatively

insensitive to hydrology, but nevertheless, understanding the hydrology remains the largest impediment to fully understanding Lake Rotokauri dynamics.[39]

- Concentrations of most typical/priority and emerging urban-derived contaminants (i.e. heavy metals, persistent organic pollutants (POPs), polybrominated diphenyl ether (PBDE) flame-retardants, wastewater markers) were below guideline values (for both applicable sediment-associated and dissolved forms) above which ecological effects would be expected, other than for zinc in Lake Rotokauri sediment and Rotokauri Drain (dissolved).
- Where guidelines were absent, those contaminants were detected at low concentrations compared to those recorded elsewhere. In addition, many were below detection limits.
- The elevated zinc concentrations most likely reflect historic and current facial eczema treatments. Urban associated increases in zinc are likely to be balanced by the decline in zinc associated with facial eczema treatments. The use of stormwater treatment devices will further ensure that urban derived zinc concentrations are maintained at a practicable minimum, and will not exceed applicable guidelines.
- Several common wastewater markers were detected (likely from septic tanks) but are likely to be eliminated as wastewater is reticulated to Pukete WWTP.
- Lake Rotokauri is a sink for metals, with dissolved concentrations generally much lower downstream than upstream of the lake.
- Outputs from preliminary contaminant load modelling suggest that copper and zinc concentrations would increase by more than 7-fold in some areas of the catchment if not effectively treated. Increases of this magnitude would exceed guidelines for protection of aquatic organisms without stormwater treatment. Because of the effects of the lake (sink for metals) specific treatment targets for metals (in addition to those for phosphorus) have not been proposed, but rather rely on upstream stormwater treatment and sediment quality monitoring to ensure levels of copper and zinc in the lake sediments do not approach the ISQG-High.
- Aquatic metal guidelines should be retained and the target should be that water quality targets for all receiving waterbodies be set to meet both acute and chronic effects.
- To ensure that water quality targets are met, a schedule of contaminant monitoring under base flow conditions is recommended to be undertaken periodically from development initiation, throughout development, and post-development. [40]
- Stormflow monitoring should also be considered around significant design changes[41] to assess the effectiveness of stormwater treatment devices and potential acute effects.

Key water quality treatment outcomes:

- A proposed concept for stormwater quality treatment, including integration with other catchment solutions and mitigation strategies (flooding, erosion and ecology), has been developed. This concept is generally consistent with the RSP (Central Green Corridor) and achieves the water quality targets determined through the water quality assessment, in particular removing >70% of phosphorous from stormwater prior to discharge to receiving waterbodies.

[39] Matters relating to lake hydrology are further addressed in Section 5.5.3 (Future actions) and Section 8.2 (Proposal for catchment monitoring).

[40] A schedule of recommended contaminant monitoring is included in Section 8.2 (Proposal for catchment monitoring).

[41] For example, following completion of significant catchment staging and establishing permanent treatment systems, or if/where significant design changes in permanent treatment systems have occurred.

- The concept includes a treatment train approach with sub-catchment scale wetlands in conjunction with upstream means of compliance controls for development to provide source treatment for enhanced phosphorous removal.
- Central sub-catchment wetlands must be integrated into the proposed floodways, where possible, and designed as linear green corridors. Wetlands must be constructed off line within the base of these green corridors. These will provide efficient land use and robust treatment with protection from uncontrolled flow velocities. Flood storage will be provided within the corridor for infrequent flood events with the wetlands being protected from all events less than the estimated 2 year ARI flood level.
- It is considered that the concept will contribute to an integrated solution that can achieve the water quality targets for the catchment whilst providing for multiple outcomes through development of the catchment.
- The proposed concept includes provision of offline wetland treatment for the whole of the Southern Development Area comprising 20.35 Ha of wetlands in total, i.e.
    - 17 Main Corridor Wetlands (MCW) within the 'Central Green Corridor' with an area of 11.7Ha
    - 13 Sub-catchment Wetlands outside the Central Green Corridor with an area of 8.6Ha.
- The proposed central wetland treatment in the Waiwhakareke Development Area (W1, W2 and W3) will also combine to improve bank stability and mitigate potential erosion issues relating to development in this area.[42]

In summary there are significant water quality issues relating to growth in the catchment, both during and post development. These issues must be avoided, or otherwise minimised, through provision of adequate site controls during development and through permanent stormwater treatment infrastructure and source controls in the post development situation. The proposed treatment solution provides a credible means of achieving this and, in doing so, meets the relevant O&Ts assessed in Table 3-7 above.

Regular receiving environment monitoring to gauge the ongoing effectiveness of the proposed treatment solution in meeting catchment specific water and sediment quality targets will be required, as will regular inspections and maintenance of the central sub-catchment wetlands and source controls to sustain optimum treatment performance.[43] This is further addressed in Section 5.5.3 (*Future Actions*) and in Section 8.2 (*Proposal for Catchment Monitoring*) of this ICMP.

It is finally observed that the landscape and urban design opportunity associated with the Central Green Corridor, which encapsulates the floodway extent and central treatment elements, will be considerable. From a RSP perspective it presents a range of character opportunities, from recreation and amenity areas in the built up town centre to more naturalised zones with cycle and walking routes. A concept impression of the central treatment wetlands, and how they may feature in context to adjacent land-use, is provided in Figure 3-14 below.

[42] The exclusion of stock from the main watercourses would further help to improve bank stability and reduce the mobilization of suspended solids and related water quality issues in this area.

[43] As determined through the technical assessments and in conjunction with HCC CSDC monitoring programme and HCC SMP (for inspections and maintenance activities) to achieve all round efficiencies.

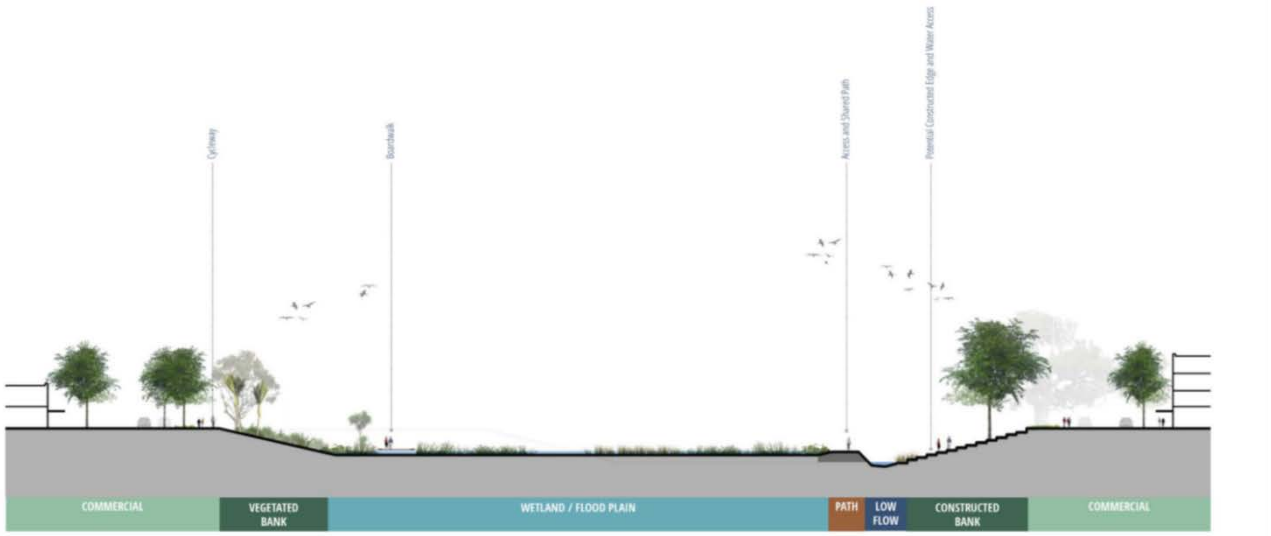

Figure 3-14: Central Green Corridor (concept plan developed by Morphum Environmental Ltd)

3.2.5 Aquatic, terrestrial and riparian ecology

Most of the information presented in this section is from the technical report titled: *Rotokauri ICMP – Ecological Assessment and Inputs* (Kessels Ecology, 2016), (Appendix C). This report provides complete information, including the detailed methods and assumptions that were applied in generating the information.

The general scope of the work undertaken included ecological investigations and assessment. It focussed on understanding the ecological conditions and values within the general vicinity of the catchment and the implications for stormwater management in the Southern Development Area.[44] In particular it assessed the ecological implications of the proposed stormwater solution and the conceptual design elements of the main infrastructure. This factored inputs and design elements from other disciplines as outlined in Sections 3.2.1 – 3.2.4 above. It also identified BPOs for maintaining and enhancing ecological values and ultimately contributing to the overall stormwater management solution for the catchment.

In relation to the methods applied, some key observations and tags include:

- The realignment of the Rotokauri Drain to establish the Central Green Corridor will involve significant deepening and widening of the existing drain and associated destruction of habitat. However, the proposed mitigation and restoration initiatives will eventually compensate for any adverse effects of construction, and will contribute towards greater ecological values in the catchment (discussed further below).
- The conceptual design of the proposed major drainage solution was undertaken by AECOM as detailed in the report titled *Rotokauri ICMP - Major Drainage: Preferred Option & Stormwater Management Solution Report* (2016), (Appendix C).
- The conceptual design of the proposed central treatment solution, inclusive of extended flood storage and conveyance footprints within the central corridor, was undertaken by Morphum Environmental Ltd as

[44] As of 2015-16 when the ecological investigations and assessment work was undertaken, there was not any foreseeable development being planned in the Northern Development Area.

detailed in the report titled *Rotokauri ICMP - Water Quality Treatment Concept Development Report* (2016), (Appendix C).

- The investigations and assessment work undertaken included:
    - Review and synthesis of relevant literature and existing databases
    - Field surveys at various sites along the Rotokauri Drain
    - GIS analysis and mapping of land use, key ecological features, watercourses and reserves
    - Assessment of ecological significance using WRC's RPS criteria for assessing sites of significant indigenous vegetation and habitats of indigenous fauna, and
    - Development of BPOs for maintaining and enhancing ecological values, inclusive of concept design requirements to help inform the overall stormwater management solution for the catchment.

Figure 3-15 below shows the combined major drainage and central treatment infrastructure in the MPD / fully developed catchment situation. Of particular note the 'main storage and conveyance channel' and the 'main corridor wetlands' combine to depict the Central Green Corridor. The 'conveyance swales' depict the primary drainage corridors, also referred to as 'Secondary Green Corridors'.

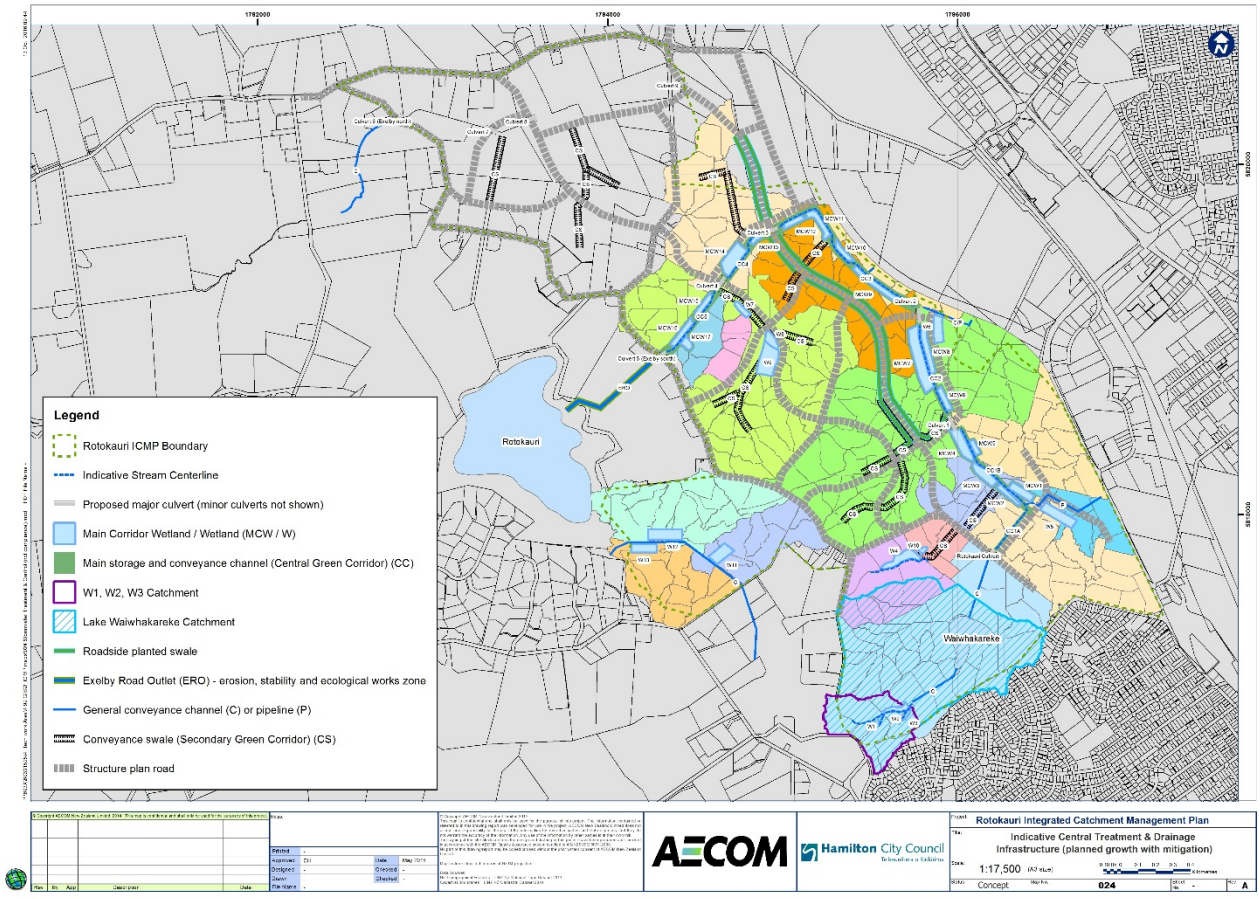

Figure 3-15: Major drainage and central treatment infrastructure - Southern Development Area

<u>Key outcomes and assessment against relevant objectives and targets (Section 1.7)</u>

A high level assessment of the main investigations and assessment outcomes against the relevant O&Ts in Section 1.7 of this document, is presented in Table 3.8 below. This is followed by an overall summary of the main assessment outcomes which follow through to Section 5 of this ICMP ('BPO, Solutions and Implementation'), as necessary.

Table 3-8: Assessment of ecological issues against relevant O&Ts

Id	O&Ts	Assessment	Issue	Comment
SO1	Application of natural systems in the urban form	This objective can be met through establishing the overall stormwater solution, inclusive of the Central Green Corridor and Secondary Green Corridors to create an open space blue/green corridor network	Historically, natural systems have not been applied in the urban form and this has resulted in significant, and often irreversible, decline in the natural environment and mauri of waterbodies (e.g. biodiversity values, loss of stream habitat and degradation)	The proposed stormwater solution, inclusive of the Central Green Corridor and Secondary Green Corridors to create an open space blue/green corridor network, would address this issue (to be finalised in design development including eco-sensitive design requirements)
SO5	Mauri of the catchment waterbodies	As per above	As per above	As per above
SO6	Stormwater effects on receiving environment	As per above	As per above	As per above
SO11	Resource consent compliance (HCC CSDC)	This objective can be met through establishing the overall stormwater solution and meeting multiple HCC CSDC requirements. In particular the requirement for CMPs to determine integrated catchment management solutions based upon BPOs	There are significant ecological issues to be addressed (mitigated) through eco-sensitive infrastructure design and ecological protection and enhancement initiatives throughout the catchment Failure to do so would contravene the HCC CSDC and the requirements for catchment management plan approval	The proposed stormwater solution, inclusive of the Central Green Corridor and Secondary Green Corridors to create an open space blue/green corridor network, would address this issue (to be finalised in design development including eco-sensitive design requirements)
CS1	Rotokauri Structure Plan	This objective can be met through establishing the overall stormwater solution, inclusive of the Central Green Corridor and Secondary Green Corridors to create an open space blue/green corridor network	Potential inconsistency with the overarching vision, objectives, policies and guiding principles of the RSP	The proposed stormwater solution, inclusive of the Central Green Corridor and Secondary Green Corridors to create an open space blue/green corridor network, is consistent with the RSP (to be finalised in design development including eco-sensitive design requirements)

Id	O&Ts	Assessment	Issue	Comment
CS2	Key stakeholder engagement	This objective can be met through ongoing engagement and collaboration with key stakeholders	Consultation and collaboration with private landowners, developers, WRC, WDC, LRMC and WAG is essential in coordinating ecological protection and enhancement initiatives in the catchment	HCC and key stakeholders will need to work together to coordinate, design and establish the proposed stormwater solution, inclusive of the Central Green Corridor and Secondary Green Corridors to create an open space blue/green corridor network
CS3	Ecological protection and enhancement	This objective can be met through establishing the proposed stormwater solution, inclusive of the Central Green Corridor and Secondary Green Corridors to create an open space blue/green corridor network This includes restoring and creating habitat to resemble historic conditions, where possible, consistent with other ecological protection and enhancement initiatives in the catchment (Lake Waiwhakareke Natural Heritage Park)	The Rotokauri Catchment possesses significant ecological values, inclusive of a thriving banded kokopu population in the lower reaches of the Rotokauri Drain and black mudfish populations in modified tributary drains. The adverse impacts associated with habitat destruction, and/or instream degradation as a consequence of development, need to be avoided where practicable and otherwise minimised	The proposed stormwater solution, inclusive of the Central Green Corridor and Secondary Green Corridors to create an open space blue/green corridor network, would address this issue (to be finalised in design development including eco-sensitive design requirements)

Id	O&Ts	Assessment	Issue	Comment
CS7	Catchment development	This objective can be met through establishing adequate site controls during development, i.e. for bulk earthworks, provision of services and during housing construction. Best practice erosion and sediment controls, inclusive of flocculation systems, will be required to meet the catchment specific water and sediment quality targets Also by undertaking in-stream works in accordance with resource consent requirements and approved construction methods/plans, inclusive of fish relocation procedures/plans where applicable	A deterioration in the water and sediment quality of receiving waterbodies is predicted to occur without adequate site controls in place during development, and if the catchment specific water quality targets are not met. In-stream works associated with realignment of the Rotokauri Drain and the diversion of tributary drains / modified watercourses, will have significant short term impacts on the ecological values of the catchment	The establishment and ongoing maintenance of best practice site controls will be required throughout the development stages of the catchment In-stream works will need to be undertaken in accordance with resource consent requirements and approved construction methods/plans, inclusive of fish relocation procedures/plans where applicable The establishment of new watercourse alignments and ecological restoration initiatives is also required to mitigate the effects of development and meet national and regional policy requirements for ecological protection and enhancement
CS8	Catchment monitoring and information gathering	This objective can be met through ongoing water and sediment quality monitoring both during and post development Also through monitoring stream biodiversity post realignment of the Rotokauri Drain, and other modified watercourses where applicable, as per the technical assessment recommendations	A deterioration in the water and sediment quality of receiving waterbodies is predicted to occur, both during and post development, without adequate site controls and stormwater treatment in place The adverse impacts associated with habitat destruction, and/or instream degradation as a consequence of development, need to be avoided where practicable and otherwise minimised	Ongoing monitoring, as per technical assessment recommendations, will be essential in gauging the effectiveness of site controls and stormwater treatment systems in protecting receiving water quality Protecting and/or restoring significant ecological values, such as the thriving population of banded kokopu in the lower reaches of the Rotokauri Drain, or black mudfish populations in modified tributary drains, will need to be gauged and responded to accordingly

Summary of Assessment and Observations

An overall summary of the main assessment outcomes is presented below. This includes a breakdown summary of the conceptual design elements of the main infrastructure, and how these relate to the ecological values of the catchment (present and future). It also includes a summary of the ecological effects which are anticipated through development and how these effects should be mitigated.

Central Green Corridor (main storage and conveyance channel with main corridor wetlands)

- The creation of a central green corridor has the potential to restore indigenous vegetation to the area and enhance the ecological connectivity between lakes Rotokauri and Waiwhakareke. A central corridor incorporating a central stream channel, marginal floodplain wetlands and longitudinal stormwater treatment wetlands is proposed. This will improve biodiversity by providing habitat for indigenous flora and fauna and will help to buffer the water quality in the central stream channel from adjacent land use and development.
- It is recommended that a defined stream channel is created within the central corridor so that aquatic habitat is available at low flows. The width of the stream channel should be similar to the current stream width ranging from 1.5 m to 2.8 m with an average channel width of 1.8 m.
- The integrated solution includes provision of off-line sub-catchment / marginal floodplain wetlands. These wetlands will ensure that all stormwater runoff is centrally treated prior to discharge and, in conjunction with upstream source controls, will provide the necessary levels of protection for instream fauna in accordance with catchment specific water and sediment quality targets (Streamlined Environmental Ltd, 2015).
- The wetland treatment systems will contribute to the ecological functioning of the central corridor through the creation of diverse habitats and channel complexity in times of flood (Roach et al. 2009). In addition, some aquatic species such as eels are known to utilise flooded areas and associated habitats as a feeding area (Jellyman 1989; Chisnall and Hayes 1991).
- It is important to have a mixture of shallow inundated and ephemeral areas in the wetland. This assists with phosphorous removal, improves oxygenation of the sediments, promotes diverse wetland vegetation and assists in the degradation of organic material.
- The design of wetland outlets need to allow variability in the hydrologic regime, i.e. allow for variability in water levels and occasional drying of ephemeral wetland areas. However, longer detention times are favourable for sediment and phosphorous removal, and there needs to be a balance between allowing sufficient detention times and allowing variation in water levels. A suitable area of permanent pool storage is around 10 to 15% of the total wetland area (Wong et al. 1999).

Secondary Green Corridors (primary conveyance swales/corridors)

- Primary conveyance swales will drain stormwater from the sub-catchments to the Central Green Corridor. These conveyance swales will be either grassed or planted depending on the average water level. Grassed swales will be dry most of the time and planted swales will be wet most of the time.
- Fish passage should be maintained into planted conveyance swales by ensuring that culverts are installed in accordance with the guidelines outlined below. Fish passage into grass swales is not required.

General conveyance channels (existing modified watercourses)

- The general conveyance channels include other watercourses within the ICMP area. Existing watercourses should be retained and enhanced, as far as practicable, to improve their natural character. If diversion is required for development purposes, watercourses should be replaced and enhanced to improve biodiversity values and ecological connectivity in the wider catchment area.
- Indigenous riparian vegetation establishment will further improve the biodiversity of these watercourses and enhance the connectivity. Fish passage should be maintained in existing watercourses by ensuring culverts are installed in accordance with the guidelines outlined below. Detailed ecological assessment of these watercourses will be required to plan how they should be restored and protected in accordance with the Restoration Zone Concept, also detailed below. This is envisaged through development planning and assessments undertaken in support of resource consent applications for development.

Culverts and fish passage – general guidelines

- The proposed stormwater solution includes restriction of flood flows at culverts.[45] Restricting stormwater flow at culverts may have adverse effects for fish passage as, in general, larger culverts provide easier access for fish swimming upstream and have less potential to become perched. It is recommended that further ecological analysis is carried out in conjunction with the design team (at detailed design stage) to ensure that any existing and future culverts are optimised for both hydraulic function and fish passage.
- At present the downstream end of the Exelby Road culvert terminates a substantial distance above the stream with a steep surface leading up to the outlet. This culvert is likely to exclude non-climbing indigenous and pest fish species to the upper catchment, including Lake Waiwhakareke, and special consideration needs to be given to fish passage requirements at this site (at detailed design stage).
- For other culverts to be installed between Lake Rotokauri and Lake Waiwhakareke, consideration should be given to providing fish passage. Fish and aquatic macroinvertebrate passage can be expected if the culvert is sufficiently large and installed below the natural streambed so that natural bed-load movement forms a stable bed inside the culvert (Stevenson and Baker 2009, Boubée et al. 1999). The outlet design of the culvert is critical in preventing scouring and over-hanging lips (arch culverts are ideal for this).
- The key ecological design features for culverts are as follows:
  - Culverts should be installed so that the invert is about 300 mm below the channel invert
  - Culverts should be set at the same or lesser grade than the existing stream bed and at a gradient of no more than 1 in 300
  - Average water velocities in the culvert should be 0.3 m/s or lower.
  - Culvert width should be sufficient to contain the existing natural channel width plus 0.5 m as a minimum on each side
  - Channel beds at upstream and downstream ends of the culvert should be protected against erosion, aggradation and degradation
  - Overhanging vegetation should be planted at both ends of the culvert, and
  - Boulders should be fixed to culvert abutments and along edges of the channel outlet structure where grades are steeper than 1 in 300.

Ecological effects of development during construction

The ecological effects of development during construction generally relate to soil disturbance, sediment transportation and instream earthworks. With regard to soil disturbance and sediment transportation:

- Management of sediment laden runoff during the construction phase is critical for protecting ecological and water quality values. In particular this phase has the greatest risk of sediment-bound phosphorus being delivered to downstream environments (Cooke et al. 2015). Earthworks and creation of bare earth surfaces during construction can result in increased sediment transport into streams, and other aquatic environments, which can have negative impacts on aquatic biota and plants.
- Effects of suspended sediments in freshwater ecosystems have been well studied (see reviews by Wood and Armitage (2007) and Ryan (1991) and include:
  - Decreased light penetration in the water leading to reduction in growth of macrophytes
  - Damage to macrophytes and moss by physical abrasion
  - Smothering of aquatic plants, reducing quality of food for macroinvertebrates
  - Reduction in feeding of fish and macroinvertebrates
  - Increased invertebrate drift, and

[45] Currently limited to the Exelby Road culvert to meet flood protection LOS in the downstream catchment, subject to detailed design.

- Clogging interstitial spaces and filling in pools and riffles, reducing habitat quality.

All of these effects result in degradation of water and habitat quality for in-stream biota.

- During construction, care will be needed to prevent silt and concrete from directly discharging into waterways. Erosion and sediment control measures should be adopted in accordance with WRC best practice guidelines (Environment Waikato, 2009). Monitoring during construction will ensure that any potential erosion and/or sediment issues are identified at an early stage and remedied accordingly.
- Construction activities will result in bare earth surfaces. These areas if left unvegetated are at risk of weed invasion with the opportunity to spread throughout the catchment. All bare earth surfaces should be resown with grass, and/or replanted with suitable locally sourced native plants, as soon as possible following construction so there will be limited opportunities for weeds to establish on these sites.
- Of particular importance, all machinery brought onto construction sites should be thoroughly prior cleaned so as not to act as vectors for weed propagules. Another important measure is to ensure that any topsoil or fill brought on site is free of weed seeds or fragments, i.e. it must be treated for weeds beforehand.

With regard to instream earthworks:

- Instream earthworks and diversion activities will be necessary in the development of the Central Green Corridor, primary conveyance swales and general conveyance channels. These activities, and any other in-stream works (e.g. for culvert replacement or installation), have the potential to adversely affect aquatic biota and habitats.
- Instream earthworks can disturb habitat for aquatic flora and fauna and can cause large sediment inputs. Instream earthworks should therefore be planned and isolated to avoid sediment releases to water. This is particularly relevant for earthworks in and around the Rotokauri Drain as this waterway provides habitat for At Risk-Declining species such as giant kokopu.
- In-stream earthworks have been shown to reduce native fish abundance by 52% following excavation in a small Waikato stream (Greer et al. 2012). Giant kokopu were particularly affected by the earthworks and all tracked giant kokopu reportedly abandoned the site. Common bullies and giant kokopu both showed a significant drop in numbers after complete channel clearance. Therefore, depending on the extent of instream earthworks, relocation of fish prior to earthworks, and recovery and relocation of fish during earthworks, may be required. Methods will depend on construction methodology and best practise at the time of construction.[46]

<u>Proposed ecological protection and enhancement</u>

A key assessment finding was that although highly modified, watercourses within the catchment provide important habitat for indigenous fauna, including the nationally At Risk giant kokopu. Key ecological priorities include maintaining and restoring habitat values throughout the catchment, and enhancement of the ecological corridor between Lake Rotokauri and Lake Waiwhakareke.

In that regard a restoration and habitat creation concept is proposed. This is specifically designed to:

- Mitigate the adverse effects of development and the provision of major infrastructure in the catchment
- Meet the HCC CSDC requirements for catchment management plans and new stormwater activities
- Meet the relevant O&Ts presented in Section 1.7 of this ICMP, and
- Meet national and regional policy requirements for biodiversity and freshwater management (including the Vision and Strategy for the Waikato River).

[46] To be determined through relevant resource consent applications prior to construction.

The restoration and habitat creation concept incorporates the goal of restoring habitat to resemble historic states. Five restoration zones have been identified as depicted in Figure 3-16 and described below:[47]

- Waiwhakareke Zone – this zone extends from Lake Waiwhakareke to just north of Rotokauri Road and was historically a bog, a wetland type characterised by low nutrient concentrations and rainwater inputs.
- Central Corridor Zone - this zone was a former fen wetland in the upper to middle reaches of the Rotokauri Drain.
- General Tributary Zone - this zone incorporates modified and unmodified permanent and ephemeral watercourses within the general catchment area (other than the Rotokauri Drain).
- Giant Kokopu Zone – this zone is less modified and steeper than other parts of the Rotokauri Drain and provides habitat for giant kokopu.
- Lake Rotokauri Zone - this zone is situated near the downstream end of the Rotokauri drain, before it flows into Lake Rotokauri. This zone would have historically been a marginal wetland.

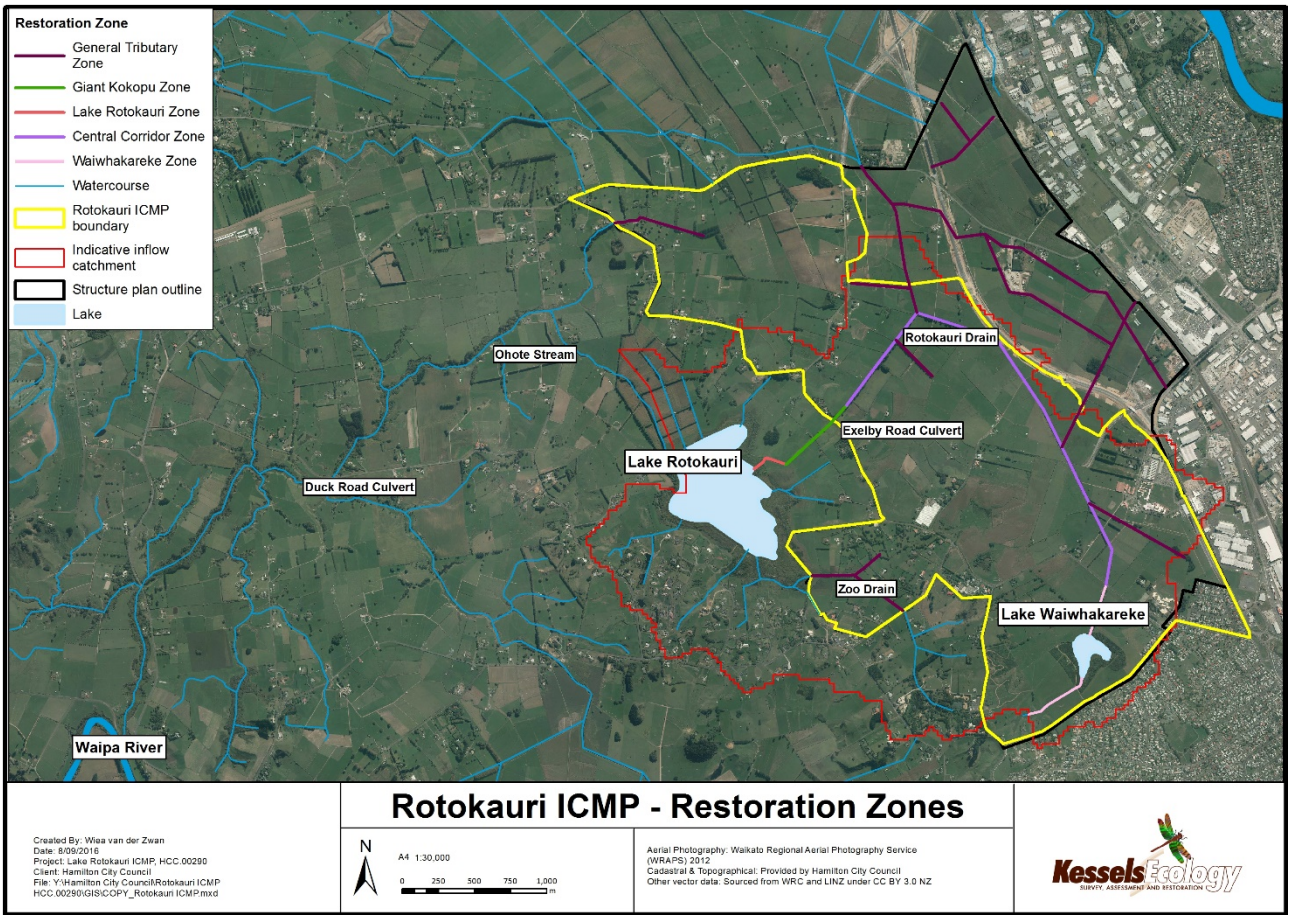

Figure 3-16: Restoration and habitat creation concept – Restoration Zones

[47] There are several unidentified watercourses within the main catchment and sub-catchments which are not shown in Figure 3-16. These are subject to future site surveys via resource consent applications prior to development.

The restoration priorities for each of these zones will be tailored to each of the unique habitat types and accord with relevant lake management and restoration plans, where applicable, as previously documented in this ICMP.

It is proposed that the Rotokauri Drain stay confined to its current banks in the Waiwhakareke, Giant Kokopu and Lake Rotokauri zones[48], with erosion protection proposed in the Giant Kokopu and Lake Rotokauri zones. In these zones the wetland and/or riparian vegetation should be tailored to the historical site characteristics.

In the Giant Kokopu Zone, indigenous riparian vegetation should be established to protect and enhance the thriving giant kokopu population. Riparian vegetation will provide organic inputs to the stream, providing habitat complexity and colonising substrate for aquatic invertebrates. Riparian vegetation will also provide stream shade and terrestrial inputs which make up a significant component of a giant kokopu diet.

To avoid adverse changes in habitat for giant kokopu, it is recommended that the existing stream channel in the Giant Kokopu Zone area, immediately upstream of Exelby Road culvert, is retained in its current natural form. This will require sympathetic design of the central corridor in this location (refer to Figure 3-15, CC5 for location details).

The Exelby Road culvert at the upstream end of the Giant Kokopu Zone is currently perched and, as such, is likely restricting upstream passage to climbing species such as giant kokopu and eels. This culvert will require modification to control increased flow volumes and should provide for the passage of indigenous climbing fish species (while excluding exotic pest fish species). A concrete lined ramp with spaced boulders is recommended as this would retain access for indigenous climbing fish and may also help to stabilise the culvert outlet. Other methods to prevent the passage of exotic pest fish species could include anti jump bars and restricting the water depth along the ramp (subject to detailed design).

The Central Corridor Zone relates to the Central Green Corridor and occupies one of the largest restoration areas within the catchment. This zone was formerly a fen wetland and the areas surrounding the main conveyance channel should be planted to help recreate historic patterns and processes. The central corridor will also have a permanently flowing central channel, marginal floodplain and stormwater treatment wetlands. The central channel should include deeper pool areas along with shallower run lengths of stream, and should be designed to follow a more natural meandering channel profile. Vegetation should be planted along the banks to help stabilise and retain the meandering nature of the channel. Large wood should be added to the edges of the channel and within the marginal wetland areas to provide habitat while vegetation is establishing. Along the top of the drier sloped banks, large specimen trees can be planted which may provide habitat and feeding areas for bats and avifauna once established.

The General Tributary Zone incorporates smaller, predominantly modified, permanently flowing and ephemeral watercourses. Habitat considerations are similar to those proposed for the Central Corridor Zone.

Table 3-9: Summary of restoration zones with existing ecological values and key considerations for development

Zone	Existing ecological values/characteristics	Key considerations for development
Waiwhakareke Zone	Adjacent to Waiwhakareke Natural Heritage Park	Restoration should be coordinated with plans for the Waiwhakareke Natural Heritage Park Ecosourced plants Protection of hydrology of Lake Waiwhakareke and surrounds
Central Corridor Zone	Location of central conveyance channel and green corridor Currently a modified watercourse	A permanently flowing central channel should be created The central channel should incorporate meanders, in-stream structures and habitat diversity

[48] Unless otherwise determined through further ecological assessments, development of the restoration and habitat creation concept or lake reserve management plans.

		Fish habitat structures should be installed
General Tributary Zone	Predominantly modified, permanently flowing and ephemeral watercourses	Allowance should be made for a permanently flowing channel in permanent watercourses The channel should incorporate meanders, in-stream structures and habitat diversity Fish habitat structures should be installed
Giant Kokopu Zone	An abundant population of giant kokopu is present in the section of the Rotokauri Drain near Exelby Road The Exelby Road culvert currently restricts access of swimming fish (including pest species) to upstream areas	Habitat requirements include: • low water velocity • areas of deeper water • riparian vegetation • in-stream cover such as log-jams, debris dams, undercut banks, boulders etc, and • a dynamic flow regime with pools providing areas of lower flow within the stream. Fish passage past the Exelby Road culvert should be restricted to climbing species only, to prevent pest fish species such as koi carp from invading Lake Waiwhakareke. Eco-sensitive erosion protection is required to stabilise the stream channel downstream of Exelby Road
Lake Rotokauri Zone	Low gradient section near the margins of Lake Rotokauri	Restoration should be coordinated with plans for Lake Rotokauri Reserve

In summary there are significant ecological issues relating to growth in the catchment. These issues must be avoided, or otherwise minimised, through factoring eco-sensitive design requirements into the overall stormwater solution as proposed in this section. In doing so the relevant O&Ts assessed in Table 3-8 will be met, as will the various national and regional policy requirements relating to ecological protection and enhancement.

Receiving environment monitoring will be required to gauge in-stream biodiversity (macroinvertebrates, macrophytes and fish) in the realigned Rotokauri Drain/Central Green Corridor and other modified watercourses post construction. So too will the monitoring recommended by Streamlined Environmental Ltd (2015) to ensure that the catchment specific water and sediment quality targets are being met (in particular to ensure that water and sediment quality parameters remain within acceptable guideline values for protecting freshwater ecology). This monitoring, along with several 'future actions' which are associated with the ecological requirements and implementation initiatives proposed in this section, is further addressed in Section 5.5.3 (*Future Actions*) and in Section 8.2 (*Proposal for Catchment Monitoring*) of this ICMP.

3.2.6 Summary of outcomes and issues

In this section the main outcomes and issues identified in the above sections have been broadly collated and are shown in Table 3-10 below. This allows for further grouping in Section 5 – '*Best Practicable Options, Solutions and Implementation*.' Each issue has been assigned with an 'Issue ID' and a priority which reflects the implementation urgency that is associated with it. These are as follows:

- *GH - Growth High: expected to be addressed during the next 1-3 years.*
- *GM - Growth Medium: expected to be addressed during the next 4-10 years.*
- *GL - Growth Low: expected to be addressed post 10 years.*

Table 3-10: Main outcomes and issues summary

ID	Issue	Description	Category [1]	Priority
F1	Downstream flood protection / LOS	Requirement to meet downstream flood protection LOS through observing the operating level limits of Lake Rotokauri	Flooding	GH-GM
F2	Flood storage requirements	Significant flood storage requirements within the development area (MPD). Flood mitigation / major drainage solution is proposed	Flooding	GH-GM
F3	Residual flooding	Residual flooding within the development area (MPD). Flood mitigation / major drainage solution is proposed	Flooding	GH-GL
F4	Interim flood storage (pre-establishment of the major drainage solution)	Interim flood storage of runoff from new development, pre-establishment of the major drainage solution, is required	Flooding	GH-GL
HG1	High groundwater levels	High groundwater levels are encountered throughout the catchment	Hydrogeology & geotech	GH-GM
HG2	Ground constraints (impermeable soils)	Widespread soakage is not considered feasible due to high groundwater levels and ground constraints. Localised soakage maybe possible	Hydrogeology & geotech	GH-GL
HG3	Groundwater drawdown	Groundwater drawdown as a consequence of the major drainage solution (central corridor) - ground consolidation/settlement within the development area. Mitigation measures are required (i.e. flexibility to be built into permanent works)	Hydrogeology & geotech	GH-GL
HG4	Lake Waiwhakareke - maintaining ground water levels	Risk of groundwater drawdown in proximity to Lake Waiwhakareke as a consequence of the major drainage solution (central corridor). Issue avoidance measures are required	Hydrogeology & geotech	GH-GM
SCE1	Waiwhakareke Development Area - erosion susceptibility	Moderate to high erosion susceptibility in the Waiwhakareke Development Area. Gully and stream channel stabilisation and protection measures are required	Stream channel erosion	GH-GM
SCE2	Waiwhakareke Reserve - erosion 'hot spot'	Erosion 'hot spot' and minor historical mass wasting in the Waiwhakareke Reserve. Ongoing monitoring and reactive remediation as required	Stream channel erosion	GH-GL
SCE3	Lake Rotokauri sub-catchment - erosion susceptibility and 'hot spot'	Erosion susceptibility, historical mass wasting and slumping, and erosion 'hot spot' between Exelby Road outlet and Lake Rotokauri. Stream channel stabilisation and protection measures are required	Stream channel erosion	GH-GM
SCE4	Lake Rotokauri outlet to Duck Road Bridge – erosion susceptibility	Erosion susceptibility between Lake Rotokauri outlet and Duck Road Bridge with evident stream undercutting. Ongoing monitoring, assessment and protection works where necessary	Stream channel erosion	GH-GL
WQ1	National and regional policy settings	Stormwater discharges are required to be treated to avoid directly related adverse effects. Also to meet national and regional policy settings for water quality and receiving environment health (during and post development)	Water quality	GH-GL

WQ2	High value receiving waterbodies	The main receiving waterbodies are highly valued and are subject to water quality improvement and restoration initiatives	Water quality	GH-GL
WQ3	Priority contaminants	N & P are the principle contaminants of concern (particularly P). Cu, Zn and emerging urban derived contaminants are also of concern. Catchment specific water and sediment quality targets have been determined and a stormwater treatment solution is proposed	Water quality	GH-GL
WQ4	Sediment laden runoff during development	Sediment laden runoff requires stringent site controls to minimise export of phosphorous bound TSS and related water quality impacts during development and physical works	Water quality	GH-GL
WQ5	Interim stormwater treatment (pre-establishment of central sub-catchment wetlands)	Interim stormwater treatment of runoff from new development, pre-establishment of central sub-catchment wetlands, is required	Water quality	GH-GL
WQ6	High risk facility sites	High risk facility sites present additional risks to water quality, the stormwater network and receiving environment health. Site/activity specific management plans and treatment systems are required	Water quality	GH-GL
E1	Potential decline in biodiversity values	Potential habitat loss, fragmentation and degradation as a consequence of development and provision of major infrastructure. Mitigation, eco-sensitive infrastructure design, protection and enhancement measures are required	Ecology	GH-GL
E2	Rotokauri Drain realignment (flood storage / conveyance and central sub-catchment wetlands)	Establishing the overall stormwater solution (Central Green Corridor) requires significant deepening and widening of the Rotokauri Drain. Mitigation, eco-sensitive infrastructure design, protection and enhancement measures are required	Ecology	GH-GM
E3	Other modified watercourses (primary conveyance swales and general conveyance channels)	Establishing the primary conveyance swales (Secondary Green Corridors) requires significant realignment and diversion of existing watercourses. Mitigation, eco-sensitive infrastructure design, protection and enhancement measures are required	Ecology	GH-GL
E4	At Risk giant kokopu population	There is a thriving population of At Risk giant kokopu in the downstream reach of the Rotokauri Drain. A combination of issue avoidance and mitigation measures are required	Ecology	GH-GL
E5	Fish passage	Modifications to the Exelby Road culvert outlet to enable the passage of indigenous climbing fish species, whilst excluding exotic pest fish species, are required	Ecology	GH-GM
E6	Sediment laden runoff during development	Sediment laden runoff requires stringent site controls to minimise export of TSS and related adverse ecological impacts during development and physical works	Ecology	GH-GL

E7	Stream channel protection works	Eco-sensitive design and construction methods for undertaking stream channel stabilisation and protection works, are required	Ecology	GH-GL
O1	Potential for inconsistency with the Rotokauri Structure Plan and ICMP outcomes	There is potential for inconsistent development to occur within the catchment. Major three waters infrastructure solutions, which are consistent with the RSP and ICMP outcomes, are proposed	Other	GH-GL
O2	Constraints on the availability of infrastructure	The Rotokauri Catchment is substantially 'greenfield'. Current constraints on the availability of major infrastructure limit the extent to which land can be released for development and/or new development adequately serviced	Other	GH-GL

[1]) Categories: stormwater – flooding (F), hydrogeology & geotech (HG), stream channel erosion (SCE), water quality (WQ), ecology (E); wastewater (WW) and water supply (WS); other (O)

3.3 Wastewater Assessments

Most of the information contained in this section is from Appendix B – *Rotokauri ICMP Three Waters Infrastructure Integration Report* (AECOM, 2016).

Given that the Rotokauri catchment is substantially greenfield, the existing wastewater infrastructure is minor and the focus of assessments has been provision for growth and mitigating issues related to growth. Accordingly, this section sets out a summary of assessments, issues and the proposed wastewater infrastructure servicing solutions.

Outcomes and assessment against objectives and targets

The catchment is substantially greenfield with very little existing development and wastewater infrastructure. Accordingly, there are no dry weather or wet weather overflows to report.

The Rotokauri catchment area is intended to be served by a gravity wastewater collection network designed in accordance with HCC Infrastructure Technical Specifications. The catchment is bordered by the Far Western Interceptor (FWI) which will serve the catchment.

The wastewater collection network has been designed to minimise wastewater pumping stations; however, it is not possible to eliminate all pumping stations due to the topography of the catchment, practical limitations (i.e. maximum depth of wastewater collection networks) as well as the invert levels of the central drainage corridor proposed to the west of the ICMP boundary.

The existing wastewater infrastructure includes one existing pump station (as at September 2016) discharging to the gravity sewer on Rotokauri Road. No overflows have been recorded at this pump station This servicing solution was implemented to facilitate development ahead of the strategic wastewater infrastructure. This interim pumping station and rising main will be decommissioned following development of the permanent wastewater solution to service the Rotokauri growth cell.

Far Western Interceptor

The 1050mm diameter FWI currently connects to the Western Interceptor in the vicinity of Norman Hayward Place. Three 1050mm diameter capped connections have been installed at approximately equal intervals along the FWI under the Te Rapa Bypass. The 2 northern connections will service trunk connections from the Rotokauri Structure Plan area. The southern connection will be extended to the Western Interceptor on Avalon Drive to complete the FWI and divert a portion of flow from the Western Interceptor.

Vertical alignment of the proposed 1050mm diameter extension of the existing section of the FWI to the Western Interceptor is constrained by upstream and downstream levels. Preliminary design indicates a gradient of 1:1000 can be achieved at an average depth of 4m.

A preliminary horizontal alignment has been identified consistent with the structure plan roads and drainage corridor and is subject to detailed planning and integration with other service requirements and constraints, particularly stormwater infrastructure. Construction is planned for 2017/2018.

Trunk and local network requirements

The Rotokauri catchment is broken into 7 key sub catchments.

- Two sub-catchments will be serviced completely by gravity to the FWI
- Three sub-catchments will be serviced by gravity network draining to a trunk wastewater pumping station discharging to the FWI (either directly via connection constructed over the stormwater channel via road crossing or indirectly via gravity trunk main)
- One sub-catchment currently serviced by onsite wastewater systems which will be serviced by gravity network and local pump-station discharging to the trunk network in the future. This sub-catchment is zoned for future residential development and is located on the Western side of Exelby Road and inside Hamilton boundaries

- A small undeveloped area located on the corner of Baverstock and Brymer Rd is zoned for residential development and is expected to accommodate approx. 20 dwellings. This catchment cannot achieve gravity connection to the existing system, due to its location on the downhill side of the ridge line and existing gravity sewer invert levels. Developing this area will require on lot private pumps discharging to the gravity sewer on Baverstock Road. This specific area has been assessed as too small to be supported by a public pump station due to the low number of potential dwellings that cannot achieve a gravity connection. Better understanding of timing of the development, final proposed number of dwellings and future HCC policy will inform the servicing of this area
- The existing gravity network servicing Baverstock Road has sufficient capacity to accommodate the additional discharge for development in that available area (approx. 20 dwellings) following the decommissioning of the temporary discharge from the Kawariki Drive/Rotokauri Rd Pump Station and diversion of this flow to the FWI
- If development of this area is proposed before the disconnection of the temporary pump station discharge capacity of the existing network needs to be investigated and confirmed and may require local mitigation or upgrades to accommodate the additional flow. In this instance, the developer will be responsible for investigating the network capacity and funding local mitigation or upgrade solutions that may be necessary to service the development of this area.

The local and trunk wastewater networks will be designed to incorporate high level gravity overflows in the event of pump station failure or excessive wet weather flows. The overflows will maximize the use of available storage in the network, and where possible discharge to the downstream gravity network rather than to the receiving environment.

It may be appropriate to consider alternative reticulation options to service the Rotokauri growth cell. Further technical assessment is expected to be carried out by HCC separate to the ICMP. Further assessments could include investigations into the feasibility and benefit of low pressure sewers for future development areas, or other wastewater systems as new technologies become available.

Wet weather flow & network constraints

In theory separated networks should not have stormwater entering the system. While modern materials, construction techniques and quality assurance processes can reduce the potential for stormwater to enter the network, conventional gravity reticulation systems will always involve stormwater ingress to some degree. This stormwater ingress is due to direct stormwater inflow, for example through infiltration (both base groundwater infiltration and rainfall dependent infiltration) and cross connections (storm water network connections to the wastewater network).

For this reason wastewater networks are designed to accommodate increased flows (wet weather flow) as a result of rainfall events. Despite the design provisions to accommodate wet weather flow, during intense events total capacity of the network can be exceeded resulting in overflows from the network. While the network will be engineered to reduce the likelihood of such overflows (e.g. through provision of high level network overflows and bulk storage facilities), it is important that network overflows (if they were to occur) are managed in a controlled manner, i.e. through designed overflow structures or manholes into the environment.

An assessment was carried out against the relevant O&Ts for this section as listed in Section 1.7. A summary of this assessment is shown in Table 3-11: Assessment of wastewater network against relevant O&Ts.

Table 3-11: Assessment of wastewater network against relevant O&Ts

Id	O&Ts	Assessment	Issue	Comment
WW 1	Effects on receiving environment	No exceptional adverse effects currently or anticipated	Nil	Compliant

Id	O&Ts	Assessment	Issue	Comment
WW 2	Resilience	Potential for overflows in the future requires management	Potential for pump failure. Potential for overflows.	- Storage in accordance with the ITS (currently 9 hours average dry weather inflows) required at new pump stations, - high level gravity overflows to downstream network, - wet weather storage on FWI
WW 3	Network Capacity	No network capacity issues currently or anticipated in future. Trunk Network will be sized to accommodate all potential development in the catchment. Strategic infrastructure has sufficient capacity to service full development of growth cell.	Potential intensification of development beyond that assumed during network design	- Staging of development will need to be aligned with provision of network capacity. - Construction of local network to be in accordance with HCC requirements and of quality workmanship and materials to minimise potential for inflow and infiltration.
WW 4	Dry weather overflows	No dry weather overflows now or in the future anticipated	Dry weather overflows can occur due to insufficient network capacity; network blockages or pump station failures	- Storage in accordance with the ITS (currently 9 hours average dry weather inflows) required at new pump stations

Id	O&Ts	Assessment	Issue	Comment
WW 5	Wet weather overflows	Wet weather overflows are anticipated to be managed/minimised through staged development, gravity high level overflows and provision of central storage.	Poor quality design, construction and cross connections could result in increased wet weather flows. Climate change could increase the peak wet weather flowrate, wet weather flow frequency and duration and increase the volume, frequency and duration of wet weather overflows.	- Construction of local network to be in accordance with HCC requirements and of quality workmanship and materials to minimise potential for inflow and infiltration. Enforce tradewaste and wastewater bylaw - Include high level gravity overflows to downstream network in network design. - The network shall be designed to manage wet weather overflows to the receiving environment (if at all) in a controlled manner through constructed overflows where appropriate (note that resource consent may be required to support this)
WW6	Best Design Practice	Management of low flows and generation of Hydrogen Sulphide during early development staging through Best Practice Engineering Design	Generation of Hydrogen Sulphide from Wastewater creates a corrosive environment that without management reduces the life of the asset.	- Best Practice design and pipe material selection can manage this risk. - Flushing programmes may be required to manage low flow conditions i.e. sedimentation, corrosion and odour

Summary of Assessment and Observations

There is just one existing pump station in the Rotokauri area and records indicate that no overflows have been recorded at this pump station located on Rotokauri Road.
The catchment is substantially greenfield with very little existing development and wastewater infrastructure. Accordingly, there are no dry weather or wet weather overflows to report.

The Rotokauri catchment area is intended to be served by a gravity wastewater collection network designed in accordance with HCC Infrastructure Technical Specifications. The catchment will include a total of four public wastewater pump stations to convey wastewater from the local network to the FWI.

A small development is proposed on the corner of Baverstock and Exelby Road which will require on lot private pumps discharging into the gravity sewer on Baverstock Road. The capacity of the existing network needs to be investigated and confirmed and may require local mitigation or upgrades to accommodate the additional flow if developed ahead of the commissioning of the FWI and decoupling of the temporary connections to the local network.

The concept of removing WWPS1 and servicing the associated catchment via WWPS2 has been investigated and confirmed as viable, however at the time of writing, the preliminary wastewater network design for the catchments associated with WWPS1 and WWPS2 were incomplete. In line with HCC objective to reduce the number of pump

stations in its network it is anticipated that WWPS1 will be eliminated and the associated catchment will be serviced by WWPS2. As a result the design information presented in the ICMP for each wastewater pump station catchment (including catchment boundaries and storage requirements) are likely to change.

3.4 Water Supply Assessments

Given that the Rotokauri catchment is substantially greenfield, the existing water supply infrastructure is minor and the focus of assessments has been provision for growth and mitigating issues related to growth. Accordingly, this section sets out a summary of assessments, issues and the proposed solution in terms of water supply infrastructure.

The existing water supply system in the Rotokauri area is described as being serviced by Blue zone pressure (via the Water Treatment Plant) with some elevated areas (e.g. Ruske Place) at or below HCC desired level of service for pressure during peak summer demand periods.

Under the Water Master Plan Philosophy, this single Blue zone will eventually become 3 separate supply zones called the Pukete Zone (Brown), Newcastle Zone (Green) and the Dinsdale Zone (Orange). Refer to Figure 3.17 below.

The timing along with the physical capital works to create these zones has a bearing on the rate of water demand growth that can be serviced in Rotokauri.

Most of the information contained in this section is from the document titled *Rotokauri Water Supply Capacity Assessment* (Motts Macdonald, 2016) (Appendix C). The report discusses the methods used and provides more detail.

Outcomes and assessment against objectives and targets

The water supply system proposed to service the Rotokauri Catchment area has been developed in accordance with the HCC Infrastructure Technical Specifications and using the Water Master Plan for Hamilton.

The master plan uses the following level of service targets to assess infrastructure needs:

- Minimum water pressure during peak domestic demand at ground level is 10m at the point of supply
- Maximum static pressure at ground level for each lot is limited to 100m
- Design of the reticulation system conforms to the NZ Fire Fighting Water Supplies Code of Practice (SNZPAS 4509).
- Minimum reservoir storage volumes are the equivalent to 1 peak day across the entire network
- Allow the ability for operations to have full control of Reservoir turnover and maintain 50% turnover once per day
- Maximum head losses are limited to 10m per 1000m of pipeline at peak domestic demand.

Future demand in green field areas where little or no existing demand is available uses the assumptions in the HCC Infrastructure Technical Specifications for Water Supply: An average daily demand of 260 l/person/day (0.003 l/s/person average instantaneous) with a peak instantaneous flow rate of five times this amount (0.015 l/s/person).

In general, the current storage and zoning approach for Hamilton is to split the City into western and eastern areas, divided by the Waikato River, for water storage and use. The master plan approach keeps the storage within the zone it services without long pipe runs and more risky river crossings. There is currently no need for a new reservoir in the Rotokauri area or an additional treatment plant on the western side of the river within the 2061 design horizon.

Figure 3-17 below shows the main water supply network with future water network zones.

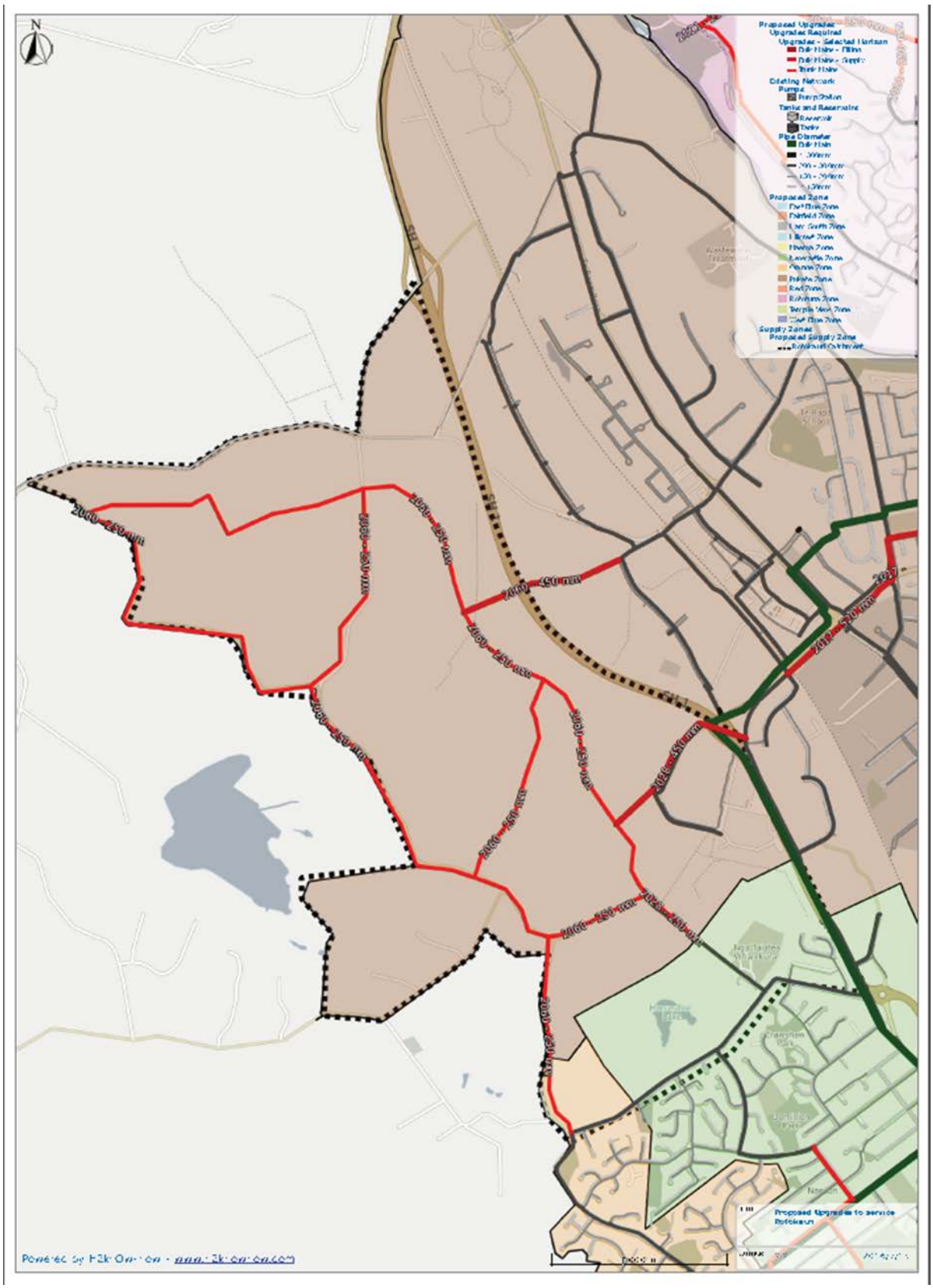

Figure 3-17: Future water network zones

An assessment was carried out against the relevant O&Ts for this section as listed in Section 1.7. A summary of this assessment is shown in the table below.

Table 3-12: Assessment of the water supply network performance against relevant O&Ts

Id		O&Ts	Assessment	Issue	Comment
WS1		Mapping network capacity for existing and future demand	Elevated areas of Rotokauri have pressures below desired level of service	Future planned staged works will resolve current low pressure issues.	A staged approach to development will be needed to ensure adequate network capacity.
WS2		Water demand management	Limited existing development and no exceptional demand management issues identified or anticipated	-	-
WS 3		Resilience	No current resilience issues identified	Ongoing effort required by all parties to ensure planned and unplanned events are considered during development	-

Summary of Assessment and Observations

Elevated areas in the Rotokauri area (e.g. Ruske Place) are at or below the required level of service. Any additional development in the Rotokauri area will require prior construction of significant water supply infrastructure including Stage 1 and 2 discussed below in order to provide adequate water pressure to elevated areas.

Water supply performance in the Rotokauri area will ultimately be determined by the creation of 2 new zones called the Newcastle and Pukete Zones and the extension of the existing Dinsdale zone. The commissioning of the proposed Rototuna Reservoir and Zone in 2018 will remove the current reliance on the Pukete Reservoir to supply the Rototuna area at peak demand times. Further details are provided in the document titled *Rotokauri Water Supply Capacity Assessment* (Motts Macdonald, 2016) (Appendix C).

Once the Rototuna reservoir is completed, Rototuna Zone is created the Pukete reservoir will return to its intended use, servicing the western side of the river. At that time it is planned to build a dedicated bulk main supply line to service the proposed Pukete Zone with the bulk main planned to be commissioned in 2019.
In the interim period between the Rototuna reservoir completion and the Pukete supply line completion, it is recommended to undertake the following:

- Use the eastern bulk main to fill the Pukete reservoir and the western bulk main to supply the West Blue Zone
- Construct a dedicated fill (delivery) pipe from the existing bulk mains on Pohutakawa Road to the Pukete Reservoir to offer resilience to Rototuna area during the construction of the Rototuna Reservoir (currently under construction)
- Implement the proposed Orange Zone extension to provide pressure LOS to Ruske Place
- Partially close the Rototuna Zone; two bulk supply points will remain to feed the zone from the WTP outside of peak demand periods.

Once the Pukete supply line is completed the Pukete zone will be closed, resulting in significant system performance improvement. Pressures throughout Rotokauri are then expected to exceed 20m at all times.

Staged construction is proposed for extension of existing supply lines and trunk mains to service the new development of the Rotokauri area. Stage 1 - relates to any proposed development prior to the future 520mm Bulkmain supply from Pukete Reservoir to the Rotokauri area. Refer Figure 3-18 below.

1. To facilitate growth this requires the installation of a 450mm main along Te Wetini Drive connected temporarily to the existing 250mm on Te Wetini, this extends as a 250mm main from the end of the 450m and connecting to the existing 250mm on Rotokauri Road.
2. Implementation of the proposed 'orange' water zone extension to isolate the elevated area (Ruske Place) from the 'brown' Pukete Zone.

Stage 2 - construction of the 520mm link between Pukete Reservoir and the 450mm on Te Wetine Dr, disconnect from 250mm once in place.

Stage 3 - relates to remaining available development east of SH1 to Exelby Rd involving a 450mm bulk main across SH1 and 13km of 250mm trunk mains west of SH1.

Figures 3-18 below shows the existing and proposed water supply infrastructure for the Rotokauri catchment and Figure 3-19 sets out an indicative construction programme.

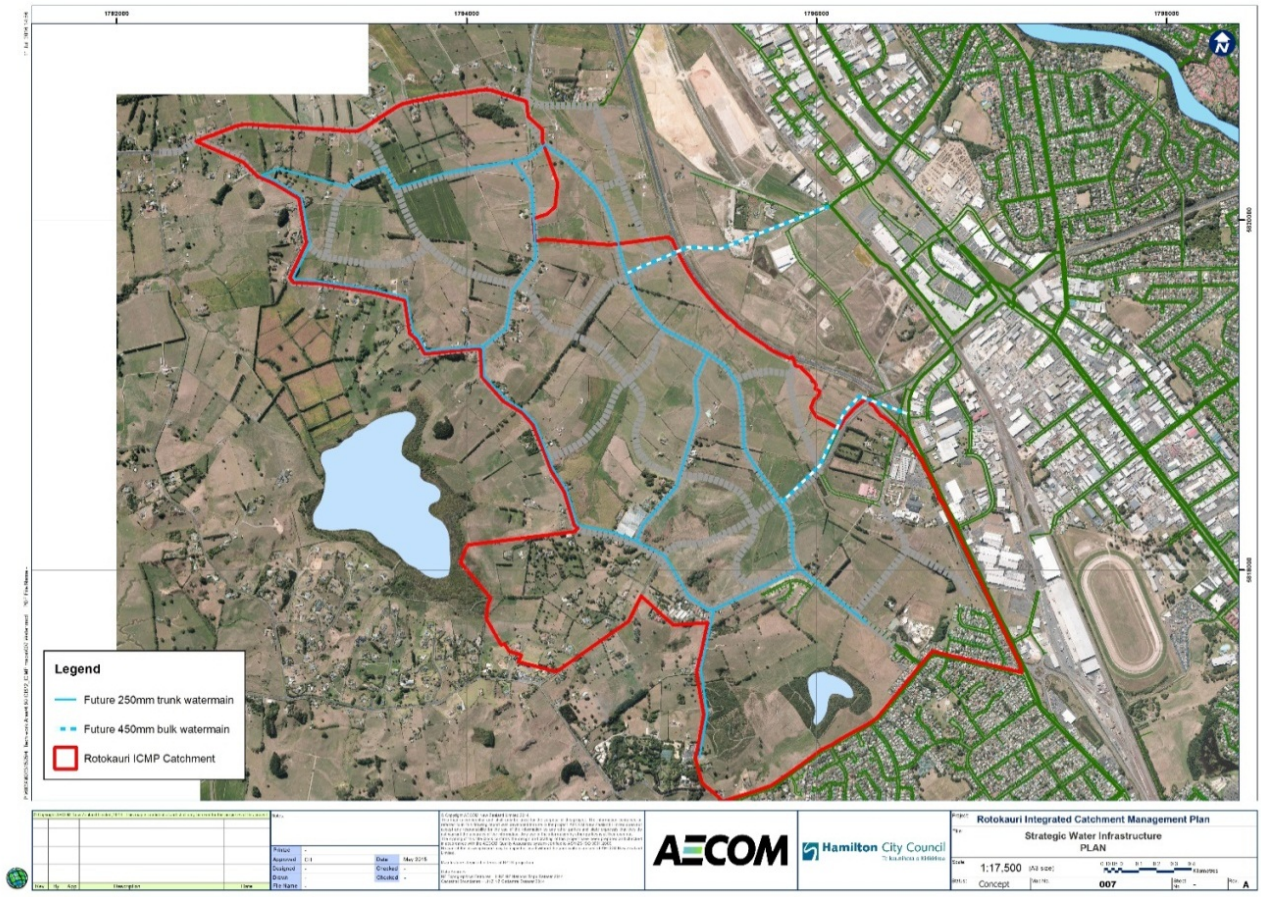

Figure 3-18: Existing and proposed water supply infrastructure

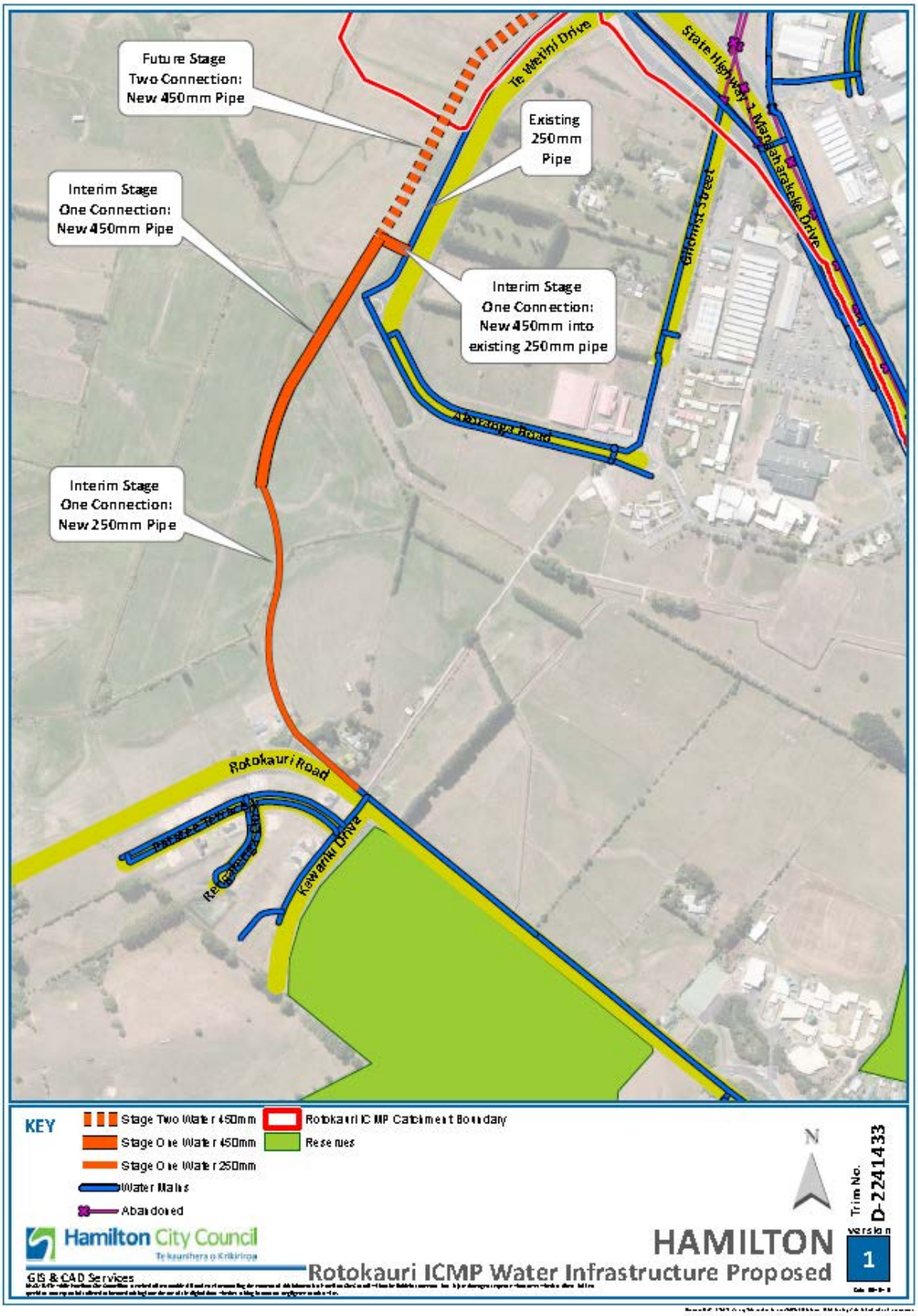

Figure 3-19: Water infrastructure staged construction

4 Opportunities, Options and Analysis

4.1 The Process

4.1.1 Identification of opportunities, options and proposed management solutions

Section 3 of this ICMP presented the key outcomes, issues and proposed management solutions where relevant, which have been determined through the ICMP development process. It is important to note that the inclusion of proposed management solutions in this earlier section reflects both the historical and iterative nature of the catchment investigations and assessments undertaken. These relate to the RSP development process, subsequent options identification and assessment process (Beca Infrastructure Ltd, 2013), conceptual infrastructure design of the central drainage corridor (Beca Infrastructure Ltd, 2014), and the more applied investigations and assessments undertaken to support this ICMP (AECOM, 2016; CH2M Beca, 2016; Streamlined Environmental Ltd, 2015; Morphum Environmental Ltd, 2016; Kessels Ecology, 2016).

4.1.2 Options assessment process

The sections below outline the identification and analyses process undertaken, along with the main options which have been considered to provide for growth and to address the key issues relating to growth, within and beyond the general catchment area.

In undertaking these assessments, matters pertaining to costs, benefits, implementation risks, technical feasibility, ability to meet relevant legislative requirements, consistency with relevant policy and planning provisions and consent-ability have been considered. Alignment with generic and catchment specific O&Ts (Section 1.7) and application of water sensitive principles have also been considered.

4.2 Catchment Specific Requirements

The HCC CSDC[49] requires an *"… integrated catchment management approach based upon the Best Practicable Option to avoid as far as practicable and otherwise minimise, the cumulative adverse effects of all new stormwater diversion and discharge activities in developing catchments."* Given that the Rotokauri Catchment is largely 'greenfield', the BPOs and integrated catchment solutions determined through this ICMP, will generally be implemented as part of development and ongoing management within the catchment. However, if a developer proposes an option that is not presented in this ICMP, the developer must demonstrate that it is the most appropriate option (inclusive of factoring for cumulative adverse effects), and that it will meet all relevant O&Ts as presented in Section 1.7 of this ICMP. This information will need to be included as part of a Water Impact Assessment as required under the District Plan.

If an alternative option is proposed by a developer, the following matters must be satisfied as a minimum:

- It must be demonstrated that the proposed option is indeed the BPO, and will meet the stormwater quantity, quality and receiving environment requirements for the catchment
- It must be demonstrated that the proposed option will meet all relevant condition requirements of the HCC CSDC[50]
- Unless specifically superseded by the requirements of this ICMP, all development design must be in accordance with the HCC ITS

[49] Condition 30.

[50] Obtaining site specific land-use and stormwater discharge consents from WRC, will not of itself demonstrate this. An assessment against the condition requirements of the HCC CSDC will also be required.

- Development design must specifically consider cumulative environmental and infrastructure effects, and
- Development design must provide for long-term management of potential adverse effects within and beyond the general catchment area over which these effects may occur. This relates to the wider Ohote Stream Catchment as shown in Drawing 001-A (refer to Section 1).

4.3 Option Identification and Analyses

4.3.1 Pre-ICMP development

The document titled '*Rotokauri Growth Cell – Planning & Design Summary Report'* (Beca, 2013) provides a complete summary of the pre-ICMP development options which were identified and previously assessed, particularly in relation to stormwater management which included twelve wide ranging options. These options were assessed based on cost and benefit and then ranked, with the four top scoring options being selected for more detailed assessment. These four options included:

- Increased flow to Lake Rotokauri
- Onsite management combined with central floodway
- Provision of a wetland within the Lake Rotokauri sub-catchment, and
- Green Corridor Concept (with conveyance swales and central floodway).

Ultimately the Green Corridor Concept was selected and further progressed to conceptual design in 2012. This is described in the document titled *'Preliminary Stormwater Investigation Lake Rotokauri Catchment Development Area – Part 2'* (Beca, 2014). However, this option was progressed on the basis of best practice design principles and did not include hydrologic modelling to determine the effects on downstream catchment hydrology and flood management LOS (WDC and WRC). The central floodway was also designed to accommodate 80% of pre-development flows.

Although widely considered to be 'best practice', with the benefit of further catchment investigation and assessments (including hydrologic modelling), this design requirement would not have mitigated downstream flooding issues and would also have resulted in less than optimal central drainage infrastructure (including higher capital costs).

4.3.2 ICMP development

The documents listed below combine to provide a complete summary of the options which were identified and assessed as part of the ICMP development process, along with the process undertaken. These options relate to the main stormwater management and water quality issues through-out the catchment, and the infrastructural solutions which were subsequently developed through this process.

- AECOM, 2016. *Rotokauri ICMP - Major Drainage: Preferred Option & Stormwater Management Solution Report.* (Appendix C)
- AECOM, 2016. *Rotokauri ICMP - Major Drainage: Options Report* (Appendix C)
- Morphum Environmental Ltd, 2016. *Rotokauri ICMP - Water Quality Treatment Concept Development Report* (Appendix C).

<u>Stormwater Management</u>
With regard to stormwater management and major drainage requirements, the previous four top scoring options were initially revisited.[51] Also, with an improved understanding of catchment hydrology and major drainage requirements (via hydrologic modelling outputs), these options were refined to:

[51] Other potential options were also considered and informed through initial hydrologic modelling outputs. For example, modifying the Lake Rotokauri outlet weir and/or increasing stream channel capacity between the lake

- Convey all flow to Lake Rotokauri without storage or control
- Provide off-line storage upstream of a central conveyance system
- Provide storage in a downstream wetland (Lake Rotokauri sub-catchment), and
- Provide storage within a central conveyance system.

Section 4 of the AECOM solution report, presents the factors which affected and were considered in selecting a preferred option. It was ultimately determined that provision of storage within a central conveyance system was the BPO, subsequent to the following key outcomes:

- Storage should be contained within the current RSP drainage corridor. Alternative locations such as off line storage in reserves could be further considered in detailed design and implementation
- The volume in upper storage basins should be kept to a minimum to reduce land area requirements and width through the commercial area of the RSP, and
- The depth of the upper storage basin, downstream of Rotokauri Road and Lake Waiwhakareke, should be no more than 2m in order to protect groundwater levels in proximity to the lake. Width should also be minimised so that the adjacent Council reserve area is maximised.

This process was followed by initial storage basin optimisation to achieve the above outcomes and to minimise infrastructure requirements throughout the catchment area. It was also subject to proving and refinement (via proving model runs) to achieve the final concept and proposed management solution.

Stormwater Quality Treatment

With regard to stormwater quality treatment requirements, a central wetland concept was initially developed by the ICMP project team to generally align with the RSP and catchment specific O&Ts (Section 1.7). This concept was subsequently advanced by Morphum Environmental Ltd through consideration of four potential options combined with source controls to meet full treatment requirements (i.e. > 70 total phosphorous removal). The four options included:

- Wetlands constructed on-line in the central conveyance channel
- Wetlands constructed off-line in proposed floodway footprints
- Wetlands constructed off-line in extended floodway footprints (widened conveyance channel), and
- Sub-catchment wetlands.

It was ultimately determined that a treatment train approach is the BPO and proposed management solution for the catchment, comprising main corridor wetlands in extended floodway footprints and central sub-catchment wetlands, where required, due to space constraints. These centralised treatments can function in conjunction with upstream source controls (on-lot and sub-catchment) to achieve full treatment requirements for the catchment (refer to Section

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outlet and Duck Road Bridge to increase storage capacity in the lake and discharge rates from the lake, respectively. However, in these examples, factors such as jurisdictional boundaries, shallow gradients, land availability, flooding dynamics within and beyond the downstream Drainage Area and potential impacts on existing flood extents and the Ohote Stream (due to higher flow rates)**,** all presented greater constraints (refer to Section 7 and 8 of the report titled *Rotokauri ICMP - Major Drainage: Options Report* (AECOM, 2016)), (Appendix C). Note, these constraints do not necessarily preclude increased stream channel capacity as a potential future mitigation option, should this be required (refer to Section 7 and 10 of the *Rotokauri ICMP - Major Drainage: Preferred Option & Stormwater Management Solution Report.* (AECOM, 2016), (Appendix C).

3.2.4 for further background information). Where central sub-catchment wetlands are required due to space constraints, these will need to be off-line and acceptable to Council from an urban design and operation and maintenance perspective.

The BPOs and proposed management solutions, discussed above, are further presented in the following section (*Best Practicable Options, Solutions and Implementation*), along with other best practicable options/solutions which generally support and/or integrate with these main solutions (e.g. soakage where feasible, ecological restoration and habitat creation concept). Details relating to scope, costs and priority are also provided in the next section, along with details pertaining to ownership/responsibility and development staging.

5 Best Practicable Options, Solutions and Implementation

BPOs and integrated catchment management solutions are proposed. These BPOs and management solutions address the key issues identified in Section 3 and further discussed in Section 4. They also generally align with the RSP and meet the generic and catchment specific O&Ts presented in Section 1.7 of this document, where relevant.

The majority of BPOs and solutions presented are based on provision for growth, and avoiding or otherwise minimising issues related to growth. In this regard the report titled *'Rotokauri ICMP - Three Waters Infrastructure - Integration Report*' (Appendix B), has been specifically developed to support this ICMP. The report brings together more detailed aspects associated with the planning, staging and implementation of three waters infrastructure in the catchment, and should be read in conjunction with this ICMP.

Table 5-1 below is a summary list of the BPOs and integrated catchment management solutions (structural and non-structural). The BPOs are linked to what issues and O&Ts they address. Each BPO has also been assigned a priority which reflects the implementation urgency that is associated with it. These are as follows:

- *GH - Growth High: expected to be addressed during the next 1-3 years*
- *GM - Growth Medium: expected to be addressed during the next 4-10 years*
- *GL - Growth Low: expected to be addressed post 10 years.*

The BPOs and integrated catchment management solutions are supported by several plans and drawings. Some of these are presented in Section 5.5.4 below whilst a complete plan set is appended to this document for detailed reference purposes (Appendix A).

It is further noted that the BPOs and management solutions combine to address all of the key issues identified. The implementation of all BPOs/solutions is therefore necessary to effectively implement this ICMP in its entirety.

Table 5-1: Best Practicable Options and Management Solutions (linking with originating issues and objectives)

Best practicable options/solutions				Issues addressing (in part or in full)		Objectives addressing (in part or in full)		Priority
ID	**Description**	**Design objective**	**Category**	**ID**	**Description**	**ID**	**Description**	
GENERAL / THREE WATERS								
BPO1	**Establish the Green Corridor Network** **(Central and Secondary Green Corridors)** *Note: this solution breaks down into major drainage, stormwater treatment and ecological protection and enhancement elements / BPOs below*	To address/achieve multiple issues and objectives by creating an open space blue-green corridor network	Stormwater: Flooding Hydrogeology and geotech Water quality Ecology Other	F1 F2 F3 HG1 HG2 WQ1 WQ2 WQ3 E1 E2 E3 E4 E5 O1 O2	Downstream flood protection / LOS Flood storage requirements Residual flooding High groundwater levels Ground constraints National and regional policy settings – water quality and receiving environment health High value receiving waterbodies Priority contaminants Potential decline in biodiversity values Rotokauri Drain realignment Other modified watercourses At Risk giant kokopu population Fish passage Potential inconsistency with RSP Constraints on the availability of infrastructure	SO1 SO2 SO3 SO4 SO5 SO6 SO9 SO11 SO12 SW1 SW2 SW3 CS1 CS3 CS4 CS5 CS6	Application of natural systems in the urban form Maintaining natural hydrology Quality of discharges to the existing stormwater network Stormwater management Mauri of catchment / waterbodies Stormwater effects on receiving environment Minimising infrastructure requirements Resource consent compliance Network design for planned / unplanned events Significant flood hazards Network capacity Resilience Alignment with the Rotokauri Structure Plan Ecological protection and enhancement Protecting groundwater levels in WNHP Flood protection and downstream LOS Protecting water quality	GH-GL

BPO2	**Consultation and collaboration with key stakeholders**	To align with wider catchment and multi-agency management and development initiatives (where possible) For example - reserve management plans, lake restoration initiatives, provision of infrastructure and comprehensive urban design	Stormwater: Flooding Hydrogeology and geotech Stream channel erosion Water quality Ecology Wastewater Water Supply Other	F1 F2 F3 F4 HG2 HG3 HG4 SCE1 SCE3 WQ1 WQ2 WQ3 WQ4 WQ5 WQ6 E1 E2 E3 E4 E5 E7 O1 O2	Downstream flood protection / LOS Flood storage requirements Residual flooding Interim flood storage Groundwater constraints Groundwater drawdown Lake Waiwhakareke – maintaining groundwater levels WDA – erosion susceptibility Lake Rotokauri sub-catchment – erosion susceptibility and hot spot National and regional policy settings – water quality and receiving environment health High value receiving waterbodies Priority contaminants Sediment laden runoff during development Interim stormwater treatment High risk facility sites Potential decline in biodiversity values Rotokauri Drain realignment Other modified watercourses At Risk giant kokopu population Fish passage Stream channel protection works Potential inconsistency with RSP Constraints on the availability of infrastructure	SO1 SO3 SO4 SO6 SO7 SO8 SO9 SO11 SO12 SW1 SW2 SW3 WW2 WW3 WS1 WS3 CS1 CS2 CS3 CS4 CS5 CS6 CS7 CS8	Application of natural systems in the urban form Quality of discharges to the existing stormwater network Stormwater management Stormwater effects on receiving environment Water conservation and demand management Wastewater management Minimising infrastructure requirements Resource consent compliance Network design for planned / unplanned events Significant flood hazards Network capacity Resilience Resilience Network capacity Network capacity Resilience Alignment with the Rotokauri Structure Plan Key stakeholder engagement Ecological protection and enhancement Groundwater levels in WNHP Flood protection and downstream LOS Protecting water quality Catchment development Catchment monitoring and information gathering	GH-GL

BPO3	**Application of statutory, regulatory and non-regulatory measures to effectively implement the ICMP, including education initiatives**	The effective implementation of the BPOs and integrated management solutions identified in this ICMP	Stormwater: Flooding Hydrogeology and geotech Stream channel erosion Water quality Ecology Wastewater Water Supply Other	F1 F2 F3 F4 HG2 HG3 HG4 SCE1 SCE3 WQ1 WQ2 WQ3 WQ4 WQ5 WQ6 E1 E2 E3 E4 E5 E7 O1 O2	Downstream flood protection / LOS Flood storage requirements Residual flooding Interim flood storage Groundwater constraints Groundwater drawdown Lake Waiwhakareke – maintaining groundwater levels WDA – erosion susceptibility Lake Rotokauri sub-catchment – erosion susceptibility and hot spot National and regional policy settings – water quality and receiving environment health High value receiving waterbodies Priority contaminants Sediment laden runoff during development Interim stormwater treatment High risk facility sites Potential decline in biodiversity values Rotokauri Drain realignment Other modified watercourses At Risk giant kokopu population Fish passage Stream channel protection works Potential inconsistency with RSP Constraints on the availability of infrastructure	SO1 SO2 SO3 SO4 SO5 SO6 SO7 SO8 SO9 SO11 SO12 SW1 SW2 SW3 CS1 CS2 CS3 CS4 CS5 CS6 CS7 CS8 WW WS	Application of natural systems in the urban form Maintaining natural hydrology Quality of discharges to the existing stormwater network Stormwater management Mauri of catchment / waterbodies Stormwater effects on receiving environment Water conservation and demand management Wastewater management Minimising infrastructure requirements Resource consent compliance Network design for planned / unplanned events Significant flood hazards Network capacity Resilience Alignment with the Rotokauri Structure Plan Key stakeholder engagement Ecological protection and enhancement Groundwater levels in WNHP Flood protection and downstream LOS Protecting water quality Catchment development Catchment monitoring and information gathering All wastewater objectives All water supply objectives	GH-GL

Best practicable options/solutions				Issues addressing (in part or in full)		Objectives addressing (in part or in full)		Priority
BPO4	**Coordinated infrastructure staging and the controlled release of land for development**	The provision of major infrastructure to service new development - in accordance with the water supply, wastewater and stormwater solutions developed through the RSP and ICMP	Stormwater: Flooding Hydrogeology and geotech Water quality Ecology Wastewater Water Supply Other	F1 F2 F3 WQ2 WQ3 E1 E2 E4 E5 O1 O2	Downstream flood protection / LOS Flood storage requirements Residual flooding High value receiving waterbodies Priority contaminants Potential decline in biodiversity values Rotokauri Drain realignment At Risk giant kokopu population Fish passage Potential inconsistency with RSP Constraints on the availability of infrastructure	SO3 SO4 SO5 SO6 SO7 SO8 SO9 SO11 SO12 SW1 SW2 SW3 CS1 CS2 CS3 CS4 CS5 CS6 CS7 WW2 WW3 WS1 WS3	Quality of discharges to the existing stormwater network Stormwater management Mauri of catchment / waterbodies Stormwater effects on receiving environment Water conservation and demand management Wastewater management Minimising infrastructure requirements Resource consent compliance Network design for planned / unplanned events Significant flood hazards Network capacity Resilience Alignment with the Rotokauri Structure Plan Key stakeholder engagement Ecological protection and enhancement Protecting groundwater levels in WNHP Flood protection and downstream LOS Protecting water quality Catchment development Resilience Network capacity Network capacity Resilience	GH-GL

Best practicable options/solutions				Issues addressing (in part or in full)		Objectives addressing (in part or in full)		Priority
BPO5	**Permanent works to factor ground consolidation and settlement**	Sufficient flexibility is designed and built into permanent works to accommodate for ground consolidation settlement	Stormwater: Hydrogeology and geotech Other	HG3 O1 O2	Groundwater drawdown Potential inconsistency with RSP Constraints on the availability of infrastructure	SO12 CS1	Network design for planned and unplanned events Alignment with the Rotokauri Structure Plan	GH-GL
CATCHMENT DEVELOPMENT								
BPO6	**Application of best practice site controls during catchment development and physical works**	To minimise sediment laden runoff throughout the transitional stages of development and meet catchment specific water and sediment quality targets (Table 5-2 below)	Stormwater: Water quality Ecology	WQ1 WQ2 WQ3 WQ4 E1 E4 E6	National and regional policy settings – water quality and receiving environment health High value receiving waterbodies Priority contaminants Sediment laden runoff during development Potential decline in biodiversity values At Risk giant kokopu population Sediment laden runoff during development	SO3 SO5 SO11 CS1 CS3 CS4 CS7	Quality of discharges to the existing stormwater network Mauri of catchment / waterbodies Resource consent compliance Alignment with the Rotokauri Structure Plan Ecological protection and enhancement Protecting groundwater levels in WNHP Catchment development	GH-GL

Best practicable options/solutions				Issues addressing (in part or in full)		Objectives addressing (in part or in full)		Priority
BPO7	**Application of best practice environmental protection and mitigation measures during catchment development and physical works**	To minimise adverse environmental effects throughout the transitional stages of development, and to safeguard existing biodiversity values (habitat, flora and fauna) in areas of the catchment which are not subject to development	Stormwater: Flooding Hydrogeology and geotech Water quality Ecology	HG3 HG4 WQ1 WQ2 WQ3 WQ4 E1 E2 E3 E4 E5 E6 E7	Groundwater drawdown Lake Waiwhakareke – maintaining groundwater levels National and regional policy settings – water quality and receiving environment health High value receiving waterbodies Priority contaminants Sediment laden runoff during development Potential decline in biodiversity values Rotokauri Drain realignment Other modified watercourses At Risk giant kokopu population Fish passage Sediment laden runoff during development Stream channel protection works	SO3 SO4 SO5 SO6 SO11 CS1 CS3 CS4 CS7	Quality of discharges to the existing stormwater network Stormwater management Mauri of catchment / waterbodies Stormwater effects on receiving environment Resource consent compliance Alignment with the Rotokauri Structure Plan Ecological protection and enhancement Protecting groundwater levels in WNHP Catchment development	GH-GL

Best practicable options/solutions				Issues addressing (in part or in full)		Objectives addressing (in part or in full)		Priority
BPO8	**Establish interim flood storage and stormwater treatment solutions**	To provide the necessary levels of flood protection and stormwater treatment prior to establishing the major drainage and central treatment infrastructure	Stormwater: Flooding Water quality Ecology Other	F1 F4 WQ1 WQ2 WQ3 WQ5 E1 E4 O2	Downstream flood protection / LOS Interim flood storage National and regional policy settings – water quality and receiving environment health High value receiving waterbodies Priority contaminants Interim stormwater treatment Potential decline in biodiversity values At Risk giant kokopu population Constraints on the availability of infrastructure	SO3 SO4 SO5 SO6 SO11 SW1 SW2 CS1 CS3 CS5 CS6 CS7 CS8	Quality of discharges to the existing stormater network Stormwater management Mauri of catchment / waterbodies Stormwater effects on receiving environment Resource consent compliance Significant flood hazards Network capacity Alignment with the Rotokauri Structure Plan Ecological protection and enhancement Flood protection and downstream LOS Protecting water quality Catchment development Catchment monitoring and information gathering	GH-GM

Best practicable options/solutions				Issues addressing (in part or in full)		Objectives addressing (in part or in full)		Priority
BPO9	**Undertake regular site inspections and receiving environment monitoring during catchment development and physical works**	To ensure that all site controls, environmental protection and mitigation measures, and interim flood storage and stormwater treatment solutions are operating efficiently and minimising adverse environmental effects	Stormwater: Flooding Hydrogeology and geotech Stream channel erosion Water quality Ecology	F1 F4 HG3 HG4 SCE1 SCE3 SCE4 WQ1 WQ2 WQ3 WQ4 WQ5 E1 E2 E3 E4 E6 E7	Downstream flood protection / LOS Interim flood storage Groundwater drawdown Lake Waiwhakareke – maintaining groundwater levels WDE – erosion susceptibility Lake Rotokauri sub-catchment – erosion susceptibility and hot spot Lake Rotokauri outlet to Duck Road Bridge National and regional policy settings – water quality and receiving environment health High value receiving waterbodies Priority contaminants Sediment laden runoff during development Interim stormwater treatment Potential decline in biodiversity values Rotokauri Drain realignment Other modified watercourses At Risk giant kokopu population Sediment laden runoff during development Stream channel protection works	SO3 SO4 SO5 SO6 SO11 CS3 CS4 C5 CS7 CS8	Quality of discharges to the existing stormwater network Stormwater management Mauri of catchment / waterbodies Stormwater effects on receiving environment Resource consent compliance Ecological protection and enhancement Protecting groundwater levels in WNHP Flood protection and downstream LOS Catchment development Catchment monitoring and information gathering	GH-GL
STORMWATER								

Best practicable options/solutions				Issues addressing (in part or in full)		Objectives addressing (in part or in full)		Priority
BPO10	**Maximum use of soakage/infiltration systems where ground and groundwater conditions permit (on lot and sub-catchment)** *Note: soakage/infiltration systems shall not be applied as a method of treating stormwater due to known catchment constraints and receiving water sensitivities*	To maximise the use of ground soakage where feasible for the purpose of reducing runoff volume and maintaining groundwater levels as far as practicable	Stormwater: Flooding Hydrogeology and geotech Ecology Other	F1 F2 F3 HG3 HG4 E2 O1	Downstream flood protection / LOS Flood storage requirements Residual flooding Groundwater drawdown Lake Waiwhakareke – maintaining groundwater levels Rotokauri Drain realignment Potential inconsistency with RSP	SO1 SO2 SO4 SO5 SO6 SO9 SO10 SO11 SW1 CS1 CS3 CS4 CS5	Application of natural systems in the urban form Maintaining natural hydrology Stormwater management Mauri of catchment / waterbodies Stormwater effects on receiving environment Minimising infrastructure requirements Hierarchy of preferred stormwater disposal options Resource consent compliance Significant flood hazards Alignment with the Rotokauri Structure Plan Ecological protection and enhancement Protecting groundwater levels in WNHP Flood protection and downstream LOS	GH-GL
BPO11	**Maintain groundwater levels in proximity to Lake Waiwhakareke Natural Heritage Park**	Avoid non-natural perturbations or inadvertent changes in groundwater levels in Lake Waiwhakareke Natural Heritage Park	Stormwater: Hydrogeology and geotech Ecology Other	HG3 HG4 E2 O1	Groundwater drawdown Lake Waiwhakareke – maintaining groundwater levels Rotokauri Drain realignment Potential inconsistency with RSP	SO2 SO10 SO11 CS1 CS3 CS4 CS7	Maintaining natural hydrology Hierarchy of preferred stormwater disposal options Resource consent compliance Alignment with the Rotokauri Structure Plan Ecological protection and enhancement Protecting groundwater levels in WNHP Catchment development	GH-GL

Best practicable options/solutions				Issues addressing (in part or in full)		Objectives addressing (in part or in full)		Priority
BPO12	**Major Drainage Solution** **Including the main flood storage and conveyance channel, sub-catchment conveyance swales, general conveyance channels and pipelines, and modifications to the Exelby Road culvert outlet** **(Central and Secondary Green Corridors)**	The provision of optimised flood storage and conveyance infrastructure in the southern development area in combination with the natural storage and attenuation capacity of Lake Rotokauri Downstream flood protection LOS to be safeguarded through observing the lake operating level limits: • Normal lake operating levels = RL 22.5 – 22.8 m • Design flood level = RL 23.5 m (Moturiki Datum)	Stormwater: Flooding Hydrogeology and geotech Ecology Other	F1 F2 F3 HG1 HG2 HG4 E1 E2 E3 E4 E5 O1 O2	Downstream flood protection / LOS Flood storage requirements Residual flooding High groundwater levels Ground constraints Lake Waiwhakareke – maintaining groundwater levels Potential decline in biodiversity values Rotokauri Drain realignment Other modified watercourses At Risk giant kokopu population Fish passage Potential inconsistency with RSP Constraints on the availability of infrastructure	SO1 SO4 SO5 SO6 SO9 SO11 SO12 SW1 SW2 SW3 CS1 CS3 CS4 CS5	Application of natural systems in the urban form Stormwater management Mauri of catchment / waterbodies Stormwater effects on receiving environment Minimising infrastructure requirements Resource consent compliance Network design for planned / unplanned events Significant flood hazards Network capacity Resilience Alignment with the Rotokauri Structure Plan Ecological protection and enhancement Protecting groundwater levels in WNHP Flood protection and downstream LOS	GH-GL

Best practicable options/solutions				Issues addressing (in part or in full)		Objectives addressing (in part or in full)		Priority
BPO13	**Stormwater Treatment Train Solution** **Including central sub-catchment wetlands and upstream source controls (on-lot and sub-catchment)** **(Central Green Corridor)**	To avoid adverse water and sediment quality effects in stormwater receiving waterbodies by sufficiently treating stormwater to meet the catchment specific water and sediment quality targets (Table 5-2 below)	Stormwater: Water quality Ecology Other	WQ1 WQ2 WQ3 WQ6 E1 E2 E4 O1 O2	National and regional policy settings – water quality and receiving environment health High value receiving waterbodies Priority contaminants High risk facility sites Potential decline in biodiversity values Rotokauri Drain realignment At Risk giant kokopu population Potential inconsistency with RSP Constraints on the availability of infrastructure	SO1 SO2 SO3 SO4 SO5 SO6 SO9 SO11 SO12 SW3 CS1 CS3 CS6	Application of natural systems in the urban form Maintaining natural hydrology Quality of discharges to the existing stormwater network Stormwater management Mauri of catchment / waterbodies Stormwater effects on receiving environment Minimising infrastructure requirements Resource consent compliance Network design for planned / unplanned events Resilience Alignment with the Rotokauri Structure Plan Ecological protection and enhancement Protecting water quality	GH-GL

Best practicable options/solutions				Issues addressing (in part or in full)		Objectives addressing (in part or in full)		Priority
BPO14	**Ecological protection and enhancement through eco-sensitive infrastructure design and the restoration and protection of habitat**	To integrate eco-sensitive design elements into major drainage and stormwater treatment infrastructure, and restore habitat and biodiversity values to resemble historic states where practicable	Stormwater: Ecology Stream channel erosion Other	HG4 SCE1 SCE3 WQ1 WQ2 E1 E2 E3 E4 E5 E7 O1	Lake Waiwhakareke – maintaining groundwater levels WDE – erosion susceptibility Lake Rotokauri sub-catchment – erosion susceptibility and hot spot National and regional policy settings – water quality and receiving environment health High value receiving waterbodies Potential decline in biodiversity values Rotokauri Drain realignment Other modified watercourses At Risk giant kokopu population Fish passage Stream channel protection works Potential inconsistency with RSP	SO1 SO4 SO5 SO6 SO9 SO11 SO12 CS1 CS3 CS4 CS6	Application of natural systems in the urban form Stormwater management Mauri of catchment / waterbodies Stormwater effects on receiving environment Minimising infrastructure requirements Resource consent compliance Network design for planned / unplanned events Alignment with the Rotokauri Structure Plan Ecological protection and enhancement Protecting groundwater levels in WNHP Protecting water quality	GH-GL
BPO15	**Undertake gully and stream channel stabilisation and protection works in the Waiwhakareke Development Area**	To enable increased flow volumes and durations, due to development, through the establishment of eco-sensitive stream channel stabilisation and protection works	Stormwater: Stream channel erosion Water quality Ecology Other	SCE1 WQ1 WQ2 E1 E7 O1	WDE – erosion susceptibility National and regional policy settings – water quality and receiving environment health High value receiving waterbodies Potential decline in biodiversity values Stream channel protection works Potential inconsistency with RSP	SO1 SO4 SO5 SO6 SO9 SO11 CS1 CS3 CS6	Application of natural systems in the urban form Stormwater management Mauri of catchment / waterbodies Stormwater effects on receiving environment Minimising infrastructure requirements Resource consent compliance Alignment with the Rotokauri Structure Plan Ecological protection and enhancement Protecting water quality	GH-GM

Best practicable options/solutions				Issues addressing (in part or in full)		Objectives addressing (in part or in full)		Priority
BPO16	**Undertake stream channel stabilisation and protection works in the Rotokauri Drain between Exelby Road outlet and Lake Rotokauri** **(Lake Rotokauri sub-catchment)**	To enable increased flow volumes and durations, due to development, through the establishment of eco-sensitive stream channel stabilisation and protection works	Stormwater: Stream channel erosion Water quality Ecology Other	SCE3 WQ1 WQ2 E1 E7 O1	Lake Rotokauri sub-catchment – erosion susceptibility and hot spot National and regional policy settings – water quality and receiving environment health High value receiving waterbodies Potential decline in biodiversity values Stream channel protection works Potential inconsistency with RSP	SO1 SO4 SO5 SO6 SO9 SO11 CS1 CS3 CS6	Application of natural systems in the urban form Stormwater management Mauri of catchment / waterbodies Stormwater effects on receiving environment Minimising infrastructure requirements Resource consent compliance Alignment with the Rotokauri Structure Plan Ecological protection and enhancement Protecting water quality	GH-GM
BPO17	**Undertake stream channel stabilisation and protection works in the wider catchment area if/when required** *Note: the wider catchment area includes the Southern and Northern Development Areas, Lake Waiwhakareke Natural Heritage Park, Lake Rotokauri sub-catchment and the Ohote Stream between Lake Rotokauri outlet and Duck Road Bridge*	To enable increased flow volumes and durations, due to development, through the establishment of eco-sensitive stream channel stabilisation and protection works (if/when required)	Stormwater: Stream channel erosion Water quality Ecology Other	SCE2 SCE4 WQ1 WQ2 E1 E7 O1	Waiwhakareke Reserve – erosion hot spot Lake Rotokauri outlet to Duck Road Bridge National and regional policy settings – water quality and receiving environment health High value receiving waterbodies Potential decline in biodiversity values Stream channel protection works Potential inconsistency with RSP	SO1 SO4 SO5 SO6 SO9 SO11 CS1 CS3 CS6	Application of natural systems in the urban form Stormwater management Mauri of catchment / waterbodies Stormwater effects on receiving environment Minimising infrastructure requirements Resource consent compliance Alignment with the Rotokauri Structure Plan Ecological protection and enhancement Protecting water quality	GH-GL

Best practicable options/solutions				Issues addressing (in part or in full)		Objectives addressing (in part or in full)		Priority
BPO18	**Undertake regular site inspections and receiving environment monitoring on completion of significant catchment staging, the establishment of major stormwater infrastructure and following stream channel stabilisation and protection works** *Note: major development and infrastructure staging is anticipated over several years and monitoring should be undertaken following key stages of development*	To ensure that development, permanent stormwater infrastructure and stream channel protection works are meeting the O&Ts and the overall design objectives and requirements of this ICMP	Stormwater: Flooding Hydrogeology and geotech Stream channel erosion Water quality Ecology Other	F1 HG3 HG4 SCE1 SCE2 SCE3 SCE4 WQ1 WQ2 WQ3 WQ6 E1 E2 E3 E4 E5	Downstream flood protection / LOS Groundwater drawdown Lake Waiwhakareke – maintaining groundwater levels WDE – erosion susceptibility Waiwhakareke Reserve – erosion hot spot Lake Rotokauri sub-catchment – erosion susceptibility and hot spot Lake Rotokauri outlet to Duck Road Bridge National and regional policy settings – water quality and receiving environment health High value receiving waterbodies Priority contaminants High risk facility sites Potential decline in biodiversity values Rotokauri Drain realignment Other modified watercourses At Risk giant kokopu population Fish passage	SO3 SO4 SO5 SO6 SO11 CS3 CS4 C5 CS6 CS7 CS8	Quality of discharges to the existing stormwater network Stormwater management Mauri of catchment / waterbodies Stormwater effects on receiving environment Resource consent compliance Ecological protection and enhancement Protecting groundwater levels in WNHP Flood protection and downstream LOS Protecting water quality Catchment development Catchment monitoring and information gathering	GM - GL
WASTEWATER								
BPO19	**Extension of the Far Western Interceptor (FWI)**	To enable servicing of new development in Rotokauri	Wastewater	O2 -	Constraints on the availability of infrastructure Existing capacity of the Western Interceptor	S08 SO9 WW2 WW3 WW4	Wastewater management Minimising infrastructure requirements Resilience Network capacity Dry weather overflows	GH

Best practicable options/solutions				Issues addressing (in part or in full)		Objectives addressing (in part or in full)		Priority
BPO20	**FWI alignment with central roading and drainage corridors**	To optimise a gravity solution for the catchment and minimise the infrastructure footprint	Wastewater	O2 -	Constraints on the availability of infrastructure Alignment of major infrastructure	S09 SO12	Minimising infrastructure requirements Network designed for planned and unplanned events	GH
BPO21	**Best practice infrastructure design**	To maximise design life, reduce asset maintenance and operational safety requirements	Wastewater	-	Low flow management and hydrogen sulphide generation during early development staging	SO8 SO11 SO12 WW1 WW2 WW3 WW4 WW5 WW6	Wastewater management Resource consent compliance Network design for planned and unplanned events Effects on receiving environment Resilience Network capacity Dry weather overflows Wet weather overflows Network capacity	GH-GL
WATER SUPPLY								
BPO22	**Connection of 520mm bulk mains from Pukete Reservoir to Rotokauri area**	To improve water supply to the Rotokauri area	Water Supply	O2	Constraints on the availability of infrastructure Commercial and domestic water demand as development proceeds	WS1	Network capacity	GH
BPO23	**Creation of water zones**	To improve water supply to the Rotokauri area	Water Supply	O2 - -	Constraints on the availability of infrastructure LOS for elevated areas Commercial and domestic water demand as development proceeds	WS1	Network capacity	GH
BPO24	**Extension of existing supply lines and trunk mains**	To enable servicing of new development in Rotokauri	Water supply	02	Constraints on the availability of infrastructure	SO9 WS1	Minimising infrastructure requirements Network capacity	GH-GL

Best practicable options/solutions				Issues addressing (in part or in full)		Objectives addressing (in part or in full)		Priority
BPO25	**Rainwater reuse**	To lower water supply demand and meet multiple three waters integration objectives	Water Supply	O2 - -	Constraints on the availability of infrastructure Disposal of stormwater Reduction in water use	SO9 SO10	Minimising infrastructure requirements Stormwater retention for reuse	GH-GL

Table 5-2 sets out the catchment specific water and sediment quality targets as relating to the 'catchment development' and 'stormwater treatment solution' BPOs above.

Table 5-2: Summary of water and sediment quality targets

Parameter	Units	Cu	Zn
Water quality targets			
USEPA CMC (acute, stormwater)	µg/L	4.3	42
ANZECC (chronic, baseflow)	µg/L	1.4	8
Sediment quality targets			
ISQG Low (baseflow)	mg/kg	65	270
ISQG High (baseflow)	mg/kg	200	410
Nutrient treatment targets (Southern Development Area)			
Phosphorus	Removal rate > 70 (%)		

5.1 Implementation Methods

The focus of the Rotokauri ICMP is on provision for growth and avoiding or otherwise minimising issues related to growth. The proposed BPOs and integrated management solutions presented above are firmly fixed on these objectives whilst aligning with the RSP and meeting the O&Ts presented in Section 1.7 of this document. However, until such as time as the major infrastructure solutions are established in the catchment there will be constraints on growth and the ability to service development.

In this regard the report titled *'Rotokauri ICMP - Three Waters Infrastructure - Integration Report*' (AECOM, 2016), (Appendix B) has been developed to support this ICMP, and to help inform the more detailed aspects associated with the planning, staging and implementation of three waters infrastructure in the catchment. The report sets out key staging options (Sections 4, 5 and 6) along with specific details and requirements which need to be factored when implementing the ICMP (Section 9). Similarly, Section 10 of the report sets out an indicative programme of works, the key implementation steps and several considerations pertaining to the assessments and other requirements which should be factored into detailed design and implementation planning. As stated above, this report is appended to the ICMP for detailed reference purposes and should be read in conjunction with this ICMP as required.

With regard to major infrastructure funding, the funding decisions of Council are made via the Long Term Plan (LTP) process in accordance with the LGA which is informed by Councils 30 Year Infrastructure Plan and planning documents (e.g. District Plan, Hamilton Urban Growth Strategy). The timing of Council initiated infrastructure provision is therefore part of the LTP process.

It is also noted that developer led provision of major infrastructure as identified in this ICMP (refer to Section 5.5 – *Means of Compliance*) will be required as conditions of resource and/or building consents.

As required by the HCC CSDC (Condition 30), major infrastructure is provided for in concept network plans with an indicative programme of works (Appendix A and B). In addition, all BPOs and integrated management solutions have been translated into a range of actions, projects and compliance requirements which are included in the 'means of compliance' section below (Section 5.5).

Mechanisms for enabling implementation include:

- **Development proposals / applications** – development proposals will be assessed against the BPOs, major infrastructure solutions and 'means of compliance' presented in this ICMP at the time of resource and/or building consent application. Resource consent conditions will be written and enforced accordingly. In this regard developers are referred to the various network plans and means of compliance maps and drawings to assist with development planning (Section 5.5.2 and Appendix A). Developers will also need to check with HCC on the status of these documents and participate in pre-application meetings to understand requirements prior to developing proposals and lodging consent applications.
- **Enforcement – District Plan and Bylaws** – Council has adopted a stormwater bylaw[52] which sets out Councils powers under the LGA to manage, regulate and protect, and to prevent the misuse of Council's land, structures or infrastructure associated with stormwater drainage. This is further supported by an Education Strategy (HCC website).
- **Waikato Regional Council Rural Drainage Areas/Networks** – Waikato Regional Council has powers relating to the maintenance of rural land drainage areas/networks to maintain groundwater levels, manage surface ponding after rainfall and prevent flooding. HCC's Education Strategy includes information relevant to ensuring Waikato Regional Council's land drainage requirements are met.

[52] Came into force on 28th September 2015.

- **Councils Long Term Plan** – the LTP is used as a funding mechanism for infrastructure required for the catchment. ICMP's will contribute to funding decisions on infrastructure projects in the LTP.
- **Existing programmes** such as:
    - Planned maintenance[53] and operational improvements
    - Asset renewal programmes
    - Design and development in accordance with the ITS
    - Level of customer service (satisfaction surveys, complaints, monitoring)
- **Education strategy – this requires effective internal and external communication -** incorporated into City Waters education strategy and determines appropriate communications plan within one month of ICMP approval. The strategy needs to ensure that affected Units understand and apply ICMP content and implement it though mechanisms such as consent approval processes and conditions. The external communication strategy needs to ensure that the ICMP is widely understood, referenced in consent applications and by key stakeholders, and that BPOs are adopted to ensure that the ICMP is fully implemented. Measures will include: Roadshow, Intranet, Website – ICMP, Website – FAQ, Territorial authority websites where appropriate.
- **Collaboration with other agencies** - collaboration with other agencies on implementing the ICMP, District Plan changes, resource consent approvals and bylaw reviews to ensure that design parameters for stormwater and all other ICMP requirements are met.

5.2 Capital Works Programme

As mentioned in the section above, the report titled *'Rotokauri ICMP - Three Waters Infrastructure - Integration Report'* (AECOM, 2016), (Appendix B) has been developed to support this ICMP, and to help inform the more detailed aspects associated with the planning, staging and implementation of three waters infrastructure. Section 10 of the report sets out an indicative programme of works and includes details relating to planning and designation, land purchase, design and assessment and physical works to establish the main stages of major infrastructure in the catchment (Southern Development Area).

Section 11 of the same report outlines indicative implementation costs for the main three waters infrastructure components (Table 14) and overall stage costs (Table 15). It includes a summary of the current LTP funding allowances for drainage, water and wastewater for Rotokauri (Table 16) and concludes that the need for additional funding within the current LTP period will depend on the timing of development in the initial stages (Stages 1 and 2).

For complete information regarding these details the reader is directed to the referred report in Appendix B.

5.3 Operations and Maintenance

The operation and maintenance (O&M) responsibility for three waters infrastructure assets sits with developers until those assets are vested in Council. Thereafter, HCC is responsible for undertaking O&M activities in relation to those assets, along with associated resource consent requirements on transferal, i.e. transferral of asset related consents from developers to HCC.

Developers who are designing and constructing new infrastructure are required to do so in general accordance with the HCC ITS and activity specific O&M requirements (as determined through resource and building consents prior to development).

O&M activities are generally undertaken by HCC in accordance with the relevant Activity Management Plans, Stormwater Management Plan (as relating to the HCC CSDC #105279) and other resource consents / management plans as required. Operational requirements as pertaining to activity specific bylaws, and the obligations of third

[53] For example, road catchpits and sumps which are currently cleaned on an annual cyclic basis. However, streets with known leaf fall problems are swept up to three times a week to forestall blockages.

parties in relation to those bylaws, are also closely monitored by HCC on an ongoing basis (for example via the Stormwater and Tradewaste Bylaws).

5.4 Design Parameters for Stormwater Management

The following tables outline design parameters and requirements to be achieved for stormwater management in the Rotokauri Catchment. These have been informed through catchment specific technical investigations and assessments (Appendix C), and have been selected to address catchment specific risks and sensitivities as outlined in Section 3 of this document. They have also been selected to meet the various management objectives as presented in Section 1.[54]

The parameters shall be used in the design of stormwater management and treatment devices within the Southern Development Area and Northern Development Area, as applicable. For further information regarding the design of specific devices, refer to the HCC Infrastructure Technical Specifications, Auckland Council Technical Publication 10 (TP10) or other design manual(s) if approved in advance by HCC.

Unless specifically superseded by the requirements of this ICMP, all development design shall be in accordance with the HCC Infrastructure Technical Specifications, or other technical specifications if approved in advance by HCC.

Table 5-3: Design parameters for stormwater management – Southern Development Area

SOUTHERN DEVELOPMENT AREA		
ITEM / PARAMETER	**REQUIREMENT**	
WATER QUALITY		
Stormwater Discharges (achieved at point of discharge) *Note: refer to Section 8.2 for discussion on proposed monitoring requirements*	Treatment / contaminant removal rates	
Total Phosphorous (TP)	Greater than 70% removal achieved via overall treatment train/system (source controls and central sub-catchment wetlands)	
TP / Source Controls	An average 40% removal achieved via source controls (upstream of central sub-catchment wetlands)	
TP / Central Sub-catchment Wetlands	An average of 50% removal achieved via central sub-catchment wetlands on a catchment-wide basis	
Total Suspended Solids (TSS)	Greater than 90% removal achieved via overall treatment system (including erosion and sediment controls during development and housing construction)	
Receiving Waterbodies (achieved after reasonable mixing)	Guideline values	
	Cu (µg/L)	Zn (µg/L)

[54] The design parameters and requirements to be achieved for stormwater management were developed prior to 'Proposed Waikato Regional Plan Change 1 – Waikato and Waipa Catchments (Healthy Rivers)' which was notified in late 2016. At the time of writing this ICMP it not clear how the short term and long term numerical water quality targets, as presented in the plan change, will ultimately relate to urban stormwater discharges. Therefore, guidance in this matter is required from the WRC and the water quality parameters in Tables 5-3 and 5-4 may need to be revised, if/where necessary. A 'future action' for this is included in Section 5.5.3.

SOUTHERN DEVELOPMENT AREA		
ITEM / PARAMETER	**REQUIREMENT**	
Note: 'receiving waterbodies' include the Central Green Corridor (Rotokauri Stream) post development		
USEPA CMC (acute – storm-flow)	Less than 4.3	Less than 42
ANZECC (chronic – base-flow)	Less than 1.4	Less than 8
	Other requirements	
Micro-organisms	No exceedance of relevant guideline values (*Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas.* MfE, 2003)	
Ammoniacal-nitrogen	Less than 0.88 gm/m^3	
pH	Between 6 and 9 pH units	
Temperature	Less than a 3° Celsius change in water temperature, and No greater than 23° Celsius maximum water temperature	
Dissolved oxygen (DO)	Greater than 80% saturation	
Turbidity	Less than 25 NTU	
Colour / visual clarity	No conspicuous change in colour or visual clarity	
Gross pollutants	No gross pollutants	
SEDIMENT QUALITY		
Receiving Waterbodies	Guideline values	
	Cu (mg/kg)	Zn (mg/kg)
ISQG Low (lakebed sediments)	65	270
ISQG High (lakebed sediments)	200	410
GROUNDWATER RECHARGE		
Soakage	Soakage to the maximum extent practical	
ENVIRONMENTAL FLOW		
Extended Detention	Extended Detention Volume (EDV) is assessed by multiplying the Water Quality Volume (WQV) by 1.2. WQV equates to 24 mm rainfall depth in Hamilton. This volume is then stored and released over a 24-hour period	
FLOOD STORAGE		
Interim flood storage (prior to development of the Central Green Corridor)		
Flood storage proportional to development	Equivalent to a minimum of 1200m^3 per hectare of development (gross including roads and reserves)	
Permanent central flood storage (post development of the Central Green Corridor)		
All areas draining to the Central Green Corridor	Flood storage within the Central Green Corridor. Note: discharge control (peak flow attenuation) is not required for any storm event as this will be controlled via Exelby Road culvert outlet	
Localised flood storage (residual flooding)		

SOUTHERN DEVELOPMENT AREA	
ITEM / PARAMETER	**REQUIREMENT**
Localised flood storage	Flood storage within local conveyance swales, road reserves and public reserve areas – subject to detailed assessment – sufficient to store residual flooding below the central corridor MPD 100 year + CC flood level
OVERLAND FLOW – ALL AREAS	
Overland flow	Overland flow in roads or designated drainage reserves to convey MPD 100 year flow to conveyance swales and the Central Green Corridor, as per the ITS. Note: this requirement extends to the upper reaches of all sub-catchment areas
LAKE LEVEL MANAGEMENT	
Lake Waiwhakareke	Maintain groundwater levels in proximity to lake
Lake Rotokauri	Maintain existing lake operating levels: • Normal operating range: RL 22.5m – RL 22.8m (Moturiki datum) • Design flood level: RL 23.5 (Moturiki datum)
FREEBOARD	
Freeboard	Freeboard shall be provided as per the requirements of Section 4.2.4.10 of the HCC ITS. Where the ITS 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); and • The final design flood level of the major drainage system. Further assessment will be required to define these levels

Table 5-4: Design parameters for stormwater management – Northern Development Area

NORTHERN DEVELOPMENT AREA		
ITEM / PARAMETER	**REQUIREMENT**	
WATER QUALITY		
Stormwater Discharges (achieved at point of discharge)	Treatment / contaminant removal rates	
Total Suspended Solids (TSS)	Greater than 75% removal achieved via overall treatment system	
Receiving Waterbodies (achieved after reasonable mixing)	Guideline values	
	Cu (µg/L)	Zn (µg/L)
USEPA CMC (acute – storm-flow)	Less than 4.3	Less than 42
ANZECC (chronic – base-flow)	Less than 1.4	Less than 8
	Other requirements	

NORTHERN DEVELOPMENT AREA		
ITEM / PARAMETER	**REQUIREMENT**	
Micro-organisms	No exceedance of relevant guideline values (*Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas.* MfE, 2003)	
Ammoniacal-nitrogen	Less than 0.88 gm/m^3	
pH	Between 6 and 9 pH units	
Temperature	Less than a 3° Celsius change in water temperature, and No greater than 23° Celsius maximum water temperature	
Dissolved oxygen (DO)	Greater than 80% saturation	
Turbidity	Less than 25 NTU	
Colour / visual clarity	No conspicuous change in colour or visual clarity	
Gross pollutants	No gross pollutants	
SEDIMENT QUALITY		
Receiving Waterbodies	Guideline values	
	Cu (mg/kg)	Zn (mg/kg)
ISQG Low (lakebed sediments)	65	270
ISQG High (lakebed sediments)	200	410
GROUNDWATER RECHARGE		
Soakage	Soakage to the maximum extent practical	
ENVIRONMENTAL FLOW		
Extended Detention	Extended Detention Volume (EDV) is assessed by multiplying the Water Quality Volume (WQV) by 1.2. WQV equates to 24 mm rainfall depth in Hamilton. This volume is then stored and released over a 24-hour period	
PEAK FLOW ATTENUATION		
Attenuation	2 and 10 year ARI design storms	
Catchment outlet	Maintain the existing Exelby Road culvert outlet at its existing size or smaller to maintain or restrict peak discharges	
FLOOD STORAGE		
All areas draining to a Central Green Corridor	Flood Storage is expected to be required within a Central Green Corridor with discharge controlled at the Exelby Road culvert outlet (subject to planning and assessment)	
OVERLAND FLOW – ALL AREAS		
Overland flow	Overland flow in roads or designated drainage reserves to convey MPD 100 year flow to conveyance swales and the Central Green Corridor, as per the ITS. Note: this requirement extends to the upper reaches of all sub-catchment areas	
FREEBOARD		

NORTHERN DEVELOPMENT AREA	
ITEM / PARAMETER	**REQUIREMENT**
Freeboard	Freeboard shall be provided as per the requirements of Section 4.2.4.10 of the HCC ITS. Where the ITS 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); and • The final design flood level of the major drainage system. Further assessment will be required to define these levels

5.5 Means of Compliance

This section outlines the general requirements and proposed major infrastructure for the catchment in accordance with BPOs and integrated management solutions discussed in Sections 3, 4 and 5 above. It also outlines some key future actions and opportunities that will assist HCC, developers and other key stakeholders to meet the overall requirements of this ICMP.

The following table provides a high-level overview of the 'means to comply' and effectively implement the Rotokauri ICMP through various stages of development planning, permitting (resource and building consents), development and building works. Further information can be found within the various ICMP supporting tables, the maps and drawings presented in Section 5.5.2 and Appendix A, and the various technical documents which inform this ICMP (Appendix B and C).

The definitions relevant to the funding column in the table are:

- *Developer*: person/people/company applying for Consent
- *Development*: funding by developer (as above), HCC via 10 year plan or other funding party as appropriate.

Table 5-5: Means of compliance with ICMP

Item / Section / Map Reference *(where)*	Solution / Requirement *(what)*	Details *(why)*	Assessment Timing (Key Approvals) *(how)*	Priority/Staging *(when)*	Funding *(who)*
GENERAL REQUIREMENTS					
1	**Developers and key stakeholders shall work together and collaborate with HCC** to effectively implement the Rotokauri ICMP	To implement the solutions and meet the requirements of the ICMP – actions BPO2	Resource Consent	As required by development	-
2	**All infrastructure sizing, locations and alignments are preliminary** and shall be confirmed by detailed design and integrated with other infrastructure (e.g. roads)	To implement the solutions and meet the requirements of the ICMP	Resource Consent	As required by development	-
3	**Networks shall be designed to ITS standards** (unless specified otherwise within this ICMP) and sized to service the fully developed catchment to the design parameters and requirements	To achieve minimum levels of service	Resource Consent	As required by development	-
4	**Development proposals** which are lodged with HCC and/or WRC ahead of major infrastructure shall demonstrate how the solutions and requirements of the Rotokauri ICMP will be met. This includes showing that development proposals: - Are consistent with the solutions and requirements of the ICMP - Will not compromise future development or implementation of major infrastructure, and	To implement the solutions and meet the requirements of the ICMP - actions BPO4	Resource Consent	As required by development	-

Item / Section / Map Reference *(where)*	Solution / Requirement *(what)*	Details *(why)*	Assessment Timing (Key Approvals) *(how)*	Priority/Staging *(when)*	Funding *(who)*
	- Can establish interim flood storage and stormwater treatment solutions in the catchment which meet the design parameters in Table 5-3 of this ICMP **Note:** Pre-lodgement meetings with HCC and/or WRC are required ahead of development proposals to ensure that they will meet these requirements				
5	**Resource consent applications** for development activities shall be lodged with HCC and WRC contemporaneously, and both Council's shall work together to ensure that decision outcomes are consistent with the solutions and requirements of the Rotokauri ICMP **Note 1:** Small scale development sites may not trigger WRC requirements for soil disturbance activities. In these instances HCC will ensure that site specific erosion and sediment controls (including flocculation treatment systems) are required via HCC land use and/or building consents. HCC may also seek advice and specific input from WRC as required **Note 2:** Ecological assessments are required for all modified watercourses in the catchment. These watercourses shall be identified by developers at the time of development planning and subject to the *'best practice ecological protection and mitigation measures' r*equired below (CDR/Item 10) **Note 3:** Pre-lodgement meetings are encouraged way ahead of development proposals to ensure that they will meet these requirements	To implement the solutions and meet the requirements of the ICMP - actions BPO2, BPO3 and BPO4	Resource Consent	As required by development	-

Item / Section / Map Reference *(where)*	Solution / Requirement *(what)*	Details *(why)*	Assessment Timing (Key Approvals) *(how)*	Priority/Staging *(when)*	Funding *(who)*
6 **Section 5.5.3**	**'Future actions'** as detailed in Section 5.5.3 of this ICMP shall be undertaken as specified	To implement the solutions and meet the requirements of the ICMP – actions several BPOs	Detailed design and ICMP implementation planning	HIGH PRIORITY To inform detailed design of major infrastructure	-
CATCHMENT DEVELOPMENT REQUIREMENTS					
7	**Site/activity specific technical investigations and assessments** shall be undertaken as part of development planning and shall include, but not be limited to, hydrological, hydrogeological, geotechnical and ecological investigations/assessments	To implement the solutions and meet the requirements of the ICMP - actions BPO4	Resource Consent	As required by development	Developer
8	**Sufficient flexibility shall be designed and built into permanent works** to accommodate for ground consolidation settlement. This needs to be determined and assessed in accordance with relevant statutory requirements, industry standards and codes on a site/activity specific basis **Note:** Matters to consider include, but are not necessarily limited to, proximity to the Central Green Corridor and subsequent lowering of the groundwater table, site specific soil profiles and development type/sensitivity to settlement. Suitably qualified persons will need to be engaged to assess these matters on a site/activity specific basis and the findings reported via detailed geotechnical reports at the time of resource and/or building consent applications	Rotokauri ICMP - actions BPO5	Resource Consent Building Consent	As required by development	Developer Property owner

Item / Section / Map Reference *(where)*	Solution / Requirement *(what)*	Details *(why)*	Assessment Timing (Key Approvals) *(how)*	Priority/Staging *(when)*	Funding *(who)*
9 **Section 5.4 / Table 5-3**	**Interim flood storage** (prior to development of the Central Green Corridor) shall be proportional to development and equivalent to a minimum of 1200m^3 per hectare of development (gross including roads and reserves) **Note:** Interim flood storage shall connect to the Rotokauri Drain and be located outside the footprint area of the future Central Green Corridor, unless otherwise determined at the time of consent	ICMP - actions BPO4 and BPO9 HCC CSDC – consistent with several condition requirements	Resource Consent	As required by development	Developer
10 **Section 5.5.1 / Table 5-6** **Section 5.5.2 / Figure 5-3 / Tables 5-6 and 5-7 (Appendix A)**	**Best practice ecological protection and mitigation measures** shall be applied in all catchment development and physical works activities, and throughout all transitional stages of development. In this regard, modified watercourses shall be protected and enhanced where practicable, and major drainage and stormwater treatment infrastructure shall be designed and constructed in accordance with the design requirements outlined in Tables 5-6 and 5-7 respectively **Note 1:** If/where development proposals include the diversion or infilling of modified watercourses, these shall be subject to ecological assessment and offset mitigation proposals which include ecological restoration and habitat creation elsewhere in the catchment (as per BPO14 and in accordance with Figure 5-3 and Table 5-7). Note, the Rotokauri Drain, which is subject to major realignment works, has been assessed as part of this ICMP and proposed offset mitigation is provided through BPO1, BPO11 and BPO13	ICMP - actions BPO4, BPO7 and BPO14 HCC CSDC – consistent with several condition requirements	Resource Consent	As required by development	HCC Developer (as an integral part of development works)

Item / Section / Map Reference *(where)*	Solution / Requirement *(what)*	Details *(why)*	Assessment Timing (Key Approvals) *(how)*	Priority/Staging *(when)*	Funding *(who)*
	Note 2: Construction Management Plans, Watercourse Realignment/Ecological Plans and Indigenous Fish Rescue/Relocation Plans shall be required via site/activity specific resource consents				
11	**Erosion and sediment controls** shall be in accordance with HCC and WRC requirements, and shall be established on site and approved by HCC and WRC (as required) prior to any soil disturbance activities taking place **Note 1:** This applies to all catchment development and physical works activities where soil disturbance activities are undertaken, e.g. bulk earthworks and development of major infrastructure/services where best practice guidelines, standards and relevant City bylaws shall be applied **Note 2:** Flocculation treatment systems shall be established on all development sites to treat sediment laden runoff prior to discharge from the site (e.g. to the stormwater network or directly to the receiving environment). In this regard flocculent bench testing to determine the reactivity of soils to treatment shall be undertaken, and the most efficient flocculent type applied via condition of resource consent or associated management plan	ICMP - actions BPO6 and BPO7 HCC CSDC – consistent with several condition requirements	Resource Consent	As required by development	Developer
12	**Soil rehabilitation** shall be undertaken on completion of development and construction activities to reverse compaction effects and to improve near surface soakage	ICMP - actions BPO7 and BPO10	Resource Consent Building Consent	As required by development	Developer

Item / Section / Map Reference *(where)*	Solution / Requirement *(what)*	Details *(why)*	Assessment Timing (Key Approvals) *(how)*	Priority/Staging *(when)*	Funding *(who)*
		HCC CSDC – consistent with several condition requirements			
13	**Monitoring** of soil disturbance and construction activities, as outlined in Section 8 of this ICMP, shall be undertaken as specified and as per detailed monitoring requirements determined in advance by HCC and WRC respectively (i.e. via site/activity specific resource consents) **Note:** Monitoring of soil disturbance activities during housing construction shall be undertaken by HCC and suitably qualified and experienced Erosion and Sediment Control officer/s	ICMP - actions BPO9 HCC CSDC – consistent with several condition requirements	Resource Consent	As required by development	Developer
ADDITIONAL ON LOT REQUIREMENTS					
Three Waters Management (within Hamilton City boundary)					
14	In addition to the requirements of Item 11, site specific construction and sediment controls will be required for all on-lot development and construction activities. These controls shall be regularly inspected and maintained to ensure minimum soil loss and sediment discharge from sites	ICMP - actions BPO6 and BPO7 HCC CSDC – consistent with several condition requirements	Resource Consent Building Consent	As required by development	Developer
15	**All lots:** Low flow fixtures are installed as per ITS specifications	District Plan Water Bylaw ICMP	Building Consent	Following consent approval	Property owner

Item / Section / Map Reference *(where)*	Solution / Requirement *(what)*	Details *(why)*	Assessment Timing (Key Approvals) *(how)*	Priority/Staging *(when)*	Funding *(who)*
16	**All lots:** On lot stormwater management (water efficiency measures) shall be installed in accordance with the mandatory requirements of an approved Water Impact Assessment (WIA) or, if no mandatory requirements, a reduced at source measure with a preference of reuse, soakage or bioretention. All measures shall be in accordance with HCC Three Waters Management Practice Notes Where a stormwater re-use tank is installed, this shall include a permanent storage volume for internal use (toilet flushing and laundry) and external use (e.g. watering gardens, washing vehicles on grassed areas) **Note 1:** Stormwater re-use tanks shall capture up to 100% of roof area (where practical) and be in keeping with HCC Three Waters Management Practice Notes **Note 2:** If/when treatment is provided at source through lot scale treatment devices, these can be mandated as part of the lot titles and covenants will need to be legally binding in the instance that they are part of the overall stormwater management treatment suite. This will need to include maintenance obligations to ensure that long term performance is maintained	District Plan ICMP – actions BPO6 HCC CSDC – consistent with several condition requirements	Building Consent	As required by development	Property owner
17	**High Risk Sites:** Site specific comprehensive treatment systems will be required for high risk sites to manage high concentration contaminant runoff	Stormwater Bylaw ICMP – actions BPO13	Building Consent and Inspections	As required by development	Property owner

Item / Section / Map Reference *(where)*	Solution / Requirement *(what)*	Details *(why)*	Assessment Timing (Key Approvals) *(how)*	Priority/Staging *(when)*	Funding *(who)*
STORMWATER					
General Requirements					
18 **Section 5.4 / Tables 5-3 and 5-4**	**The stormwater network**, including all stormwater management and treatment infrastructure/devices, shall be designed, constructed, operated and maintained to meet the design parameter requirements detailed in Section 5.4 / Tables 5-3 and 5-4 of this ICMP	ICMP - actions several BPOs HCC CSDC – consistent with several condition requirements	Resource Consent and Compliance Monitoring Building Consent and Inspections	As required by development	As per breakdown in line items below
19 **Section 8**	**Catchment Monitoring** shall be undertaken in accordance with site/activity specific resource consents, the ICMP technical report recommendations (Appendix C), Section 8.2 (*Proposal for Catchment Monitoring*) and the HCC CSDC / Monitoring Programme as required Detailed monitoring methodologies shall be determined and approved in advance by HCC and the WRC respectively (i.e. via site/activity specific resource consents and the HCC CSDC Monitoring Programme - Condition 37)	To ensure that ICMP solutions / requirements are effective in avoiding or otherwise minimising adverse environmental effects, and to respond accordingly ICMP - actions BPO9 and BPO18 HCC CSDC – meets monitoring condition requirements	Resource Consent and Compliance Monitoring	Throughout catchment development and ICMP implementation	Development
20 **Section 5.4 / Tables 5-3 and 5-4**	**Freeboard** shall be provided as per the requirements of the HCC ITS. Where the ITS 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	District Plan ICMP – actions BPO3	Resource Consent and/or Building Consent (if/where a freeboard level is identified via Resource Consent)	As required by development	Development

Item / Section / Map Reference *(where)*	Solution / Requirement *(what)*	Details *(why)*	Assessment Timing (Key Approvals) *(how)*	Priority/Staging *(when)*	Funding *(who)*
	year ARI overland flow paths and local freeboards); and • The final design flood level of the major drainage system. **Note:** Further assessment will be required to define these levels				
21	**Soakage** shall be the primary method of disposal unless it is proven not to be feasible. In this regard: - Developers shall undertake sufficient testing to determine if suitable soakage characteristics are present - Contamination of groundwater shall be avoided via pre-treatment devices where applicable (refer to Means of Compliance - Source Control Options / Table 5-6 and Figure 5-2) **Note 1:** Soakage/infiltration systems shall not be applied as a method of treating stormwater due to known catchment constraints and receiving water sensitivities **Note 2:** Soakage systems shall be designed to minimise adverse impacts on non-permeable paving areas (e.g. footpaths and carriageways)	ICMP - actions BPO10 and BPO11 HCC CSDC – consistent with several condition requirements	Resource Consent and/or Building Consent	As required by development	Developer
22 **Section 5.4 / Tables 5-3 and 5-4**	**Overland flow** in roads or designated drainage reserves shall convey the MPD 100 year flow to conveyance swales (Secondary Green Corridors), and the main storage and conveyance channel (Central Green Corridor), as per the requirements of the HCC ITS	District Plan ICMP – actions BPO3 and BPO12	Resource Consent	As required by development	Developer

Item / Section / Map Reference *(where)*	Solution / Requirement *(what)*	Details *(why)*	Assessment Timing (Key Approvals) *(how)*	Priority/Staging *(when)*	Funding *(who)*
	Note: This requirement extends to the upper reaches of all sub-catchment areas				
23 **Section 5.4 / Tables 5-3 and 5-4**	**Flood storage within local conveyance swales, road reserves and public reserve areas** shall be sufficient to store residual flooding below the central corridor flood level, subject to detailed assessment	District Plan ICMP – actions BPO3 and BPO12	Resource Consent	As required by development	Developer
Major Drainage Infrastructure					
24 **Map #004 & #005** **Section 5.5.2 (Appendix A)**	**Central Green Corridor - main storage and conveyance channel (CC)** – this forms the central drainage network and Rotokauri Drain realignment. It incorporates flood storage, conveyance and off-line central sub-catchment wetlands (further described below). It also incorporates a naturally constructed low flow stream channel to provide instream habitat and ecological connectivity between the two lake reserves and upstream conveyance swales (Secondary Green Corridors) **Note:** Discharge control (peak flow attenuation) for upstream development areas is not required for any storm event. This will be controlled via Exelby Road culvert outlet	ICMP - actions BPO1, BPO4, BPO12 and BPO14 HCC CSDC – consistent with several condition requirements	LTP programme of works Notice of Requirement / Designation Resource Consent	HIGH PRIORITY Detailed design, designation and land requirements As per staging and indicative programme of works (Three Waters Infrastructure Integration Report / Appendix B)	Development
25 **Map #004 & #005** **Section 5.5.2 (Appendix A)**	**Major culverts (Culvert)** – these are typically located within the main storage and conveyance channel. They convey stormwater between flood storage basins as well as controlling flow so that the basins are utilised evenly (as far as practical)	ICMP - actions BPO1, BPO4, BPO12 and BPO14 HCC CSDC – consistent with several condition requirements	LTP programme of works Notice of Requirement / Designation Resource Consent	HIGH PRIORITY Detailed design, designation and land requirements As per staging and indicative programme of	Development

Item / Section / Map Reference *(where)*	Solution / Requirement *(what)*	Details *(why)*	Assessment Timing (Key Approvals) *(how)*	Priority/Staging *(when)*	Funding *(who)*
				works (Three Waters Infrastructure Integration Report / Appendix B)	
26 **Map #004 & #005** **Section 5.5.2 (Appendix A)**	**Secondary Green Corridors – primary conveyance swales (CS)** – these form part of the central drainage network and convey stormwater from sub-catchments to the main storage and conveyance channel (Central Green Corridor). They shall be designed as naturally lined open channels (grassed or planted depending on water levels and ecological enhancement opportunities), and at minimum gradients to slow drainage to the central corridor and maintain the natural catchment runoff response (as far as practical)	ICMP - actions BPO1, BPO4, BPO12 and BPO14 HCC CSDC – consistent with several condition requirements	Resource Consent	As required by development	Development
27 **Map #004 & #005** **Section 5.5.2 (Appendix A)**	**General conveyance channel (C) or pipeline (P)** – This infrastructure will typically link existing drainage elements to new infrastructure. This infrastructure could be open channel (C), piped (P), or either (C/P) depending on site constraints and opportunities. However, ecological connectivity and enhancement opportunities shall be fully considered and integrated with other major drainage infrastructure where practical, subject to site specific assessments	ICMP - actions BPO4, BPO12 and BPO14 HCC CSDC – consistent with several condition requirements	Resource Consent	As required by development	Development
28 **Map #004 & #005**	**All major drainage infrastructure** shall be designed and located in general accordance with the requirements of Tables 5-6 and 5-7, subject to detailed design and accepted Engineering Plans	ICMP - actions BPO1, BPO4, BPO12 and BPO14	Resource Consent	As required by development	Development

Item / Section / Map Reference *(where)*	Solution / Requirement *(what)*	Details *(why)*	Assessment Timing (Key Approvals) *(how)*	Priority/Staging *(when)*	Funding *(who)*
Section 5.5.1 / Table 5-6 **Section 5.5.2 / Figure 5-4 / Table 5-7** **(Appendix A)**	**Note:** The locations of the major drainage infrastructure as shown on Maps #004 and #005 are indicative	HCC CSDC – consistent with several condition requirements			
Stormwater Treatment Infrastructure					
29 **Map #005, B & C** **Section 5.5.2** **(Appendix A)**	**A Stormwater Treatment Train** shall be implemented for all development areas within the catchment. This shall comprise **Central Sub-catchment Wetlands** and upstream **Source Controls** for contributing catchment areas (including all surface typologies - on-lot, roads and reserves) The key contaminants of concern are Total Suspended Solids, Copper, Zinc, Nitrogen and Phosphorous, the latter being the most limiting in terms of receiving environment water quality (Lakes Waiwhakareke and Rotokauri) A combined treatment efficiency of >70% Total Phosphorous removal is required to meet the catchment specific water quality targets. This shall be achieved via: - An average of 40% Total Phosphorous removal at source via optional Source Controls, and - An average of 50% Total Phosphorous removal via Central Sub-catchment Wetlands on a catchment-wide basis	ICMP - actions BPO1, BPO4, BPO13 and BPO14 HCC CSDC – consistent with several condition requirements	Resource Consent Building Consent	As required by development	Development

Item / Section / Map Reference *(where)*	Solution / Requirement *(what)*	Details *(why)*	Assessment Timing (Key Approvals) *(how)*	Priority/Staging *(when)*	Funding *(who)*
	Note: These percentages combine to achieve an overall treatment train efficiency of > 70% Total Phosphorous removal				
30 **Map #005, B & C** **Section 5.5.2 (Appendix A)** **Section 5.5.1 / Table 5-6**	**Central Sub-catchment Wetlands** (also referred to as 'Main Corridor Wetlands' and 'Wetlands' depending on location), shall provide Water Quality Volume (WQV) and Extended Detention Volume (EDV) for all contributing catchment areas. They shall also be designed and located in general accordance with the requirements of Table 5-6, subject to detailed design and accepted Engineering Plans	ICMP - actions BPO1, BPO4, BPO13 and BPO14 HCC CSDC – consistent with several condition requirements	Resource Consent	As required by development	Development
31 **Map #005** **Section 5.5.2 (Appendix A)** **Section 5.5.1 / Table 5-6**	**Source Controls** shall be determined in accordance with the requirements of Table 5-6, subject to detailed design and accepted Engineering Plans **Note:** Bio-retention raingardens or wetlands shall be utilised where feasible, however, other options may be utilised in combination with on-lot stormwater treatment if/where demonstrated to be the BPO (via a Water Impact Assessment at the time of Resource Consent)	ICMP - actions BPO13 HCC CSDC – consistent with several condition requirements	Resource Consent	As required by development	Developer
Waiwhakareke Development Area – Specific Sub-catchment Requirements					
32 **Map #005 and B** **Section 5.5.2**	**On lot, source controls and central sub-catchment wetlands:** As per general requirements as detailed in Items 29 - 31 above **Note 1:** If/where central sub-catchment wetlands are not possible due to sub-catchment constraints, the overall	ICMP - actions BPO13 and BPO14 HCC CSDC – consistent with several condition requirements	Resource Consent Building Consent	As required by development	Development

Item / Section / Map Reference *(where)*	Solution / Requirement *(what)*	Details *(why)*	Assessment Timing (Key Approvals) *(how)*	Priority/Staging *(when)*	Funding *(who)*
(Appendix A) Section 5.5.1 / Table 5-6	treatment efficiency of >70% Total Phosphorous removal will need to be met via Source Controls (on-lot and sub-catchment measures) **Note 2:** Source controls shall be sized to treat all upstream catchment areas (including brownfield areas) due to the sensitivity of the receiving environment and the water quality improvement initiatives in the downstream reserve				
33 **Section 5.5.2 / Figure 5-3 / Table 5-7 (Appendix A)**	**Gully and stream channel stabilisation, protection and enhancement works –** riparian planting (and other stabilisation measures if/where necessary) shall be established in combination with source controls and central sub-catchment wetlands	ICMP - actions BPO14 and BPO15 HCC CSDC – consistent with several condition requirements	Resource Consent	As required by development	Development
Rotokauri Drain - Stream Channel Stabilisation and Protection Works – Exelby Road to Lake Rotokauri (Outside HCC jurisdiction)					
34 **Map #004, #005, #023 Section 5.5.2 / Figure 5-3 / Table 5-7 (Appendix A)**	**Stream channel stabilisation, protection and enhancement works** shall be undertaken in the Rotokauri Drain between Exelby Road culvert and Lake Rotokauri **Note:** The Rotokauri Drain in proximity to Exelby Road (upstream and downstream) has significant ecological value, including a thriving population of At Risk giant kokopu. Eco-sensitive stream channel stabilisation and protection works shall be applied	To enable increased flow volumes and durations from the upstream development area ICMP - actions BPO12, BPO14 and BPO16 HCC CSDC – consistent with several condition requirements	LTP programme of works Landowner Agreement Resource Consent Joint Management Agreement btw HCC and WRC for ongoing maintenance works (Rotokauri Drainage Area)	HIGH PRIORITY As per staging and indicative programme of works (Three Waters Infrastructure Integration Report / Appendix B)	Development

Item / Section / Map Reference *(where)*	Solution / Requirement *(what)*	Details *(why)*	Assessment Timing (Key Approvals) *(how)*	Priority/Staging *(when)*	Funding *(who)*
WATER					
35 **Figure 3-19 (D-2241433) (Appendix A)**	**Strategic connection between Te Wetini Drive and Rotokauri Road** (250mm/450mm water mains) **Stage 1A of 3 stages** required to service the catchment for water supply	Minimum levels of service maintained in existing elevated areas Allows development of up to 200 additional sections and provides strategic link for further development	Resource Consent (if not already in place, will be required for land development)	HIGH PRIORITY **Before any development**	Development
36 **Figure 3-17 Appendix A**	**Creation of City Water Zones** (Dinsdale, orange zone extension) Stage 1B of 3 stages required to service the catchment for water supply	Enables growth and to achieve minimum levels of service Allows development of up to 800 sections (additional 600)	LTP programme of works	HIGH PRIORITY	HCC Programmed to be completed by 30 June 2017 as per 2015 LTP, subject to change
37 **Figure 3-19 (D-2241433) (Appendix A)**	**Connection of bulk mains from Pukete Reservoir to Rotokauri** and creation of Pukete water zone. **Stage 2 of 3 stages** required to service the catchment for water supply	To enable remaining development in the catchment	LTP programme of works Detailed design, designation and land requirements to support bulk main construction	MEDIUM PRIORITY	HCC Bulk mains programmed to be installed by 30 June 2019 as per 2015 LTP,

Item / Section / Map Reference *(where)*	Solution / Requirement *(what)*	Details *(why)*	Assessment Timing (Key Approvals) *(how)*	Priority/Staging *(when)*	Funding *(who)*
					subject to change Zone creation funding may be separate
38 **Figure 3-18** **Map #007** **(Appendix A)**	**Strategic trunk and bulk water mains** (250mm and 450mm) are required in specified locations as shown on the map Detailed design and staging shall ensure that minimum flows and pressures are achieved for both the proposed and existing service areas Stage 3 of 3 stages required to service the catchment for water supply	Enables growth and to achieve minimum levels of service	Resource consent	As required by development	Development
WASTEWATER					
39	**Strategic and trunk wastewater mains** are required in specified locations as shown on the map, which may be of larger size then ITS requirements	To enable development in the catchment	Land development resource consent	As required by development	Development
40	**Wastewater pump stations, rising mains and storage** are required to ITS standards to service contributing areas	To achieve minimum levels of service	Resource Consent or LTP Programme of Works	As required by development	Development
41 **MAP ID#** **Map #006** **(Appendix A)**	**Sub-catchments A and B** All trunk gravity networks to drain to a single pump station within the sub-catchment (sub-catchment boundaries to be confirmed during detailed design)	To enable development in the catchment	Resource Consent or LTP Programme of Works	As required by development	Develop

Item / Section / Map Reference *(where)*	Solution / Requirement *(what)*	Details *(why)*	Assessment Timing (Key Approvals) *(how)*	Priority/Staging *(when)*	Funding *(who)*
42 **Map #006 (Appendix A)**	**Far Western Interceptor Extension** Interceptor extended from Te Rapa Bypass to the Western Interceptor at Avalon Drive	To enable development in the catchment Provides connectivity to the WW network Improves network resilience through increased storage	LTP Programme of Works Detailed design, resource consents and land requirements to support interceptor construction	HIGH PRIORITY Programmed to be commissioned in 2017/18. Timing subject to land access	HCC Programmed to be installed by 30 June 2018 as per 2015 LTP, subject to change
43 **Map #006 (Appendix A)**	**Sub-catchment C** All trunk gravity networks to drain to a single pump station within the sub-catchment (preliminary sub-catchment boundaries to be confirmed during detailed design) **Note:** Trunk mains in sub-catchment C requires sizing to accommodate future flows from sub catchment D at full development. Emergency storage for sub-catchment D will be provided within the sub-catchment D local network and does not need to be provided for in Sub-catchment C	To enable development in the catchment and service sub-catchment D	Resource Consent or LTP Programme of Works	Requires FWI Extension to be in place	Development
44 **Map #006 (Appendix A)**	**Sub-catchment D** Currently large lot on site disposal with minimum sections size of 2500m² Future infill development will be serviced by a gravity network draining to a local pump station. The pump station will discharge by rising main into the top of a gravity trunk main in sub catchment C	To enable development in the catchment		Requires trunk mains and pump stations to service Sub catchment C to be in service	Development

Item / Section / Map Reference *(where)*	Solution / Requirement *(what)*	Details *(why)*	Assessment Timing (Key Approvals) *(how)*	Priority/Staging *(when)*	Funding *(who)*
45 **Map #006 (Appendix A)**	**Sub-catchments E and F** Gravity networks draining direct to the Far Western Interceptor	To enable development in the catchment	Resource consent	Sub-catchment F requires the FWI extension to be in service	Development
46 **Map #006 (Appendix A)**	**Sub-catchment G** Combination of gravity discharge to existing network and on lot private pump stations as required if gravity connection is not viable If development is proposed ahead of the FWI and strategic trunk network, the developer shall confirm the capacity available in the downstream local network and identify any mitigation needed to address capacity constraints Any mitigation works shall be implemented and funded by the developer	To enable further development in the catchment	Resource consent Building consent if private pumps are required	FWI to be in place and the existing development area (Patete/Rotokauri Rd) in Sub-catchment D diverted from the local network	Development
47	**If the opportunity to acquire land in proximity to the Far Western Interceptor arises**, securing the land for siting additional bulk wastewater storage should be considered	Improved network performance and future proofing	As opportunity arises for any HCC services	As opportunities arise	Development

5.5.1 Major drainage and stormwater treatment infrastructure

Table 5-6 below expands on the means of compliance for major drainage and stormwater treatment infrastructure in the catchment, and sets out some key design requirements that should be factored in the further planning and design stages of this infrastructure. Further details, design considerations and background information can be sourced from the relevant technical documents (Appendix C) and the document titled *Rotokauri ICMP - Three Waters Integration Report* (AECOM, 2016), (Appendix B).

Table 5-6: Means of compliance – major drainage and stormwater treatment infrastructure

STORMWATER TREATMENT TRAIN INFRASTRUCTURE - TO SERVE SOUTHERN DEVELOPMENT AREA					
DEVELOPER PROVIDED INFRASTRUCTURE ***To be designed and constructed in combination with the major drainage infrastructure (refer to Figures 5-2 and 5-3 in Section 5.2.2 and Map #004 and Map #005 in Appendix A)*** **General Description** **Stormwater treatment train infrastructure comprises Central Sub-catchment Wetlands and upstream Source Controls for contributing catchment areas (including on-lot, roads and reserves), as per the source control treatment options below. The key contaminants of concern are Total Suspended Solids, Copper, Zinc, Nitrogen and Phosphorous, the latter being the most limiting in terms of receiving environment water quality (Lakes Waiwhakareke and Rotokauri).** **A combined treatment efficiency of > 70% Total Phosphorous removal is a minimum requirement. This requires an average of 40% Total Phosphorous removal at source via optional Source Controls and an average 50% Total Phosphorous removal via Central Sub-catchment Wetlands on a catchment-wide basis.**					
SOURCE CONTROLS - for contributing areas upstream of Central Sub-catchment Wetlands (all surface typologies including on-lot, roads and reserves) **Note 1: Source controls shall be determined via site specific Water Impact Assessments in accordance with the options presented below. Source controls may also include mandatory on-lot measures or be limited to sub-catchment source control measures depending on site constraints, opportunities or preferences when developing an optimal solution.** ***Note 2: If/when treatment is provided at source through lot scale treatment devices, these can be mandated as part of the lot titles and covenants will need to be legally binding in the instance that they are part of the overall stormwater management treatment suite. This will need to include maintenance obligations to ensure that long term performance is maintained.** **Note 3: Soakage/infiltration systems shall not be applied as a method of treating stormwater due to known catchment constraints and receiving water sensitivities.**					
Source Control Option	**Total Phosphorous Removal Rate**	**Minimum proportion of contaminant load to reach device (% of Catchment) required to achieve Phosphorus target**	**Assessment Timing (Key Approvals) *(how)***	**Priority / Staging *(when)***	**Funding *(who)***
			Resource consent	As required by development	Development
Raingardens	60%	67%			
Wetlands	50%	80%			

Proprietary Filters	40%	100%			
Swales	30% (only when catchment is small enough to allow 9 minutes hydraulic residence time)	100% plus other measures			
Alternatives and combinations	May be considered to suit sub-catchment specific BPO to achieve minimum 40% Total Phosphorous removal, and be integrated with development form and overall landscape design aspirations. May be assessed using contaminant load modelling				
*On-lot measures	To assist in meeting overall source control requirements the above options may be integrated with mandatory on-lot measures that include rainwater tanks or other measures as listed above				
*Rain Tank	10% (with partial harvest for toilet flushing and laundry use)	Up to 100% of roof area (where practical) plus other measures. Also, to be in keeping with the HCC Three Waters Practice Notes			

Key design considerations and requirements

- **Source controls which have high efficiency removal rates for Total Phosphorous (i.e. bio-retention raingardens and wetlands) shall be centrally located in high contaminant load areas as a priority over lower load areas** (e.g. commercial and industrial areas, high traffic volume areas, carparks)
- **The consideration of alternative source controls provides flexibility for developers to develop an optimal solution.** For example, bio-retention raingardens used on most high contaminant load land-uses (such as high traffic volume areas, commercial or industrial) combined with rainwater tanks with partial re-use used on residential lots, may be able to achieve the target for mixed land-use sub-catchments. However, all contributing areas draining to a Central Sub-catchment Wetland must meet the supplementary source control requirement of 40% Total Phosphorous removal (average) as a stand-alone performance to function as a treatment train
- **Bio-retention raingardens and wetlands are the preferred source controls for Rotokauri where site conditions permit.** They are the only stand-alone treatment devices considered capable of reliably meeting the treatment target for source controls. However, raingardens will need to be designed to withstand the relatively high groundwater constraints of the catchment and be located to target high contaminant load areas over lower load areas as priority
- **The application of bio-retention raingardens should be determined on a site specific basis** but will be likely in areas within 550m of the Central Green Corridor or within 200m of the Secondary Green Corridors (primary conveyance swales), or on land sloping 5-15% to achieve necessary fall.

CENTRAL SUB-CATCHMENT WETLANDS – also referred to as 'Main Corridor Wetlands' or 'Wetlands' depending on location (refer to Map #005)							
Map Ref ***(where)***	**Solution / Device ID** ***(what)***	**Indicative Requirements (Subject to final sub-catchment areas)**		**Details** ***(why)***	**Assessment Timing (Key Approvals)** ***(how)***	**Priority / Staging** ***(when)***	**Funding** ***(who)***
		WQV (m^3)	**Area (m^2)**				
Map #005 Section 5.5.2 (Appendix A)	MCW1	2000	6600	Treats CC1b North Areas	Resource Consent	As required by development	Development
	MCW2	1200	4000	Placeholder for treatment of Reserves South West of CC1b and CC1a			
	MCW3	2400	7800	Treats CC1b South development areas			
	MCW4	3100	10200	Treats Areas South of CC2 however due to town centre will need to divert flows southeast to discharge upstream to CC1b			
	MCW5	800	2600	Placeholder to Treat CC1b Northwest Areas. Will ultimately replace Akoranga Pond when Central Green Corridor is constructed.			
	MCW6	1300	4200	Treats CC2 North Areas			
	MCW7	6600	21900	Treats large sub-catchment to south of CC2. will need realigned/alternate sub-catchment conveyance channel or water quality pipeline running from areas further south. has potential to be moved further north and discharge to CC3 if required.			
	MCW8	2500	8100	Treats CC2 North Areas			
	MCW9	2900	9600	Treats CC3 South East Areas			
	MCW10	1200	3900	Treats CC3 North Side will need to integrate with NZTA drainage			

	MCW11	2000	6700	treats CC3 South areas offline from incoming conveyance swale			
	MCW12	1100	3700	Treats CC3 Southwest areas			
	MCW13	600	1700	Treats CC4 East areas conveyed by road swales			
	MCW14	4100	13700	Treats CC4 North Areas. Potential to realign parallel to incoming sub-catchment conveyance drainage reserve			
	MCW15	1500	4800	Treats CC5 Northwest Areas			
	MCW16	1800	5900	Treats CC5 Northwest Areas			
	MCW17	900	3000	Treats areas to SE of CC5 outside Central Green Corridor. may be realigned parallel to corridor subject to earthworks / topographical constraints			
	W1	300	800	Treats flows from SW including outlet of recent pipeline which will require water quality diversion pipe			
	W2	1200	3800	Treats development areas upstream of Lake Waiwhakareke, part of a series of offline sub-catchment wetlands treating flows from Zoo sub-catchment west of Brymer Rd. Intake upstream of W1 outlet			
	W3	400	1100	Treats SW development areas upstream of Lake Waiwhakareke			
	W4	2900	9500	Sub-catchment treats valley north of Lake Waiwhakareke			
	W5	3500	11400	Treats areas Southeast of CC1a off-line from CS taking flows under motorway			
	W6	2400	7800	Placeholder for off line wetland North of CC2 to treat balance of Areas Northeast of CC2			
	W7	1000	3400	Offline placeholder wetland to treat ridge catchment Southeast of CC5			
	W8	1400	4600	Sub-catchment wetland placeholder to treat Eastern Areas draining to CC5. could be located northeast of collector road offline to conveyance swale			

	W9	5000	16500	Large sub-catchment wetland as placeholder to treat southeast areas draining to CC5			
	W10	400	1200	Existing pond treats Rotokauri Rd Subdivision to Northeast. Assumed 1.0 m deep to achieve Water Quality Volume therefore it's likely that limited phosphorous performance will be achieved			
	W11	2500	8200	Placeholder wetland to treat flows to south of Lake Rotokauri development area off-line from the main catchment drainage from Zoo Area			
	W12	3500	11600	Placeholder wetland treats flows to north of Lake Rotokauri development area off-line from the main catchment drainage from Zoo Area			
	W13	2100	6800	Placeholder wetland treats flows to south of Lake Rotokauri development area off-line from the main catchment drainage from Zoo Area			

Key design considerations and requirements

- All Central Sub-catchment Wetlands (CSW) sizing and location details as presented above and shown on Map #005, are indicative. Final sizing and placement of CSW shall be determined through sub-division planning and at detailed design stage
- CSW shall be located in the Central Green Corridor where possible for efficiency of land-use (integrating with flood conveyance footprints), aesthetics, recreational and ecological linkages. CSW will also be required in other sub-catchment areas due to land area constraints
- There is flexibility to adjust CSW locations along the Central Green Corridor, as required, to integrate with development concepts as developed
- CSW shall be offline and separate from main catchment drainage flows within the Central Green Corridor so that adequate treatment is achieved before discharge to the naturally constructed central base flow watercourse (within the Central Green Corridor)
- CSW which are located in the Central Green Corridor shall be constructed above the main flood channel to avoid flooding in less than a 2 year ARI event
- Flood storage volume displaced by raised CSW will need to be made up in wider basins (corridor areas) so that the same or greater flood storage cross-section is achieved
- All CSW shall be sized to provide treatment for 100% of the water quality flows from the contributing sub-catchments (WQV), and achieve an average of 50% Total Phosphorous removal catchment-wide. They shall also provide for Extended Detention Volume (EDV)
- All CSW shall be specifically designed for enhanced Total Phosphorous removal. This includes average wetland normal water depths of 300 mm and protection (off-line) up to the predicted 2 year flood level to ensure stable shallow water levels and low velocities for enhanced phosphorous removal and plant health

- All CSW shall support optimised treatment through spreading flows across the full width of the wetland to maximize contact with emergent macrophytes and sediments
- Debris screens shall be placed upstream of culvert inlets to mitigate risk of blockage and to facilitate operational removal of any floating debris from wetlands in large flood events.

Note: For further details, design considerations and background information refer to the following documents:

- AECOM, 2016. *Rotokauri ICMP – Three Waters Infrastructure: Integration Report*
- Morphum Environmental Ltd, 2016. *Rotokauri ICMP - Water Quality Treatment Concept Development Report*
- Streamlined Environmental Ltd, 2015. *Rotokauri ICMP - Broad Scale Water Quality Assessment*
- Kessels Ecology, 2016. *Rotokauri ICMP – Ecological Assessment and Inputs.*

STORMWATER DRAINAGE INFRASTRUCTURE

DEVELOPER PROVIDED INFRASTRUCTURE

To be designed and constructed in combination with the central sub-catchment wetlands (refer to Figure 5-3 in Section 5.2.2 and Maps #004 and#005 in Appendix A)

General Description

Secondary Green Corridors / Conveyance Swales (CS) – Conveyance swales (planted or grassed) will be developed as part of the central drainage infrastructure in order to service sub-catchment development as required. These swales convey stormwater from sub catchments to the main storage and conveyance channel in the Central Green Corridor. They shall be formed in secondary green corridors as grassed or planted swales (depending on water levels and ecological enhancement opportunities) and will extend the open space green network in accordance with the Rotokauri Structure Plan.

General Conveyance Channel (C) or Pipeline (P) – This infrastructure will typically link existing drainage elements to new infrastructure. The infrastructure could be open channel (C), piped (P) or either (C/P) depending on site constraints and opportunities. However, ecological connectivity and enhancement opportunities shall be fully considered and integrated with other major drainage infrastructure where practical, subject to site specific assessments.

Map Ref ***(where)***	**Device ID / Solution** ***(what)***	**Details** ***(why)***	**Assessment Timing (Key Approvals)** ***(how)***	**Priority and Staging** ***(when)***	**Funding** ***(who)***
Map #004 and #005	Secondary Green Corridors / Conveyance Swales (CS)	Conveyance of stormwater to central sub-catchment wetlands and the naturally constructed central base flow watercourse in the Central Green Corridor. Also, providing ecological restoration and habitat creation as far as practical.	Resource Consent	At required by development	Development

Section 5.5.2 / Figure 5-3 / Table 5-7 (Appendix A)	General Conveyance Chancel (C) or Pipeline (P) or either (C/P)	Conveyance of stormwater and ecological connectivity and enhancement as far as practical - to integrate with other major infrastructure and ecological restoration initiatives			

Key design considerations and requirements

- Conveyance swales shall be designed to convey the MPD 100 year flow and as naturally lined open channels at minimum gradients - to slow drainage to the central corridor and to maintain the natural catchment runoff response as far as practical
- Flood storage within conveyance swales (and road reserves and public reserve areas) shall be sufficient to store residual flooding below the central corridor flood level, subject to detailed assessment
- For capacity reasons, conveyance swales are anticipated to need to be about 2-2.5m deep at the central corridor. If/where they are constructed in advance of the central corridor they will need to connect to the Rotokauri Drain in the interim. To achieve this they will need to be no deeper than the existing drain
- Existing modified watercourses shall be retained and enhanced as far as practical, to restore natural character and create habitat for indigenous fauna. However, if diversion or infill is required to meet development requirements, watercourses should be replaced and enhanced to improve biodiversity values and ecological connectivity in the wider catchment area
- Fish passage shall be maintained into planted swales by ensuring culverts are installed in accordance with the ecological design features below:
    - Culverts should be installed so that the invert is about 300 mm below the channel invert
    - Culverts should be set at the same or lesser grade than the existing stream bed and at a gradient of no more than 1 in 300
    - Average water velocities in the culvert should be 0.3 m/s or lower
    - Culvert width should be sufficient to contain the existing natural channel width plus 0.5 m as a minimum on each side
    - Channel beds at upstream and downstream ends of the culvert should be protected against erosion, aggradation and degradation
    - Overhanging vegetation should be planted at both ends of the culvert, and
    - Boulders should be fixed to culvert abutments and along edges of the channel outlet structure where grades are steeper than 1 in 300
- Ecological assessments are required for all modified watercourses in the catchment (including farm drains) prior to development
- Ecological enhancement initiatives shall be undertaken in general accordance with the restoration concept as shown in Figure 5-3 and outlined in Table 5-7, i.e. *'Summary of restoration zones with existing ecological values and key considerations for development'* (Section 5.5.2).

Note: For further details, design considerations and background information refer to the following documents:

- AECOM, 2016. *Rotokauri ICMP – Three Waters Infrastructure: Integration Report*
- AECOM, 2016. *Rotokauri ICMP - Major Drainage: Preferred Option & Stormwater Management Solution Report*
- Kessels Ecology, 2016. *Rotokauri ICMP – Ecological Assessment and Inputs.*

HCC PROVIDED FUTURE OR UPGRADED INFRASTRUCTURE

To be designed and constructed in combination with the central sub-catchment wetlands (refer to Figure 5-3 in Section 5.2.2 and Maps #004 and#005 in Appendix A)

General Description

Central Green Corridor / Main Storage and Conveyance Channel (CC) – this forms the central drainage network and Rotokauri Drain realignment. It incorporates flood storage, conveyance and treatment elements (i.e. the offline central sub-catchment wetlands described above). It also incorporates a naturally constructed low flow stream channel to provide instream habitat and ecological connectivity between the two lake reserves and upstream conveyance swales (Secondary Green Corridors).

Major culverts (Culvert) – Major culverts are typically located within the main storage and conveyance channel (Central Green Corridor). They will convey stormwater between flood storage basins as well as controlling flow so that the basins are utilised evenly, as far as practical. Minor culverts, not shown on the plans, are those which are not associated with the main channel and will have standard design requirements in accordance with the ITS.

Map Ref *(where)*	**Device ID / Solution** *(what)*		**Details** *(why)*	**Assessment Timing (Key Approvals)** *(how)*	**Priority and Staging** *(when)*	**Funding** *(who)*
Map #004 and #005 **Section 5.5.2 / Figure 5-3 / Table 5-7** **(Appendix A)**	Rotokauri Culvert	Existing culvert under Rotokauri Road	Draining the Waiwhakareke Reserve Area and providing conveyance and flow control to Lake Rotokauri	Culvert to be retained / NA	-	-
	Culvert 1-4	Primary conveyance and storage control culverts	Conveyance from the Waiwhakareke Reserve Area to the main channel	LTP programme of works Notice of Requirement / Designation Resource Consent	HIGH PRIORITY Detailed design, designation and land requirements As per staging and indicative programme of works (Three Waters Infrastructure Integration Report / Appendix B)	Development

	Culvert 5 (Exelby South)	Existing culvert under Exelby Road	Draining the Southern Development Area to Lake Rotokauri and providing conveyance and flow control to the lake **(Culvert to be modified to refine flow control to the lake and protect downstream LOS / lake level management regime)**	LTP programme of works Notice of Requirement / Designation Resource Consent	MEDIUM PRIORITY Detailed design, designation and land requirements As per staging and indicative programme of works (Three Waters Infrastructure Integration Report / Appendix B)	Development
	Culvert 6 (Exelby North)	Existing culvert under Exelby Road	Draining the Northern Development Area to the Ohote Stream and providing conveyance and flow control to the stream (Culvert to be retained as flow control structure)	N/A	N/A	N/A
	Culvert 7-9	Primary conveyance culvert	Conveyance and flow control between main channel sections upstream of the Ohote Stream	LTP programme of works Notice of Requirement / Designation Resource Consent	LOW PRIORITY Detailed design, designation and land requirements	Development
	CC 1A	Primary central conveyance channel for the Southern Development Area discharging to Lake Rotokauri	Main conveyance and flood storage. **Depth is restricted to 2m in this section to protect groundwater levels in Lake Waiwhakareke**	LTP programme of works Notice of Requirement / Designation Resource Consent	HIGH PRIORITY Detailed design, designation and land requirements As per staging and indicative programme of works (Three	Development

					Waters Infrastructure Integration Report / Appendix B)	
	CC 1B, 2-5	Primary central conveyance channel for the Southern Development Area discharging to Lake Rotokauri	Main conveyance and flood storage	LTP programme of works Notice of Requirement / Designation Resource Consent	HIGH PRIORITY Detailed design, designation and land requirements As per staging and indicative programme of works (Three Waters Infrastructure Integration Report / Appendix B)	Development
	CC 6 – CC 9	Primary central conveyance channel for the Northern Development Area discharging to the Ohote Stream	Main conveyance and flood storage. Could have an attenuation function (subject to design)	LTP programme of works Notice of Requirement / Designation Resource Consent	LOW PRIORITY Detailed design, designation and land requirements	Development

Key design considerations and requirements

- CC 1A shall be limited to a depth of 2m for the first 200m (minimum), to protect groundwater levels in proximity to Lake Waiwhakareke
- The central conveyance channel (CC1A-CC5) shall be designed to incorporate a naturally constructed stream channel so that aquatic habitat is available at low flows. The stream channel width shall be similar to the current Rotokauri Drain, i.e. ranging from 1.5 m to 2.8 m with an average channel width of 1.8m
- The naturally constructed stream channel shall incorporate meanders, run/riffle/pool sequences, instream fish habitat structures and habitat diversity in general accordance with the restoration concept shown in Figure 5-3 and outlined in Table 5-7, i.e. *'Summary of restoration zones with existing ecological values and key considerations for development'* (Section 5.5.2)

- CC5 shall be designed to terminate upstream of Culvert 5 (Exelby South) to protect the existing stream channel and the At Risk giant kokopu population immediately upstream of the culvert
- Modifications to Culvert 5 (Exelby South) shall be designed to enable fish passage for indigenous climbing fish only. It shall exclude exotic pest fish such as koi carp from reaching the upper catchment area (including Lake Waiwhakareke).

Note: For further details, design considerations and background information refer to the following documents:

- AECOM, 2016. *Rotokauri ICMP – Three Waters Infrastructure: Integration Report*
- AECOM, 2016. *Rotokauri ICMP - Major Drainage: Preferred Option & Stormwater Management Solution Report*
- Kessels Ecology, 2016. *Rotokauri ICMP – Ecological Assessment and Inputs*
- CH2M Beca, 2016. *Rotokauri: Hydrogeological Interpretive Report to Support ICMP.*

DOWNSTREAM CATCHMENT REQUIREMENTS - OUTSIDE HCC JURISDICTION

STREAM CHANNEL STABILISATION, PROTECTION AND ENHANCEMENT WORKS (Rotokauri Drain – Exelby Road to Lake Rotokauri)

Works to be fully scoped, designed and undertaken at the time of upstream development works (refer to Maps* #004, #005 and #023 / Appendix A*)

General Description

Exelby Road Outlet (ERO) – this represents the drainage channel between the Exelby Road culvert and Lake Rotokauri. Although located on private property within the Waikato District, the ERO will need to be sufficiently stabilised to enable increased flow volumes and durations from the upstream development area. The Rotokauri Drain in proximity to Exelby Road has significant ecological value (including a thriving population of At Risk giant kokopu), and will provide an important link to the upstream environment and Lake Waiwhakareke.

Map Ref ***(where)***	**Device ID / Solution** ***(what)***	**Details** ***(why)***	**Assessment Timing (Key Approvals)** ***(how)***	**Priority and Staging** ***(when)***	**Funding** ***(who)***
Map #004, #005 and #023 Section 5.5.2 / Figure 5-3 / Table 5-7 (Appendix A)	Exelby Road Outlet (ERO) – drainage channel between Exelby Road outlet to Lake Rotokauri	To enable increased flow volumes and durations from the upstream development area	LTP programme of works Landowner Agreement Resource Consent Joint Management Agreement btw HCC and WRC for ongoing maintenance works	MEDIUM PRIORITY As per staging and indicative programme of works (Three Waters Infrastructure Integration	Development

			(Rotokauri Drainage Area)	Report / Appendix B)	

Key design considerations and requirements

- Stream channel stabilisation and enhancement works shall extend stream length, where practical, and incorporate the ecological design features as detailed in the restoration concept shown in Figure 5-3 and outlined in Table 5-7, i.e. *'Summary of restoration zones with existing ecological values and key considerations for development'* (Section 5.5.2). Ecological design features include the following habitat requirements (i.e. 'Giant Kokopu Zone):
    - Low water velocity
    - Areas of deeper water
    - Riparian vegetation
    - In-stream cover such as log-jams, debris dams, undercut banks, boulders etc, and
    - A dynamic flow regime with pools providing areas of lower flow within the stream
- Appropriate measures shall be applied so as not to diminish existing ecological and stream function values through stream channel stabilisation and enhancement works.

Note: For further details, design considerations and background information refer to the following documents:

- AECOM, 2016. *Rotokauri ICMP – Three Waters Infrastructure: Integration Report*
- Morphum Environmental Ltd, 2016. *Rotokauri Erosion Susceptibility Assessment*
- Kessels Ecology, 2016. *Rotokauri ICMP – Ecological Assessment and Inputs.*

5.5.2 Stormwater means of compliance maps and drawings

The means of compliance maps and drawings below relate to the main BPOs and integrated catchment management solutions for stormwater and receiving environment management. These maps and drawings are also appended to this document for detailed reference purposes (Appendix A).

The maps and drawings should be read in conjunction with the means of compliance tables and key design requirements above (Tables 5-5 and 5-6).

Figure 5-1 presents a conceptual cross section of the Central Green Corridor - Southern Development Area. This shows the integrated solution for central stormwater treatment, flood storage and conveyance and enhanced ecological values and connectivity between Lake Rotokauri and Lake Waiwhakareke. It also shows potential walkways and cycleways and how the corridor may feature in context to adjacent land use.

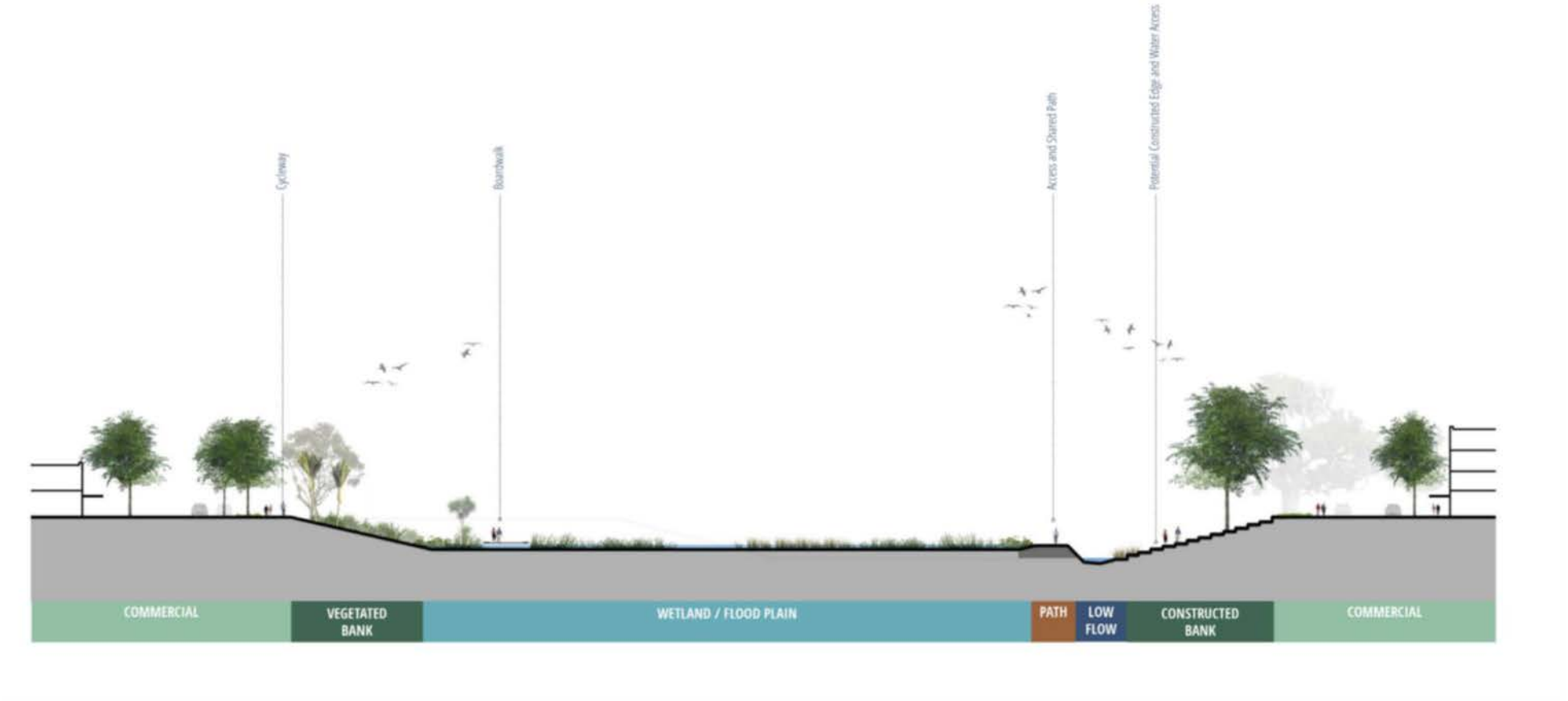

Figure 5-1: Central Green Corridor - Southern Development Area (developed by Morphum Environmental Ltd)

Figure 5-2 presents the means of compliance requirements for stormwater treatment and major drainage infrastructure - Southern Development Area.

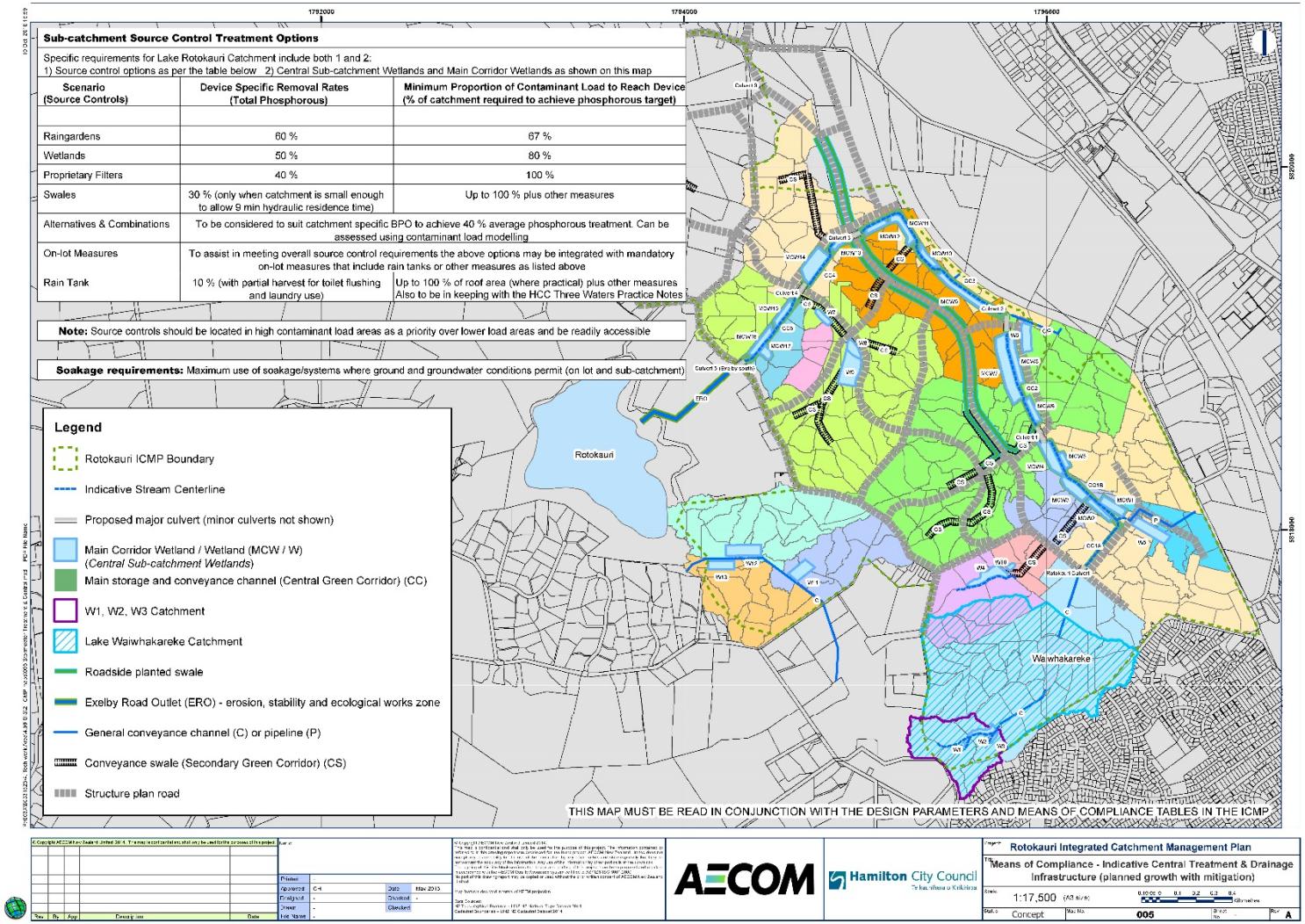

Figure 5-2: Means of compliance for stormwater treatment and major drainage infrastructure - Southern Development Area

Figure 5-3 and Table 5-7 below, present the means of compliance requirements for ecological protection and enhancement as relating to modified watercourses in the catchment. These set out the 'Restoration Zones' and design features to be included in restoration and habitat creation initiatives throughout catchment development. It is further noted that most modified watercourses in the catchment are not shown in Figure 5-3 (they have yet to be mapped and recorded). In this regard, all modified watercourses are required to be identified by developers at the time of development, and ecological assessments undertaken accordingly.

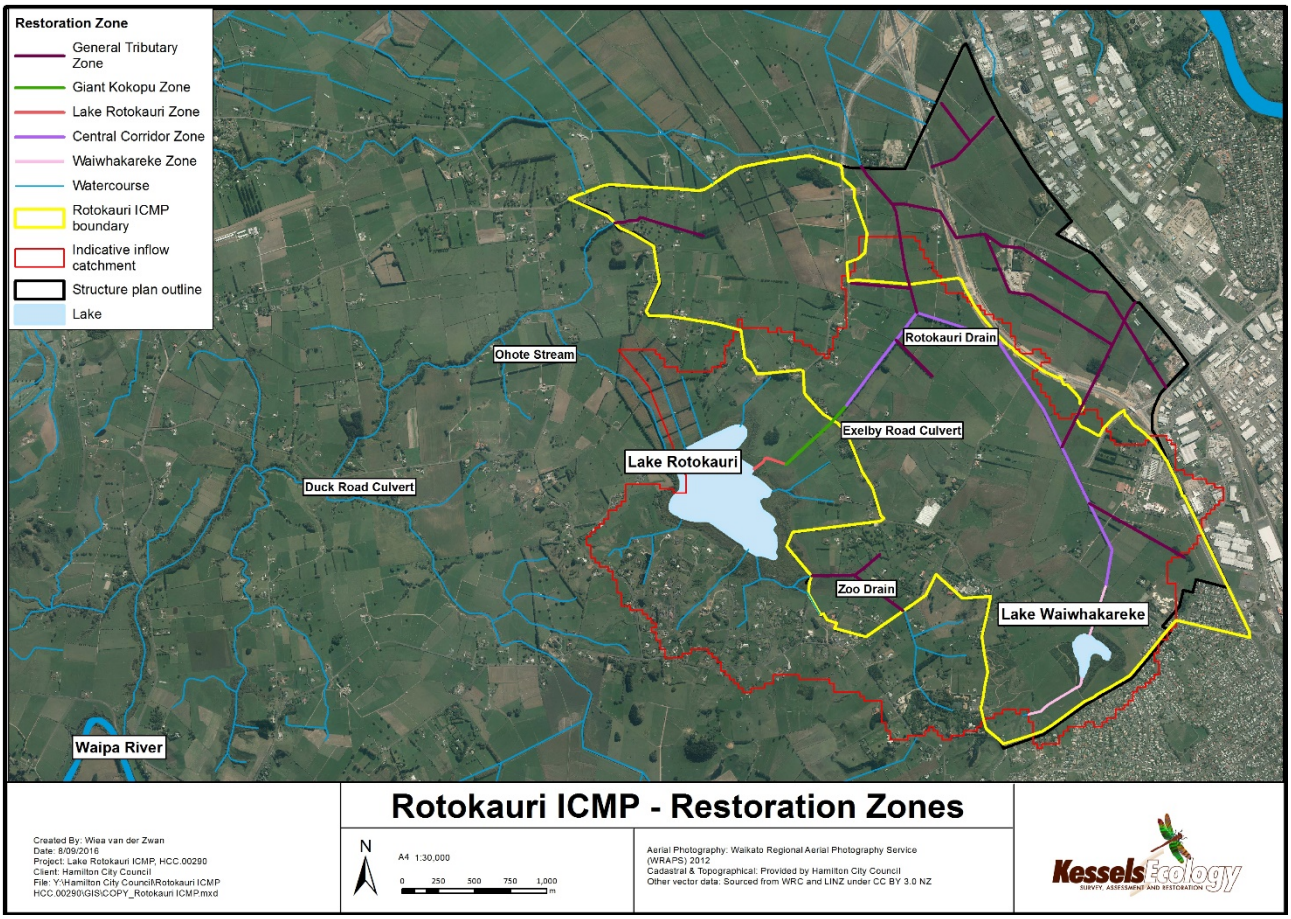

Figure 5-3: Restoration and habitat creation concept – Restoration Zones

Table 5-7: Summary of restoration zones with existing ecological values and key considerations for development

Zone	Existing ecological values/characteristics	Key considerations for development
Waiwhakareke Zone	Adjacent to Waiwhakareke Natural Heritage Park	Restoration should be coordinated with plans for the Waiwhakareke Natural Heritage Park Ecosourced plants Protection of hydrology of Lake Waiwhakareke and surrounds
Central Corridor Zone	Location of central conveyance channel and green corridor Currently a modified watercourse	A permanently flowing central channel should be created The central channel should incorporate meanders, in-stream structures and habitat diversity Fish habitat structures should be installed
General Tributary Zone	Predominantly modified, permanently flowing and ephemeral watercourses	Allowance should be made for a permanently flowing channel in permanent watercourses The channel should incorporate meanders, in-stream structures and habitat diversity Fish habitat structures should be installed
Giant Kokopu Zone	An abundant population of giant kokopu is present in the section of the Rotokauri Drain near Exelby Road The Exelby Road culvert currently restricts access of swimming fish (including pest species) to upstream areas	Habitat requirements include: • low water velocity • areas of deeper water • riparian vegetation • in-stream cover such as log-jams, debris dams, undercut banks, boulders etc, and • a dynamic flow regime with pools providing areas of lower flow within the stream. Fish passage past the Exelby Road culvert should be restricted to climbing species only, to prevent pest fish species such as koi carp from invading Lake Waiwhakareke. Eco-sensitive erosion protection is required to stabilise the stream channel downstream of Exelby Road
Lake Rotokauri Zone	Low gradient section near the margins of Lake Rotokauri	Restoration should be coordinated with plans for Lake Rotokauri Reserve

Figure 5-4 presents the means of compliance requirements for stream channel stabilisation, protection and enhancement between Exelby Road Outlet and Lake Rotokauri, including the upstream 'area of benefit'.

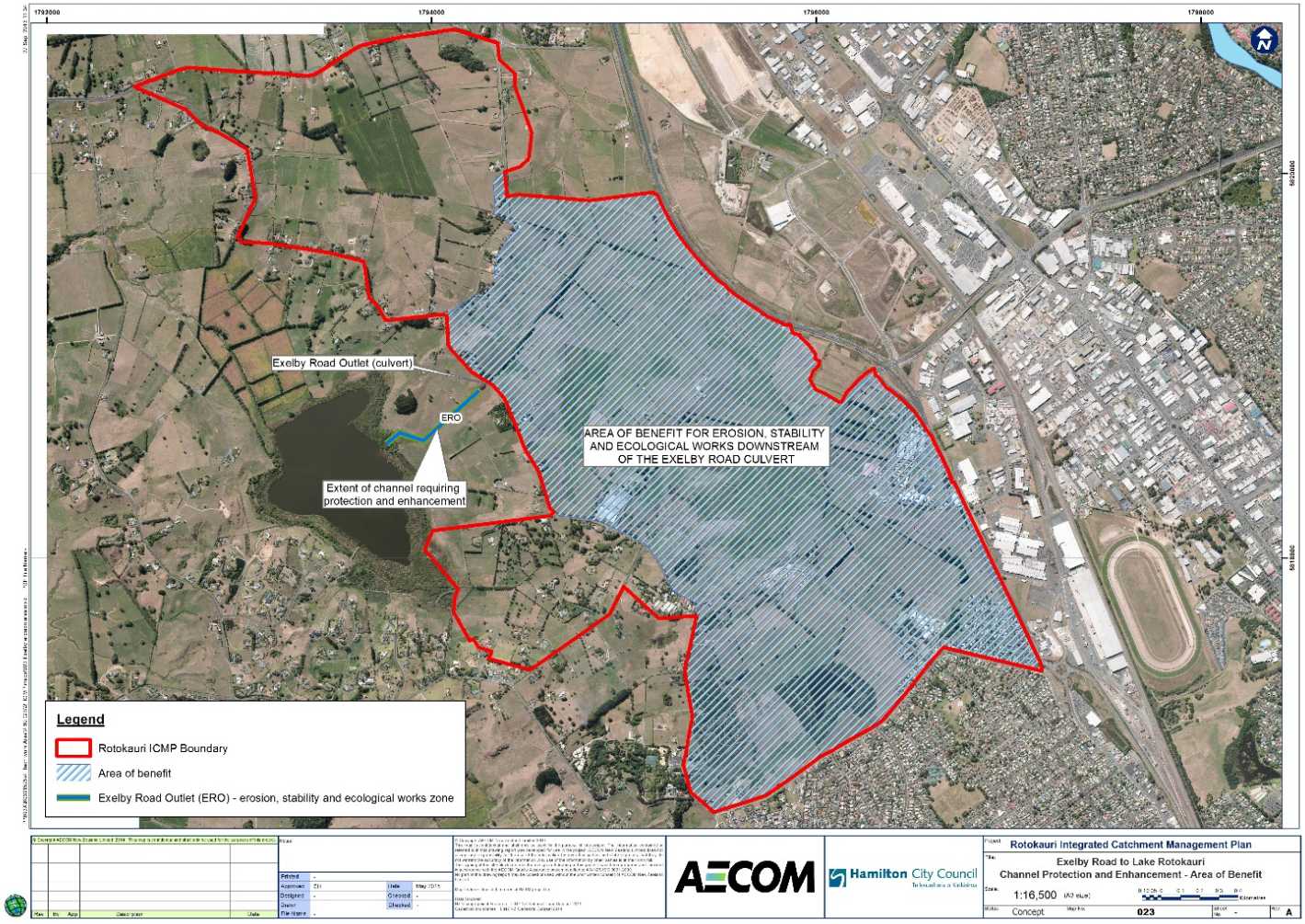

Figure 5-4: Stream channel protection and enhancement – area of benefit

5.5.3 Future actions

In support of the BPOs and means of compliance requirements set out above, the following table outlines some key actions to be considered and undertaken as part of the ongoing planning and implementation of this ICMP. As per the BPOs and means of compliance requirements, each key action has been assigned a priority which reflects the implementation urgency that is associated with it.

Further details regarding major infrastructure staging and associated implementation initiatives are provided in Sections 9 and 10 of the document titled *'Rotokauri ICMP - Three Waters Infrastructure - Integration Report'* (AECOM, 2016), (Appendix B).

Table 5-8: Future actions and opportunities

Item	Topic	Details / Comment	Recommendation / Responsibility	Priority
GENERAL				
1	ICMP initiation and implementation (including education)	Once the ICMP is finalised and approved by the HCC Project Governance Group: - Place the ICMP (and appendices) on the HCC website - Inform key stakeholders (internal and external) - Pass to the HCC Compliance Team for education purposes in accordance with HCC CSDC requirements - Include in the agenda of the Developers Forum quarterly meeting and/or other similar meetings as appropriate - Meet with HCC Development Engineers, City Planning, Planning Guidance Unit and Building Unit to ensure requirements within the ICMP (specifically BPOs, Design Parameters and Methods to Achieve Compliance) are sufficiently understood and implemented through Resource Consents and Building Consents (as required)	HCC to undertake ICMP initiation and implementation actions	HIGH PRIORITY
2	Integration with the HCC CSDC Monitoring Programme	Include the proposed catchment monitoring, as per Section 8.2 of this document, in the HCC CSDC Monitoring Programme when this is reviewed/updated (as per Condition 37 of the HCC CDSC). This should include consideration of detailed monitoring methods to ensure consistency with baseline methods and any broad-scale updates to the HCC CSDC Monitoring Programme, if/where required	HCC to include proposed catchment monitoring in the HCC CSDC Monitoring Programme	HIGH PRIORITY
3	Proposed Waikato Regional Plan Change 1 – Waikato and Waipa River Catchments (Healthy Rivers)	Seek guidance from WRC on the short term and long term numerical water quality targets for the Waikato and Waipa Rivers Catchments. In particular determine how these targets relate to urban stormwater discharges and revise the 'Design Parameters for Stormwater Management – Water Quality' (Section 5.4) if/where necessary	HCC to seek guidance from WRC	HIGH PRIORITY / ONGOING

Item	Topic	Details / Comment	Recommendation / Responsibility	Priority
4	Wider catchment management and monitoring initiatives	Explore opportunities to collaborate with other agencies on wider catchment management and monitoring initiatives. These may include, but are not limited to: - Ground and surface water monitoring in the WNHP and Lake Rotokauri Reserve areas - Water quality treatment and monitoring in the WNHP and Lake Rotokauri Reserve areas - Ecological restoration and monitoring in the WNHP and Lake Rotokauri Reserve areas - Stream channel erosion and identification of stabilisation concept projects, if/where required, in the wider catchment area	HCC and other agencies (e.g. WRC, WDC, LRMC, WAG) to explore opportunities for collaboration on wider catchment management and monitoring initiatives	HIGH PRIORITY / ONGOING
5	Rotokauri Drainage Area	Continue discussions with WRC/ICM in regard to the ongoing operation and maintenance of the Rorokauri Drain between Exelby Road culvert and Lake Rotokauri, and the rural drain(s) between Lake Rotokauri Development Area and Lake Rotokauri	HCC and WRC/ICM to further discuss and action as required	MEDIUM PRIORITY
6	Whole of life costs	Undertake a 'whole of life costs' assessment for proposed three waters infrastructure/assets in Rotokauri, including O&M costs for stormwater assets, as required	HCC to undertake 'whole of life costs' assessment as required	AS REQUIRED
7	Erosion and sediment control	Appoint or otherwise confirm a suitably qualified and experienced internal resource to undertake an erosion and sediment control advisory, monitoring and compliance auditing role, as per the means of compliance requirements (Table 5-5)	HCC to appoint a suitably qualified and experienced internal resource, as required	HIGH PRIORITY
8	Stormwater management	To ensure that HCC maintains the necessary levels of control over its stormwater network to meet relevant statutory, policy, CSDC and ICMP requirements: - Confirm the appropriate regulatory mechanism(s) to ensure that on-lot stormwater management measures are appropriately mandated and legally binding (between HCC and lot owners), if/where these form part of the overall management suite. This may be via Consent Notices or other forms of covenants/agreements, and will need to include		

Item	Topic	Details / Comment	Recommendation / Responsibility	Priority
		maintenance obligations to ensure that long term performance is maintained - Review and amend, as necessary, internal plans and procedures relating to stormwater asset maintenance (private and public) to ensure that all stormwater management measures are appropriately operated and maintained. These may include, but are not necessarily limited to, the HCC Stormwater Management Plan and the Stormwater Activity Management Plan - Develop a compliance monitoring and auditing programme to target all stormwater management measures which make up the overall management suite. These may include, but are not necessarily limited to, private on-lot measures, high risk facility sites/measures and public management devices - Appoint or otherwise confirm a suitably qualified and experienced internal resource to undertake a stormwater management advisory, monitoring and compliance auditing role, as per the means of compliance requirements (Tables 5-5, 5-6 and subsequent WIA measures/mandatory requirements) - Review the Hamilton Stormwater Bylaw (2015) and determine other means of stormwater regulation and enforcement, if necessary		
9	ICMP Review	ICMP to be reviewed and updated as required (refer to Section 9)	HCC to review and update ICMP as required	AS REQUIRED
Future ICMPs				
10	FHM and OLFP	Flood Hazard Mapping (FHM) and Overland Flowpaths (OLFP) were not undertaken for District Plan purposes within this ICMP and should be considered at a later date. Brownfield areas (Nawton and Western Heights) could be considered in the adjacent ICMP area of St Andrews	HCC to consider undertaking FHM and OLFP for Nawton and Western Heights when developing the St Andrews ICMP	Consider during St Andrews ICMP

Item	Topic	Details / Comment	Recommendation / Responsibility	Priority
Northern Development Area				
11	Discharge culvert (Exelby Road North)	Confirm the Northern Development Area culvert outlet diameter in terms of ecological requirements and maintenance of existing downstream hydraulic conditions (i.e. peak flows and base flow)	HCC to confirm the required culvert diameter in the detailed design phase	MEDIUM PRIORITY (Dependent on timing of land release and development)
12	Upstream storage and detention	Design the upstream infrastructure to maintain existing downstream hydraulic conditions through flow control at Exelby Road. Also consider the integration of off-line Central Sub-catchment Wetlands and ecological restoration initiatives, similar to the Central Green Corridor in the Southern Development Area	HCC to develop the concept design for major stormwater infrastructure	MEDIUM PRIORITY (Dependent on timing of land release and development)
13	Culvert arrangement	Confirm the arrangement of the Exelby culvert considering: - Required size and construction method - Gradient and integration with downstream channel erosion and enhancement works - Bypass flow / high level spill requirements - Minimisation of culvert blockage risk - Ecological design requirements	HCC to confirm the culvert arrangement in the detailed design phase	MEDIUM PRIORITY (Dependent on timing of land release and development)
14	Catchment investigations and assessment	Undertake hydrogeological investigations and assessment in the Northern Development Area. Also, ecological and stream channel/erosion susceptibility assessments of the Northern Tributary of the Ohote Stream (i.e. the receiving environment) to determine concept level projects to mitigate potential adverse effects and prepare the stream for cumulative volume effects, where necessary	HCC to undertake catchment investigations and assessment	MEDIUM PRIORITY (Dependent on timing of land release and development)

Item	Topic	Details / Comment	Recommendation / Responsibility	Priority
KEY IMPLEMENTATION STEPS – CENTRAL GREEN CORRIDOR				
15	Key implementation steps	Refer to Section 10.2 of the *'Rotokauri ICMP - Three Waters Infrastructure - Integration Report'* (AECOM, 2016), (Appendix B), as required, for details of key implementation steps which are required to enable development. In logical order, these include: - Hydraulic model runs for flood optimisation (see 16 to 19 below) - Landscape and Urban Design Plan (if considered to be required) - Designation of the Central Green Corridor - Land purchase of the designated land area - Project Plan (if considered to be required) - Further assessment and preliminary design (including resource consenting) - Detailed design - Procurement Plan (if considered to be required - Construction (as per the Project Plan and Procurement, as required)	Refer to the *'Rotokauri ICMP - Three Waters Infrastructure - Integration Report'* (AECOM, 2016), (Appendix B), as required	AS REQUIRED
Hydrologic and hydraulic modelling – Southern Development Area final design solution				
16	Flood storage / optimisation	Optimise the flood storage basins (Central Green Corridor) based on the final design solution inputs including: - Lake Rotokauri Design Flood Level (RL 23.5 m) - Lake Rotokauri normal operating range (RL 22.5 m – 22.8m) - Final storage configuration including adjacent reserve storage, conveyance storage and the elimination of residual flooding - Final discharge structure configuration - Long duration rainfall assessment - Model input parameter sensitivity	HCC to optimise flood storage basins based on final design solution inputs	HIGH PRIORITY

Item	Topic	Details / Comment	Recommendation / Responsibility	Priority
17	Sensitivity of final solution	Test the sensitivity of the final solution in relation to modelled parameters for runoff, rainfall and levels of development	HCC to test the sensitivity of the final solution	HIGH PRIORITY
18	Long duration rainfall	Long duration rainfall, preceding and following the design storm event, should be considered in the detailed design phase. This assessment will need to consider impacts on: - Lake Rotokauri peak level, and - Flood storage requirements	HCC to consider long duration rainfall in the detailed design phase	HIGH PRIORITY
19	Culvert block scenario	Assess culvert block scenario in conjunction with the developed discharge configuration, storage configuration and, if practical, consideration of final landform. Consideration should also be given to aspects such as: - Likelihood of blockage - Duration of blockage / time to respond - Intensity and duration of rainfall used in the assessment	HCC to assess culvert block scenario in the detailed design phase	HIGH PRIORITY
Exelby Road Culvert – Southern Development Area Outlet				
20	Exelby Road culvert diameter – base flow	Confirm the required Exelby Road culvert diameter inclusive of groundwater base flow. To date the culvert has been conceptually sized for storage and detention only; base flow may have an effect on the required diameter	HCC to confirm the required culvert diameter in the detailed design phase	MEDIUM PRIORITY
21	Exelby Road culvert arrangement	Confirm the arrangement of the Exelby culvert considering: - Required size and construction method - Gradient and integration with downstream channel erosion and enhancement works - Bypass flow / high level spill requirements - Minimisation of culvert blockage risk - Ecological design requirements	HCC to confirm the culvert arrangement in the detailed design phase	MEDIUM PRIORITY

Item	Topic	Details / Comment	Recommendation / Responsibility	Priority
General Considerations / Actions – Southern Development Area				
22	Avalon Drive inflow	Investigate the true scale of the Avalon Drive culvert inflow, or, establish whether the culvert can be partially or completely diverted to the St Andrews Catchment	HCC to investigate the true scale of the Avalon Drive culvert inflow	HIGH PRIORITY
23	Reserve storage	Confirm whether planned reserve areas can be used for flood storage and optimise the basins accordingly	HCC to confirm the utility of planned reserve areas	MEDIUM PRIORITY (Potential to affect overall sizing requirements – Basins 4 and 5)
24	Hydrogeology	- Continue groundwater level monitoring in the Southern Development Area to support assessment of groundwater / surface water interactions, including Lake Waiwhakareke survey and water balance - Undertake specific site investigations to support detailed design of the flood storage basins (and any offline storage options if/where developed)	HCC to continue groundwater level monitoring and undertake specific site investigations	HIGH PRIORITY
25	Stream channel / erosion susceptibility assessments – Southern Tributary of the Ohote Stream	- Continue to monitor and assess stream channel/erosion susceptibility of the Southern Tributary of the Ohote Stream to determine concept level projects to mitigate potential adverse effects and prepare the stream for cumulative volume effects, where necessary	HCC to undertake assessments	HIGH PRIORITY

6 Consent Compliance of this ICMP

Condition 30 of the HCC CSDC (#105279) requires that, in accordance with Condition 3(c), Catchment Management Plans (CMPs) which are prepared to guide new stormwater diversion and discharge activities in developing catchments shall be to a standard acceptable to the WRC, and shall be submitted to the WRC for written approval in a technical certification capacity. Condition 30 further requires that CMPs shall determine and recommend an 'integrated catchment management approach' which is based upon the BPO to avoid as far as practicable and otherwise minimise the cumulative adverse effects of all new stormwater activities in developing catchments.

In this regard a compliance assessment of the Rotokauri ICMP against Condition 30 of the HCC CSDC is presented in Section 6.1 below. This is followed by a more detailed assessment against Condition 30(g) and (h) requirements which relate to the environmental impacts of new stormwater activities on the catchment (Section 6.2).

In addition, Section 6.3 provides an assessment of the Rotokauri ICMP against the Waikato Tainui Environmental Plan.

It is also noted that Condition 3(a) of the HCC CSDC relates to technical certification requirements for all new stormwater diversion and discharge activities which are established after the commencement of the HCC CSDC. In particular Condition 3(a) requires all new stormwater activities to be consistent with the wider conditions of the HCC CSDC and prompts a broad-scale compliance assessment on a site/activity specific basis prior to technical certification.[55] This is a separate process and beyond the scope of this ICMP compliance assessment (Condition 30). However, it is noted that the proposed BPOs and stormwater management solutions presented in this ICMP are appropriately consistent with the wider conditions of the HCC CSDC.

6.1 Compliance with the HCC Comprehensive Stormwater Discharge Consent

The following table sets out the minimum information requirements for CMPs under Condition 30 of the HCC CSDC and how the Rotokauri ICMP meets these requirements.

Table 6-1: CSDC requirements and relevant ICMP sections

Condition	Status and comments
In accordance with Condition 3(c) of this consent, Catchment Management Plans which are prepared to guide new stormwater diversion and discharge activities in developing catchments shall be to a standard acceptable to the Waikato Regional Council, and shall be submitted to the Waikato Regional Council for written approval in a technical certification capacity, prior to the establishment of these activities. Catchment Management Plans shall determine and recommend an integrated catchment management approach which is based upon the Best Practicable Option to avoid as far as practicable and otherwise minimise, the cumulative adverse effects of all new stormwater diversion and discharge activities in developing catchments	The Rotokauri ICMP has been prepared to guide new stormwater diversion and discharge activities in the Rotokauri Catchment. It also determines an integrated catchment management approach which is based upon the BPO to avoid as far as practicable and otherwise minimise the cumulative adverse effects of all new stormwater activities in the catchment. This is further detailed in the sub-condition comments below
As a minimum, Catchment Management Plans shall include the following information:	-

[55] For further background explanation refer to the HCC CSDC / Appendix 2: Administrative Process for Incorporating New Municipal Diversion and Discharge Activities into the CSDC.

Condition	Status and comments
a) Catchment maps/drawings of the catchment delineating the catchment boundary, catchment topography, natural features, surface water bodies, existing drainage systems and infrastructure (if any) and current land-uses	A comprehensive set of catchment maps and drawings are included in Section 2 (Catchment Description) and Appendix A (ICMP Plans)
b) Classification of the surface water bodies within the catchment as detailed in the Waikato Regional Plan	Surface water classification details and drawings are included in Section 2.3.2 (Surface water classification and features) and Appendix A (ICMP Plans)
c) A description of the social, economic, ecological, amenity and cultural objectives being sought for the catchment (likely to stem from a concurrent structure planning process)	A description of ICMP generic and catchment specific objectives is included in Section 1.7 (Objectives and Targets). A description of the various social, economic, ecological, amenity and cultural values as relating to these objectives is also included in Section 2.4 (Values)
d) A description of proposed urban growth, development and land-use intensification within the catchment	A description of proposed urban land use intensification is included in Section 2.2.3 (Proposed and potential land-use change)
e) A list of the key stakeholders associated with the catchment, and details of their respective views on providing for new stormwater diversion and discharge activities within the catchment	A list of key stakeholders and details of their respective views is included in Sections 7.1 (Key Stakeholders) and 7.2 (Key Issues) respectively
f) An assessment of the current status of the catchment and its environs, together with a description of the geological, hydrological, ecological and existing infrastructural characteristics of the catchment, including any existing resource use authorisations within the catchment	An assessment of the current status of the catchment and its environs, along with existing resource use authorisations, is included in Section 2 (Catchment Description)
g) An assessment of the environmental effects of all new stormwater diversion and discharge activities on the catchment, in such detail as corresponds with the scale and significance of the effects that these activities will have on the catchment, including but not limited to, effects on:	Refer to Section 6.2 below
i) Natural features, surface water bodies and aquifers	
ii) Sites of cultural and/or historical significance	
iii) Public health	
iv) Flooding hazards	
v) Receiving water hydrology, including base flows and peak flows in rivers and streams and long-term aquifer levels	
vi) Receiving water sediment and water quality	
vii) Receiving water habitat, ecology and ecosystem health	

Condition	Status and comments
viii) Receiving water riparian vegetation	
ix) The extent and quality of open stream channels	
x) Fish passage for indigenous and trout fisheries (refer to the Waikato Regional Plan Water Management Classes for applicability)	
xi) Natural and amenity values	
xii) Existing infrastructure	
xiii) Existing authorised resource use activities	
h) An assessment of the cumulative environmental effects of all new stormwater diversion and discharge activities on the catchment over time	Refer to Section 6.2 below
i) In response to the environmental effects assessment information, an assessment of the available management options (including Low Impact Urban Design measures and stormwater management devices), for all new stormwater diversion and discharge activities within the catchment; followed by	An assessment of the available management options for all new stormwater activities within the catchment is included in Section 4 (Opportunities, Options and Analysis)
j) Recommendations on an integrated catchment management approach which is based upon the Best Practicable Option to avoid as far as practicable and otherwise minimise actual and potential adverse effects of all new stormwater diversion and discharge activities on the catchment	An integrated catchment management approach which is based upon several BPOs and stormwater management solutions is presented in Section 5 (Best Practicable Options, Solutions and Implementation). These BPOs and management solutions address the key issues identified in Section 3 and further discussed in Section 4. They also generally align with the RSP and meet the generic and catchment specific objectives presented in Section 1.7, where relevant
k) A description of proposed education and promotion initiatives to be carried out by the Consent Holder to support the integrated catchment management approach recommended by the Catchment Management Plan	A description of proposed education and promotion initiatives is included in Sections 5.5.1 (Implementation Methods) and 5.5.3 (Future Actions)
l) A description of key infrastructure works to be carried out by the Consent Holder to support the integrated catchment management approach recommended by the Catchment Management Plan	A description of key infrastructure works is referred to in Section 5.2 (Capital Works Programme) and detailed in the ICMP supporting document '*Rotokauri ICMP - Three Waters Infrastructure - Integration Report*' (AECOM, 2016), (Appendix B)

Condition	Status and comments
m) A prioritised infrastructure works schedule for implementing the integrated catchment management approach recommended by the Catchment Management Plan	A prioritised infrastructure works schedule is referred to in Sections 5.1 (Implementation Methods) and 5.2 (Capital Works Programme) and detailed in the ICMP supporting document '*Rotokauri ICMP - Three Waters Infrastructure - Integration Report*' (AECOM, 2016), (Appendix B) Note: the prioritised infrastructure works schedule is presented at the catchment scale and must be integrated into the citywide programme of works
n) A list of performance measures by which the implementation of the integrated catchment management approach recommended by the Catchment Management Plan will be gauged	Performance measures are largely reflected in the 'BPOs and management solutions' presented in Section 5 / Table 5-1, the 'Design Parameters for Stormwater Management' (Section 5.4) and the 'Means of Compliance' (Section 5.5). This includes details pertaining to major drainage and stormwater treatment infrastructure, and the 'future actions' to be considered and undertaken as part of the ongoing planning and implementation of the ICMP Performance measures are also reflected in the 'Proposal for Catchment Monitoring' (Section 8.2) and the 'Reporting and Review Process' (Section 8.3) These should be gauged and reported on an annual basis via the HCC CSDC Monitoring Programme (Condition 37) and Annual Report (Condition 39)

6.2 Assessment of Environmental Effects (Condition 30(g) and (h))

Condition 30(g) of the HCC CSDC requires an assessment of the environmental effects of all new stormwater diversion and discharge activities on the catchment, in such detail as corresponds to the scale and significance of the effects that these activities will have on the catchment. In addition, Condition 30(h) requires an assessment of the cumulative environmental effects of all new stormwater diversion and discharge activities on the catchment over time.[56]

[56] This does not in any way negate the statutory requirements for all new stormwater activities to be assessed on a site/activity specific basis at the time of development planning and pre-lodging of associated resource consents.

These assessments have therefore been integral to the Rotokauri ICMP development process and, in particular, the scoping and execution of the technical investigations and assessments undertaken to support this process. They have also followed an iterative process (i.e. each assessment informing the next) as conveyed in Section 3.2 (Stormwater and Receiving Environment Assessments), culminating in an integrated catchment management approach which is based upon several BPOs and stormwater management solutions as presented in Section 5 (Best Practicable Options, Solutions and Implementation).[57] This section also sets out key design parameters for stormwater management (Section 5.4) and the means of compliance, inclusive of future actions that will further support ICMP planning and implementation (Section 5.5).

It is generally concluded that there are significant actual and potential environmental effects associated with new stormwater diversion and discharge activities in the Rotokauri Catchment. However, the proposed BPOs and stormwater management solutions provide a credible means of 'avoiding as far as practicable and otherwise minimising adverse effects'[58], including the cumulative environmental effects of these activities on the catchment over time. There are also considerable positive environmental effects associated with new stormwater activities when mitigated, not least the establishment of the Green Corridor Network (Table 5-1 / BPO1), ecological protection and enhancement through eco-sensitive infrastructure design and the restoration and protection of habitat (Table 5-1 / BPO14) and stream channel stabilisation and protection works (Table 5-1 / BPO15-17).

It is finally noted that the proposed BPOs and stormwater management solutions (Section 5) combine to provide an 'integrated catchment management approach' and will need to be implemented in their entirety to avoid, or otherwise minimise, adverse effects on the catchment. This includes some further catchment investigations and assessment work as part of the major infrastructure and development design (Section 5.3.3 / Future actions), and the establishment of catchment specific monitoring initiatives as detailed in Section 8 (Monitoring)[59]. The ongoing operation and maintenance of the stormwater management measures which make up the overall management suite for the catchment (private and public) will also be critical in the effective implementation of the ICMP. In particular to ensure that the water quality targets and contaminant load limits as determined for the catchment are not breached (Section 3.2.4 / Water quality and treatment and Section 5.4 / Design parameters for stormwater management). The catchment specific monitoring and ongoing operation and maintenance initiatives will also need to be incorporated into reviews and updates of the HCC CSDC Monitoring Programme (Condition 37) and Stormwater Management Plan (Condition 35) respectively.

The sub-sections below respond to the minimum assessment requirements of Condition 30(g) and (h) and direct the reader to the relevant sections in the ICMP and technical assessments which have addressed environmental effects.

6.2.1 Natural features, surface water bodies and aquifers (Condition 30(g)(i))

A complete description of the natural features, surface water bodies and hydrogeological characteristics of the catchment is presented in Section 2.3 (Physical Environment) and Section 2.4 (Values). Matters pertaining to the environmental effects of new stormwater diversion and discharge activities on these features are comprehensively addressed in Section 3.2 (Stormwater and Receiving Environment Assessments) and the technical investigations and assessments in Appendix C. These are further discussed in the sub-sections below.

[57] The proposed BPOs and stormwater management solutions have also formed an integral part of the overall assessment process.

[58] Condition 30(j) requirement.

[59] Including the continuation of the vitally important groundwater level monitoring and modelling as detailed in Section 8.2.1.

6.2.2 Sites of cultural and/or historical significance (Condition 30(g)(ii))

A complete description of the sites of cultural and/or historical significance in the catchment is presented in Section 2.2.1 (Historic and cultural land-use) and Section 2.4.4 (Cultural values to Iwi and archaeological significance). These are largely related to Lake Waiwhakareke and Lake Rotokauri which are particularly valued and have historically held special spiritual and sustenance significance to local Iwi. Matters pertaining to the environmental effects of new stormwater diversion and discharge activities on these features are comprehensively addressed in Section 3.2 (Stormwater and Receiving Environment Assessments) and the technical investigations and assessments in Appendix C.

An assessment of the Rotokauri ICMP against the Waikato Tainui Environmental Plan is also presented in Section 6.3.

6.2.3 Public health (Condition 30(g)(iii))

Matters pertaining to new stormwater diversion and discharge activities, and the effects that these activities will have on public health, are comprehensively addressed in Section 3.2.4 (Water quality and treatment), Section 3.3 (Wastewater assessments) and the reports titled:

- *'Rotokauri ICMP - Three Waters Infrastructure - Integration Report*' (AECOM, 2016) (Appendix B)
- *'Rotokauri ICMP - Broad Scale Water Quality Assessment'* (Streamlined Environmental Ltd, 2015)
- '*Rotokauri ICMP - Water Quality Treatment Concept Development Report' (*Morphum Environmental Ltd, 2016).

6.2.4 Flooding hazards and receiving water hydrology (Condition 30(g)(iv) to (v))

Matters pertaining to new stormwater diversion and discharge activities, and the effects that these activities will have on flooding hazards (Condition 30(g)(iv)) and receiving water hydrology (Condition 30(g)(v)), are comprehensively addressed in Section 3.2.1 (Flooding and overland flow), Section 3.2.2 (Hydrogeology and geotechnical) and the reports titled:

- *'Rotokauri ICMP - Major Drainage: Preferred Option & Stormwater Management Solution Report' (AECOM, 2016)* (Appendix C)
- *'Rotokauri ICMP - Major Drainage: Options Report' (*AECOM, 2016) (Appendix C)
- *'Rotokauri: Hydrogeological Interpretive Report to Support ICMP* (CH2M Beca, 2016) (Appendix C).

6.2.5 Receiving water sediment and water quality (Condition 30(g)(vi))

Matters pertaining to new stormwater diversion and discharge activities, and the effects that these activities will have on receiving water sediment and water quality, are comprehensively addressed in Section 3.2.4 (Water quality and treatment) and the reports titled:

- *'Rotokauri ICMP - Broad Scale Water Quality Assessment'* (Streamlined Environmental Ltd, 2015) (Appendix C)
- '*Rotokauri ICMP - Water Quality Treatment Concept Development Report' (*Morphum Environmental Ltd, 2016) (Appendix C).

6.2.6 Other receiving water effects (Condition 30(g)(vii) to (xi)

Matters pertaining to new stormwater diversion and discharge activities, and the effects that these activities will have on receiving water habitat, ecology and ecosystem health (Condition 30(g)(vii)); receiving water riparian vegetation (Condition 30(g)(viii)); the extent and quality of open stream channels (Condition 30(g)(ix)); fish passage for indigenous and trout fisheries (Condition 30(g)(x)) and natural and amenity values (Condition 30(g)(xi)), are comprehensively addressed in Section 3.2.2 (Hydrogeology and geotechnical), Section 3.2.3 (Stream channel erosion),

Section 3.2.4 (Water quality and treatment), Section 3.2.5 (Aquatic, terrestrial and riparian ecology) and the reports titled:

- *'Rotokauri: Hydrogeological Interpretive Report to Support ICMP* (CH2M Beca, 2016) (Appendix C)
- *'Rotokauri Erosion Susceptibility Assessment' (*Morphum Environmental Ltd, 2016) (Appendix C)
- *'Rotokauri ICMP - Broad Scale Water Quality Assessment'* (Streamlined Environmental Ltd, 2015) (Appendix C)
- '*Rotokauri ICMP - Water Quality Treatment Concept Development Report' (*Morphum Environmental Ltd, 2016) (Appendix C)
- *'Rotokauri ICMP – Ecological Assessment and Inputs'* (Kessels Ecology, 2016) (Appendix C).

6.2.7 Existing infrastructure and resource use activities (Condition 30(g)(xii) to (xiii)

Matters pertaining to new stormwater diversion and discharge activities, and the effects that these activities will have on existing infrastructure (Condition 30(g)(xii)) and existing authorised resource use activities (Condition 30(g)(xiii)), are comprehensively addressed in Section 3.2.1 (Flooding and overland flow), Section 3.2.2 (Hydrogeology and geotechnical), Section 3.2.3 (Stream channel erosion), Section 3.2.4 (Water quality and treatment), Section 3.2.5 (Aquatic, terrestrial and riparian ecology) and the reports titled:

- *'Rotokauri ICMP - Major Drainage: Preferred Option & Stormwater Management Solution Report' (AECOM, 2016)* (Appendix C)
- *'Rotokauri ICMP - Major Drainage: Options Report' (*AECOM, 2016) (Appendix C)
- *'Rotokauri: Hydrogeological Interpretive Report to Support ICMP* (CH2M Beca, 2016) (Appendix C)
- *'Rotokauri Erosion Susceptibility Assessment' (*Morphum Environmental Ltd, 2016) (Appendix C)
- *'Rotokauri ICMP - Broad Scale Water Quality Assessment'* (Streamlined Environmental Ltd, 2015) (Appendix C)
- '*Rotokauri ICMP - Water Quality Treatment Concept Development Report' (*Morphum Environmental Ltd, 2016) (Appendix C)
- *'Rotokauri ICMP – Ecological Assessment and Inputs'* (Kessels Ecology, 2016) (Appendix C).

6.3 Waikato Tainui Environmental Plan

The following table provides an assessment of the Rotokauri ICMP against the relevant objectives and policies of the Waikato Tainui Environmental Plan. It is generally concluded that the Rotokauri ICMP is consistent with the objectives and policies of this plan and will assist in its implementation.

Table 6-2: Assessment of the Rotokauri ICMP against the Waikato Tainui Environmental Plan

Objective/policy	***Objective/policy met***
Goal – (Section 7) Towards Environmental Enhancement	
• An 'enhancement' approach requires the consideration of, not only individual resource use, activities, buildings, or elements, but also a holistic approach to the whole environment. • It aims for positive ecological and social outcomes where the resource use and activities effecting the environment becomes a conduit for producing resources and energy, improving physical and psychological health, remedying past pollution, and transforming and filtering waste into new resources.	The ICMP provides an enhancement approach to the provision and ongoing use of three waters infrastructure activities in the Rotokauri Catchment. This has been achieved through comprehensive technical investigations and assessments, culminating in an integrated catchment management approach which is based upon several BPOs and management solutions as presented in Section 5 ('Best Practicable Options, Solutions and Implementation'). These

• The 'enhancement' approach aims not to maintain but, through our actions, to improve the quality of the environment for future generations. • Waikato-tainui is in favour of an approach to resource use and activity operation that sees a net benefit back to the environment in such a way that the environment is actually enhanced from the resource use, activity, or development. • Resource users and activity operators need to consider how their existing or proposed use or activity can actually enhance the environment. this approach recognises that those that utilise an environmental resource for some type of benefit (whether economic, social, cultural, spiritual and/or environmental) have a responsibility to show a reciprocal benefit back to the environment.	include, but are not limited to, establishing a network of Green Corridors, major drainage and stormwater treatment train solutions, and ecological protection and enhancement through eco-sensitive infrastructure design and the restoration and protection of habitat. These initiatives will bring about tangible and reciprocal benefits to the environment once established.
Vision and Strategy	
Objective 11.7.1 *Te Ture Whaimoana (V&S) prevails in any resource management, use and activity within the Waikato River catchment in the Waikato-Tainui rohe.* *Our Vision is for a future where 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.* In order to realise the Vision, the following Objectives will be pursued: A restoration and protection of the health and wellbeing of the Waikato River.* B. The restoration and protection of the relationship of Waikato-Tainui with the Waikato River, including their economic, social, cultural, and spiritual relationships.* C. The restoration and protection of the relationship of Waikato River Iwi according to their tikanga and kawa, with the Waikato River, including their economic, social, cultural and spiritual relationships. D. The restoration and protection of the relationship of the Waikato Region's communities with the Waikato River including their economic, social, cultural and spiritual relationships.	The ICMP fully recognises the Vision and Strategy as part of the strategic context from which it derives (Section 1.3). It is also consistent with the objectives of the Vision and Strategy, in particular through developing several compatible O&Ts for the Rotokauri Catchment (Section 1.7) and BPOs and management solutions (Section 5).

E. The integrated, holistic and coordinated approach to management of the natural, physical, cultural and historic resources of the Waikato River.* F. The adoption of a precautionary approach towards decisions that may result in significant adverse effects on the Waikato River, and in particular those effects that threaten serious or irreversible damage to the Waikato River.* G. The recognition and avoidance of adverse cumulative effects, and potential cumulative effects, of activities undertaken both on the Waikato River and within its catchments on the health and wellbeing of the Waikato River.* H. The recognition that the Waikato River is degraded and should not be required to absorb further degradation as a result of human activities.* I. The protection and enhancement of significant sites, fisheries, flora and fauna.* J. The recognition that the strategic importance of the Waikato River to New Zealand's social, cultural, environmental and economic wellbeing is subject to the restoration and protection of the health and wellbeing of the Waikato River. K. The restoration of water quality within the Waikato River so that it is safe for people to swim in and take food from over its entire length.	
Objective 11.7.2 *Te Ture Whaimoana (V&S) is a guide to any resource management, use and activity within the Waikato River catchment in the Waikato-Tainui rohe.*	The development of the ICMP, and the BPOs and management solutions it identifies, have been guided by the Vision and Strategy (Sections 1.3, 1.7 and 5).
Indigenous biodiversity	
Objective - Indigenous biodiversity *15.3.1 The full range of Waikato ecosystem types found throughout the Waikato-Tainui rohe are robust and support representative native flora and fauna.* **Policy – Indigenous biodiversity** 15.3.1.1 To ensure that the full range of Waikato ecosystem types found throughout the Waikato-Tainui rohe are robust and support representative native flora and fauna.	The ICMP identifies the ecosystem types and the native flora and fauna history of the Rotokauri Catchment. It also identifies BPO's for ecological protection and enhancement through eco-sensitive infrastructure design and the restoration and protection of habitat (Section 5).
Natural hazards	
Objective –Land use and structures *17.3.1 Land use and the construction of structures occurs in a way that does not increase the risk or magnitude of a natural hazard event, and that does not increase the risk or effects on*	The ICMP is supported by hydrologic and hydrogeological investigations and assessments, and identifies BPOs and management solutions to minimise the risk and magnitude of catchment flooding (Section 5).

human life or activity in the event that a natural hazard event occurs. **Policy – Land use and structures** 17.3.1.1 To ensure that land use and structures do not increase the risk or magnitude of a natural hazard event, and does not increase the risk or effects on human life or activity in the event that a natural hazard event occurs.	
Objective – Climate change *17.3.3 - The cause and effects of climate change are understood and prepared for within the Waikato-Tainui rohe.* **Policy – understanding and managing adverse effects of climate change** 17.3.3.1 To ensure that the causes and effects of climate change are understood and prepared for within the Waikato-Tainui rohe.	The ICMP has factored the potential effects of climate change into the BPOs and management solutions identified (Section 5).
Freshwater	
Objective – The relationship between Waikato-Tainui and water *19.4.1 Waikato-Tainui engage and participate in the highest level of decision-making on matters that affect waters in the Waikato-Tainui rohe.* **Policy – Decision making** 19.4.1.1 To ensure that Waikato-Tainui engage and participate in the highest level of decision-making on matters that affect waters in the Waikato-Tainui rohe.	Waikato–Tainui have engaged and participated in the development of the Rotokauri ICMP. Further engagement and participation initiatives are envisaged throughout the implementation of the Rotokauri ICMP as identified in Section 5.5.3 (Future actions).
Objective – Water quality *19.4.2 Water quality is such that fresh waters within the rohe of Waikato-Tainui are drinkable, swimmable and fishable in all places (with water quality to the level that Kiingi Taawhiao could have expected in his time).* **Policy – water quality** 19.4.2.1 Regulators to set clearer and higher water quality targets, and to develop and incentivise methods to achieve these targets.	The ICMP identifies several BPOs and management solutions to appropriately manage three waters activities in the Rotokauri Catchment. These will assist in the restoration and protection of freshwater bodies over time (along with wider catchment initiatives). Clear stormwater treatment and contaminant load limits have also been defined in the ICMP (Sections 3.2.4 and 5.4), along with methods to achieve these targets (Section 5).
Objective – Water quality (integrated catchment management) *19.4.3 An integrated and holistic approach to management of water is achieved.* **Policy –Integrated catchment management** 19.4.3.1 To ensure that there is an integrated and holistic approach to catchment management that is effective and informative and the scope of planning is broad.	The central purpose of the ICMP is to determine an integrated and holistic approach to three waters management in the Rotokauri Catchment. In this regard the ICMP identifies several BPOs and management solutions to achieve this objective (Section 5).

Objective – Water quantity and allocation *19.4.4 Water allocation is consistent with restoring and protecting the health and wellbeing of water bodies within the rohe of Waikato-Tainui.* **Policy – Water quantity and allocation** Those regulating the use of water (including water take, and direct and indirect discharges to water): 19.4.4.1 Ensure that any water allocation framework operates under consistent principles, is equitable and efficient and restores and protects the health and wellbeing of Waikato-Tainui water bodies.	The ICMP identifies several BPOs and management solutions, including the application of water sensitive devices and a drainage hierarchy which includes the reuse of stormwater where practicable (Section 5).
Wetlands	
Objective – Wetland mauri and condition, hauanga kai, habitat 20.3.1 *Existing wetlands are protected and enhanced* **Policy – Improvement to the condition of existing wetlands** 20.3.1.1 to encourage improvements to local hydrology (where possible) to support healthy wetland function, and restoration of locally appropriate wetland biodiversity within local planning and land management practice. **Policy – Land use planning and management adjacent to wetlands** 20.3.1.2 To ensure that all land use practices that have the potential to impact on wetlands have efficient sediment, drainage, discharge, fertiliser application, and riparian buffer control practices in place to ensure that adverse impacts on wetlands are prevented. **Policy – Pest animals and plants** 20.3.1.3 refer to objective – biosecurity risks and objective – control agents for relevant objectives and policies for effectively managing pest animals and plants.	The ICMP is supported by hydrologic, hydrogeological and ecological investigations and assessments. It also identifies several BPOs and management solutions to protect and enhance existing wetlands within the Rotokauri Catchment (Section 5).
Land	
Objective – Effectively manage soil erosion 21.3.1 A*ctivities that accelerate soil erosion are managed effectively, including through the reforestation and retirement of marginal lands from existing intensive and environmentally unsustainable land uses.* **Policy – Retirement and restoration of marginal land** 21.3.1.1 to encourage local authorities and landowners to retire highly erodible land from farming and to restore and protect highly erodible lands. **Policy – Land development** 21.3.1.2 All major excavation works that have the potential to impact on waterways shall have sufficient erosion and	The ICMP is supported by water quality, erosion susceptibility and ecological investigations and assessments. It also identifies several BPOs and management solutions to effectively manage soil erosion, the life supporting capacity of land and soils, land contamination and to achieve integrated catchment management within the Rotokauri Catchment.

sediment control measures in place to ensure that adverse effects on water bodies are managed. **Policy – Riverbank erosion** 21.3.1.3 To ensure that riverbank erosion, including the erosion of river islands is effectively managed. ***Objective –The life supporting capacity of land and soils*** *21.3.2 The life supporting capacity of land and soils effectively manages soil nutrient loss and water quality so there is minimal impact on nutrient loss to waterways.* **Policy – Soil and land management practices** 21.3.2.1 To promote the adoption of best practice land and soil management that minimises soil erosion, nutrient leaching and sediment and nutrient runoff. **Policy – Land management** 21.3.2.2 Promote and encourage the development and adoption of land management practices that protects waterways from suspended sediments, nutrients and pollutants. ***Objective – Effectively manage land contamination*** *21.3.3 Effectively manage the impact of contaminated land on the surrounding environment.* **Policy – Effectively manage land contamination** 21.3.3.1 To ensure that the impact of contaminated land is effectively managed and, where possible and practicable, mitigate and restore the contaminated land. ***Objective – achieve integrated catchment management, including floodplain and drainage management*** *21.3.4 Integrated catchment management occurs across the entire rohe of Waikato-Tainui, including in catchments that impact on, or flow into the Waikato-Tainui rohe. Integrated catchment management includes the effective and sustainable management of floodplains and drainage areas to promote natural habitat enhancement.* **Policy – Integrated catchment management plans and land use** 21.3.4.1 To promote the development and use of integrated catchment management plans that adequately considers landuse, floodplain and drainage management and that promotes habitat restoration. **Policy – Collaboration with landowners and managers** 21.3.4.2 To ensure that landowners and land managers that impact on the rohe manage land sustainably and effectively. This includes land that is upstream of the Waikato-Tainui rohe. **Policy – Waikato-Tainui relationship with catchment**	

21.3.4.3 To recognise and provide for the relationship of Waikato-Tainui with catchments in the Waikato-Tainui rohe.	
Land use planning	
Objective – Approach to land use and development *25.3.1 Development principles are applied to land use and development (urban and rural) and, in particular, development in new growth cells, that enhance the environment.* **Policy – Approach to land use and development** 25.3.1.1 To encourage development principles to be applied to land use and developments (urban and rural) and, in particular, development in new growth cells, that enhance the environment. ***Objective – Urban and rural development*** *25.3.2 Urban and rural development is well planned and the environmental, cultural, spiritual, and social outcomes are positive.* **Policy – Urban development** 25.3.2.1 To ensure that urban development is well planned and the environmental, cultural, spiritual, and social outcomes are positive. ***Objective – Positive environmental and cultural effects*** *25.3.3 Land use and development has positive environmental and cultural effects.* **Policy – Positive environmental and cultural effects** 25.3.3.1 To ensure that land use and development, particularly new land use and development, has positive environmental and cultural effects.	The ICMP is supported by comprehensive technical investigations and assessments which have helped to define existing catchment values and identify the various constraints and opportunities presented by development. It also provides generic and catchment specific O&Ts to optimise the provision of three waters infrastructure and help guide development to achieve environmental enhancement. The ICMP's integrated and holistic approach to catchment management will further support positive outcomes for the catchment (environmental, cultural, spiritual and social), inclusive of positive environmental and cultural effects.
Infrastructure	
Objective – Waikato-Tainui engagement *26.3.1 Infrastructure development, upgrade, and maintenance within the Waikato-Tainui rohe occurs in partnership with Waikato-Tainui.* ***Objective – Infrastructure development, upgrade, and maintenance*** *26.3.2 Infrastructure development, upgrade, and maintenance manages economic, social, cultural, spiritual, and environmental effects.* **Policy – Infrastructure development, upgrade and maintenance** 26.3.2.1 To ensure that infrastructure development, upgrade, and maintenance manages economic, social, cultural, spiritual and environmental effects.	The ICMP has been developed within a broad strategic context (Section 1.3) including the Vision and Strategy and the objectives and policies of the Waikato-Tainui Environmental Plan. Waikato–Tainui have also engaged and participated in the development of the ICMP. Further engagement and participation initiatives are envisaged throughout the implementation of the Rotokauri ICMP as identified in Section 5.5.3 (Future actions). The provision of optimal three waters infrastructure will further manage the associated economic, social, cultural, spiritual and environmental effects within the catchment.

7 Consultation

Consultation has been undertaken with all key stakeholders (internal and external), directly affected landowners (developers and non-developers) and the wider community as an integral part of the ICMP development process. This has helped to generate a greater understanding of the Rotokauri Catchment and the issues and opportunities arising. It has also assisted with gathering baseline information and testing proposed management options.

Key actions have included:

- Development and execution of the Rotokauri ICMP Consultation Plan (HCC, 2016)
- The provision of information and meetings with key stakeholders, including regular project updates, facilitation of discussions and related follow-up actions
- Internal and external key stakeholder workshops (presenting on issues, options and proposed BPOs / management solutions)
- Targeted consultation on the Draft ICMP (Version 1), including public notification and a 'drop in' session to enable the participation of all interested parties
- Follow up communications and/or meetings with all parties who lodged submissions via the targeted consultation process.

Further details regarding this consultation are provided in the 'Rotokauri ICMP Consultation Plan' (HCC, 2016).

7.1 Key Stakeholders

A list of the parties consulted is provided in Table 7-1 (for more detailed records refer to the 'Rotokauri ICMP Consultation Plan' (HCC, 2016)).

Table 7-1: Key Stakeholders

Name
Internal Stakeholders:
City Development
City Waters
City Transportation
Parks and Open Spaces
Economic Growth and Planning
Planning Guidance
Building Control
External Stakeholders:
Private landowners (developers and non-developers)
Private landowner agents (professional consultants)
Waikato Tainui / Waikato Raupatu River Trust

Name
Te Ha o te Whenua o Kirikiriroa (including representatives of Ngati Mahanga)
Waikato Regional Council / Resource Use Directorate
Waikato Regional Council / Integrated Catchment Management Directorate
Waikato District Council
Lake Rotokauri Management Committee
Department of Conservation
WDHB / Public Health Unit
Watercare Services Ltd
Waiwhakareke Advisory Group
Tui 2000 Inc. (Friends of Waiwhakareke)
Environmental Research Institute / Centre for Biodiversity and Ecology Research (CBER)
Fish & Game Association
Waikato River Authority
Heritage New Zealand
New Zealand Transport Authority

7.2 Key Issues Raised

Submissions were received from a small number of internal and external stakeholders. The external stakeholders included Waikato Tainui / Waikato Raupatu River Trust, WRC Resource Use Directorate, WDC and the Lake Rotokauri Management Committee (joint submission), CKL Surveyors on behalf of Rotokauri Development Ltd and Tainui Group Holdings, Mr K. Pudney in relation to interests in the Waiwhakareke Natural Heritage Park, and a number of private landowners in the Waiwhakareke Development Area (upstream of the Waiwhakareke Natural Heritage Park).

The majority of submissions were generally very positive, supporting the Rotokauri ICMP and seeking only minor clarifications and/or amendments.

All submissions have been considered and acknowledged, and the issues which directly relate to the ICMP have been addressed and are reflected in this 'Final Draft' document where appropriate. A high level summary of the directly related key issues is provided in Table 7-2 (for more detailed records refer to the 'Rotokauri ICMP Consultation Plan' (HCC, 2016)).

Table 7-2: Consultation - key Issues

	Item	Addressed	Refer Section
1	Confirmation of assessment against the Waikato Tainui Environmental Plan	The ICMP has been assessed against the relevant objectives and policies of the Waikato Tainui Environmental Plan	Section 6.3
2	Proposed Waikato Regional Plan Change 1 – Waikato and Waipa River Catchments (Healthy Rivers)	The ICMP has been updated with a future action to seek guidance from WRC on the short term and long term numerical water quality targets for the Waikato and Waipa Rivers Catchments. Note, at the time of writing this ICMP it not clear how these targets will ultimately relate to urban stormwater discharges.	Section 5.4, 5.5.3
3	Clarification of ICMP scope	The ICMP has been updated to clarify ICMP scope, inclusive of sub-catchments and receiving environment assessments.	Sections 2.1, 3.2.1, 2.3.2.1
4	Existing stormwater management devices	The ICMP has been updated to clarify the quantum of treatment provided by existing stormwater management devices in the catchment.	Section 2.5.1
5	Long duration rainfall assessment	The ICMP has been updated with a future action to undertake long duration rainfall assessment to inform major drainage infrastructure and development design.	Section 5.5.3
6	Stream channel erosion and mitigation works	The ICMP has been updated to clarify and elaborate on issues relating to stream channel erosion and mitigation works.	Sections 3.2.3, 5.4 5.5, 8.2.4
7	Lake Rotokauri Development Area / Rotokauri Drainage Area	The ICMP has been updated with a future action to continue discussions with WRC/Integrated Catchment Management Directorate regarding the ongoing operation and maintenance of the drain(s) downstream of the LRDA.	Section 5.5.3
8	Locations of central sub-catchment wetlands in the Waiwhakareke Development Area	The ICMP provides indicative locations of central sub-catchment wetlands (refer to the 'means of compliance' maps and drawings in Appendix A). However, the actual locations must be determined pre-development via appropriately detailed WIAs and subdivision/land use consents.	Sections 3.2.4, 5, Appendix A
9	Consistency with the Waiwhakareke Natural Heritage Park Operative Management Plan (HCC, 2011)	The ICMP is generally consistent with the WNHP Operative Management Plan and is supported by evidence based technical assessments. Significant mitigation is proposed through the implementation of BPOs and stormwater management solutions which combine to address the associated adverse environmental and cumulative effects. These are designed to protect the WNHP and will also help to improve water quality and ecological values via eco-sensitive infrastructure design and the restoration and protection of habitat. Catchment-wide monitoring initiatives are also proposed, as are ongoing consultation initiatives to promote collaboration between all key stakeholders.	Sections 3.2, 5, 8.2
10	Consistency with Lake Rotokauri Management Plan (WDC, 2000)	The ICMP is generally consistent with the Lake Rotokauri Management Plan and is supported by evidence based technical assessments. Significant mitigation is proposed through the implementation of BPOs and stormwater management solutions which combine to address the associated adverse environmental and cumulative effects. These are designed to protect the Rotokauri Lake reserve, including the existing lake level management regime and lake management infrastructure (e.g. floating wetlands and walkways). They will also help to improve	Sections 3.2, 5, 8.2

		water quality and ecological values via eco-sensitive infrastructure design and the restoration and protection of habitat. Catchment-wide monitoring initiatives are also proposed, as are ongoing consultation initiatives to promote collaboration between all key stakeholders.	
11	Stormwater treatment requirements and 'source controls'	The ICMP has been updated to further clarify stormwater treatment requirements and the application of 'source controls' (on-lot and sub-catchment), including the ongoing operation and maintenance requirements.	Sections 3.2.4, 5
12	ICMP implementation and costs	Detailed implementation considerations will be advanced through separate and ongoing ICMP implementation initiatives.	Section 5
13	Whole of life costs – three waters infrastructure/assets	The ICMP has been updated with a future action to undertake a 'whole of life costs' assessment for proposed three waters infrastructure/assets, including the ongoing O&M costs of stormwater assets.	Section 5.5.3
14	Erosion and sediment control, including during housing construction	The ICMP has been updated with a future action to appoint, or otherwise confirm, a suitably qualified and experienced internal resource to undertake an erosion and sediment control advisory, monitoring and compliance auditing role	Section 5.5.3

7.3 Future Stakeholder Liaison

Ongoing liaison with key stakeholders and directly affected landowners will be critical to the effective implementation of the ICMP. This is recognized throughout the ICMP, in particular Section 1.7 (Objectives and Targets), Section 3.2 (Stormwater and Receiving Environment Assessments), Section 5 (Best Practicable Options, Solutions and Implementation) and Section 8 (Monitoring). Consultation may also be carried out as part of further investigations and assessment work, major infrastructure and development design, land designation and resource consent processes and general implementation where appropriate. The specifics of these initiatives fall outside the scope of this document.

8 Monitoring

8.1 Catchment Monitoring

Development and associated 'resource use' activities in the Rotokauri Catchment will be monitored in accordance with the condition requirements of relevant land, water and discharge consents. With regard to new stormwater discharge consent activities, these will be monitored in accordance with:

- Relevant monitoring conditions - prior to consent transferral to HCC and surrender in accordance with the requirements and administrative procedures of the HCC CSDC (Condition 3 and Appendix 2)
- An extended HCC CSDC Monitoring Programme (Condition 37) as informed by site specific monitoring requirements, the requirements of this ICMP and any subsequent revisions to the Monitoring Programme as allowed for.

All catchment monitoring information should be evaluated and assessed against the relevant condition and monitoring programme requirements, the design parameters for stormwater management (Section 5.4) and the relevant means of compliance requirements (Section 5.5) of this ICMP. All necessary follow-up actions should be identified and undertaken as determined through assessment.

8.1.1 Hamilton City Council responsibility

HCC holds resource consents for stormwater discharge, water take, and wastewater discharge activities. With regard to stormwater, the HCC CSDC was granted in June 2011 and authorises stormwater discharge activities as relating to the municipal stormwater network (as existing at the commencement of consent). This consent also provides for authorising new stormwater activities in accordance with the technical certification requirements of Condition 3 and as outlined above (i.e. private development/discharge consent transfer and surrender procedures).

The HCC CSDC Monitoring Programme (hereafter referred to as the 'Monitoring Programme') was prepared by HCC in December 2012. The central objectives of the Monitoring Programme are to:

- Carry out effects based monitoring of stormwater receiving environments to inform appropriate management responses to the issues identified
- Assess the performance of utilised stormwater management measures to determine and/or verify their overall effectiveness in managing and/or treating stormwater, and to guide the best practicable application of these measures in respective catchments
- Inform changes to the HCC Stormwater Management Plan to address any shortcomings in operational procedures and management initiatives included in the Stormwater Management Plan
- Review the level of subdivision and development that is occurring in developing catchments, relative to the land use assumptions underlying the integrated catchment management solutions determined via CMPs
- Determine overall compliance with the conditions of the HCC CSDC.

The Monitoring Plan was approved by WRC in 2013 and is currently being reviewed by HCC for in accordance with consent requirements.

With the exception of Lake Rotokauri monitoring (lakebed sediment sampling), no other monitoring as relating to the Monitoring Programme is undertaken in the catchment. Therefore, it is envisaged that proposed catchment monitoring, as described in Section 8.2, will be included in the revised Monitoring Programme as part of the current review process (and subject to WRC technical approval).

It is also envisaged that the HCC Stormwater Management Plan will be reviewed and updated (in accordance with Condition 35 of the HCC CSDC) to fully support the effective implementation of the Rotokauri ICMP. In particular to ensure that all stormwater management measures which make up the overall management suite in the catchment

(private and public) are appropriately operated and maintained, and are regularly inspected via sufficiently scoped compliance monitoring and auditing initiatives.

8.1.2 Development community responsibility

With regard to stormwater, developers require consents to authorise discharges to the receiving environment in accordance with the Waikato Regional Plan and other statutory requirements. The ICMP BPOs, integrated management solutions, design parameters and means of compliance requirements will therefore help to inform development planning and assist developers in the preparation of these consents. They will also assist the WRC when considering consent applications and setting appropriate level monitoring requirements.

In particular the ICMP will help to ensure that consents are issued which address cumulative adverse effects. Stormwater discharge consent conditions should also be consistent with the HCC CSDC to provide certainty that consents can be transferred to HCC post vesting of associated infrastructure.

It is further noted that any stormwater discharge consent held by a developer must meet its site/activity specific monitoring requirements (including operation and maintenance requirements) until the consent is transferred to HCC.

8.2 Proposal for Catchment Monitoring

The main types of catchment monitoring to be undertaken by HCC relate to the issues and outcomes discussed in Section 3.2 of this document, the ICMP technical report recommendations (Appendix C), and the Monitoring Programme as reviewed and updated to include the monitoring outlined below.

A map showing the main monitoring types, and the locations of existing and/or proposed monitoring sites in the catchment, should be compiled upon finalisation of the ICMP and included in the updated Monitoring Programme.

8.2.1 Groundwater level monitoring

The proposed groundwater level monitoring is based on the main assessment findings and recommendations in the report titled *Rotokauri: Hydrogeological Interpretive Report to Support ICMP* (CH2M Beca, 2016), (Appendix C) and subsequent monitoring proposal (CH2M Beca, 15 July 2016 / Ref. 6511041). In this regard it is considered that groundwater level and Lake Waiwhakareke water level monitoring should continue prior to, during and for a short time following construction of the Central Green Corridor to confirm that any changes in groundwater level are within the expected range.

The proposal (CH2M Beca, 15 July 2016 / Ref. 6511041) includes ongoing groundwater level monitoring to support assessment of groundwater – surface water interactions as follows.

During the previous investigation and assessment phase (ICMP development)*, data loggers were installed in 19 No. piezometers across the site, and in a stilling well in Lake Waiwhakareke, to provide a longer term record of seasonal variation which will inform design and improve understanding of the interaction between groundwater and Lake Waiwhakareke water levels.*

The data loggers were installed in late October and last downloaded in early June 2016 providing a 6 month record of groundwater levels over the summer / autumn period. Groundwater levels are expected to vary seasonally and on an inter-annual basis. As such ongoing groundwater level monitoring was a key recommendation of the Hydrogeological Interpretive Report.

Additionally the collection of rainfall data and a topographic survey of the lake, its surrounds and inlets / outlets has been identified as an important input for better quantifying potential effects on the lake. The existing model and data elevations are based on interpretation from Lidar.

Three key tasks have been identified to fulfil the above recommendations:

Lake Waiwhakareke Survey
A full topographic survey of the immediate lake surrounds (i.e. within 50 m of the lake edge), key inlets and outlets should be undertaken. This will better inform the ongoing assessment of the relationship between groundwater and surface water, and the relationship between the lake, the outlets and the natural weir that has formed.

Groundwater Level Monitoring
As level loggers have been deployed it is recommended that monitoring be undertaken on a 3 monthly basis for the next 12 months. This will provide an 18 month record, including at least two summer periods and one winter period. It is recommended that monitoring continue until works commence on site; however this could be at a reduced frequency once a reliable 18 month record has been obtained. Data loggers will be downloaded and the graphs of groundwater level (as contained in Appendix A of the Interpretive Report) updated on a 3 monthly basis. The graphs will also be updated to include rainfall record(s) from adjacent NIWA climate stations.

Lake Waiwhakareke Water Balance
The results of the ongoing groundwater level and lake level monitoring, the topographic survey and review of longer term rainfall data will be used to inform a water balance assessment (as suggested by the peer reviewer) that includes consideration of low flow conditions.

Preparation of Addendum Hydrogeological Report
Prepare an addendum to the Hydrogeological Interpretive Report that presents the groundwater level monitoring results (graphs of groundwater level vs. time and updated plots of inferred groundwater contours), sets out the inputs to and result of the water balance assessment for Lake Waiwhakareke and provides an updated assessment of the groundwater – surface water interaction at the lake. The need for (3D groundwater) *model update and scenario re-run should be considered at the end of the 12 month monitoring period.*

It is proposed that the above tasks be undertaken in accordance with the above monitoring recommendations and be initiated as soon as practical to obtain the necessary data and update current records. Thereafter, groundwater level monitoring should continue as required prior to, during and for a short time following construction of the Central Green Corridor to confirm that any changes in groundwater level are within the expected range.

8.2.2 Water and sediment quality monitoring

The proposed water and sediment quality monitoring is based on the main assessment findings and recommendations in the report titled *Rotokauri ICMP - Broad Scale Water Quality Assessment* (Streamlined Environmental Ltd, 2015), (Appendix C). This provides the rationale for baseflow monitoring and stormflow monitoring in the Southern Development Area as follows.

Baseflow monitoring
It is clear that Lake Rotokauri sediments are acting as a sink for many contaminants. However, their capacity to maintain this function and, at the same time not have increased contaminant levels that will cause significant adverse ecological effects, needs to be assessed periodically through a sediment-monitoring programme.
In February 2014, Tonkin & Taylor carried out monitoring of Lake Rotokauri sediments as part of the HCC CSDC Monitoring Programme (Tonkin & Taylor, 2014). The HCC CSDC specifies monitoring every 4 years. Manual grab sampling of surficial (top 100 mm) sediments at 8 sites within the lake was performed, with 6 of these designated impact sites and 2 reference sites. Sediments were analysed for total organic carbon (TOC), polycyclic aromatic hydrocarbons (PAHs), and total recoverable copper and zinc.

Current analysis (Streamlined Environmental Ltd 2015 and Tonkin & Taylor 2014) suggests little variation in sediment contaminant concentrations for sites in Lake Rotokauri. It was noted that sediment type was a uniform soft clay (grey) throughout the lake. Sediment nutrient concentrations exhibited uniformity for all sites with total phosphorus 0.69 to 0.87 mg kg^{-1} and total nitrogen 6.9 to 10.13 g $100g^{-1}$. For Tonkin & Taylor (2014), copper and zinc sediment concentrations were generally uniform and exhibited higher concentrations at reference sites than impact sites (copper: 18±4 mg kg^{-1} and 23±1 mg kg^{-1}, zinc: 265±73 mg kg^{-1}; 295±7 mg kg^{-1}; for impact and reference, respectively). The level of replication used in nutrient collection for SLAM model calibration (2 replicates at 6 sites) or Tonkin & Taylor's sampling protocol (8 sites) is probably sufficient for high priority contaminants (TN, TP, TCu, TZn) where spatial

differentiation may be useful. However, this number of sites/samples is probably excessive for the purposes of monitoring of organic contaminants, which are currently at low concentrations and therefore of low priority. For these contaminants, we suggest that composite duplicate samples of 6 sites in the lake (i.e. the methodology used in this study for heavy metal and organic contaminants) will be sufficient to provide information to assess whether concentrations are increasing or decreasing.

The frequency of monitoring necessary will depend on the time the development takes. Assuming a 10-year development scenario, 4-yearly sampling will not be sufficient to identify potential issues, as no more than 2 sampling events will occur within this time frame. This is not sufficient time to establish trends that may impact the catchment. We suggest biennial (2-yearly) monitoring is the minimum requirement for monitoring high priority contaminants (TN, TP, Cu, Zn) for a 10-year development scenario, up to at least 3 sampling events post development. For a 20-year development scenario, 4-yearly sampling will provide up to 5 sampling events. We suggest this is sufficient, with an additional sampling event 2 years after development has commenced. As for 10-year scenario, monitoring should continue for 3 sampling events post development and be reviewed thereafter.

For low priority contaminants (PAHs, TPH, PCBs, PBDEs, plasticisers) we suggest including "check" monitoring events: mid-development; immediately post-development; and some time after post-development (2 or 4 years depending on length of development). Organochlorine pesticides (OCPs) should be monitored during early stages of development to ensure significant amounts are not being released into the catchment during the development stage. OCPs associate strongly with soils and earth-moving procedures may increase loads to the catchment via particulate run-off. Lake Rotokauri catchment was historically rural landuse and legacy organochlorines (for example DDT, dieldrin) are associated with historic agricultural practices. Currently, 4-4'-DDE was the only OCP detected in Lake Rotokauri sediment and at a concentration around 10% of ANZECC ISQG-low guideline.[60] We suggest the full suite of OCPs[61] are monitored during the first two sampling events and if all OCPs are no more than 50% of ANZECC ISQG-low then monitoring for OCPs can be suspended until post-development.

Dissolved zinc and copper concentrations in Rotokauri Drain are currently around 250% and 17% of the ANZECC 95% protection guideline, respectively. Zinc concentrations are currently high while copper concentrations will increase post development if not effectively treated. While we expect that zinc concentrations will eventually decrease as use of facial eczema treatment declines, we believe there is justification for monitoring dissolved zinc concentrations given that it currently exceeds ANZECC guidelines. Therefore, both copper and zinc are considered high-priority for monitoring during normal baseflow conditions.

Our passive sampling programme detected the wastewater markers caffeine, cotinine, and paracetamol, which are almost certainly due to septic tank leachate. All these chemicals were at trace levels and likely of no environmental concern. However, the urban development should eliminate this discharge because all properties will (eventually) be reticulated to the Pukete WWTP.

High priority water soluble contaminants (zinc, copper) and low priority water soluble contaminants (wastewater markers) should be monitored in parallel with sediments. Identical methodology to this study should be used; namely DGT samplers for zinc and copper and POCIS for wastewater markers during normal baseflow conditions.

A schedule for baseflow monitoring is provided in Table 8-1 below.

[60] ANZECC ISQG-low is for the sum of all DDT metabolites, however 4-4'-DDE is makes up the greatest proportion of the total.

[61] OCPs are generally analysed as a suite of contaminants (see Appendix 1 in the Streamlined Environmental Ltd report (Appendix C)).

Table 8-1: Proposed monitoring schedule (under baseflow conditions) for Lake Rotokauri based on 10-year and 20-year development scenarios

Sampling event	Year after development started (10 year scenario)	Year after development started (20 year scenario)	Sediment monitoring		Water monitoring (baseflow conditions)	
			Number of samples[62]	Contaminants[63]	Number of samples[64]	Contaminants[63]
1	0	0	8	TN, TP, Cu, Zn	6	Cu, Zn
			2	*OCPs*		
Additional		2	8	TN, TP, Cu, Zn	6	Cu, Zn
			2	*OCPs*		
2	2	4	8	TN, TP, Cu, Zn	6	Cu, Zn
			2	*OCPs*		
3	4	8	8	TN, TP, Cu, Zn	6	Cu, Zn
4	6	12	8	TN, TP, Cu, Zn	6	Cu, Zn
			2	*PAHs, TPH, PCBs, PBDEs, plasticisers*	4	*Wastewater markers*
5	8	16	8	TN, TP, Cu, Zn	6	Cu, Zn
6[65]	10	20	8	TN, TP, Cu, Zn	6	Cu, Zn
			2	*PAHs, TPH, PCBs, PBDEs, plasticisers*	4	*Wastewater markers*
7	12	24	8	TN, TP, Cu, Zn	6	Cu, Zn
			2	*PAHs, TPH, PCBs, PBDEs, plasticisers*	4	*Wastewater markers*
8	14	28	8	TN, TP, Cu, Zn	6	Cu, Zn
9	16	32	8	TN, TP, Cu, Zn	6	Cu, Zn

Stormflow monitoring

Stormflow assessments should be based on established methodology, using flow proportional composite sampling (for example see Tonkin & Taylor, 2012). These should be implemented at a suitable time during the development stage where significant design changes are occurring. [66] *If stormflow concentrations exceed acute (USEPA) guidelines then this should trigger an instream biological survey to assess whether the guidelines are protective. The instream biological survey should include as a minimum the macroinvertebrate community index (MCI) (Stark and Maxted,*

[62] Sites sampled as per Tonkin & Taylor (2014). These analysed "as is" where designated 8 samples or analysed on two equivalent (replicate) composite samples where designated 2 samples.

[63] Italicized contaminants are low-priority and recommended for "check" monitoring events.

[64] Samples consist of triplicate DGT samplers and duplicate POCIS in Rotokauri Drain and Ohote Stream.

[65] End of development.

[66] For example, following completion of significant catchment staging and establishing permanent treatment systems, or if/where significant design changes in permanent treatment systems have occurred.

2007), but could include other qualitative assessments of nuisance growth (periphyton, macrophytes) if there is evidence of these being in abundance.

It is proposed that baseflow monitoring be undertaken in accordance with the recommended monitoring schedule (Table 8-1) and at a frequency which reflects the rate of development in the catchment. This should be gauged on an ongoing basis as part of the overall Monitoring Programme and applied accordingly, i.e. every two or four years depending on development scenario (10 or 20 years). It is also noted that the proposed baseflow monitoring is rationalised as much as possible to be compatible with the existing Monitoring Programme (i.e. Lake Rotokauri lakebed sediment sampling).

Stormflow monitoring should be considered on an ongoing basis and be undertaken in accordance with the above recommendations, subject to HCC CSDC Monitoring Programme revisions and updates, and/or advancements in monitoring or assessment methods.

8.2.3 Ecological monitoring

The proposed ecological monitoring is based on the main assessment findings and recommendations in the report titled *Rotokauri ICMP – Ecological Assessment and Inputs* (Kessels Ecology, 2016), (Appendix C). This primarily relates to post development monitoring following construction of the Central Green Corridor (Rotokauri Drain realignment) and the stream channel stabilisation, protection and enhancement works in the Rotokauri Drain between Exelby Road culvert and Lake Rotokauri.

The main recommendation is to undertake stream biodiversity monitoring (macroinvertebrates, macrophytes and fish) in the Rotokauri Drain, upstream and downstream of the Exelby Road culvert. Monitoring methods and locations should be the same as those which were applied at the time of ICMP investigations and assessment (2015/16), unless subsequently updated through the Monitoring Plan. It is also recommended that water and sediment quality monitoring be undertaken in accordance with the Streamlined Environmental Ltd (2015) recommendations, and as proposed in Section 8.2.2 above to ensure that water and sediment quality parameters remain within acceptable guideline values for protecting freshwater ecology.

With regard to development staging and stream channel stabilisation works, it is recommended that detailed Construction Management Plans, Watercourse Realignment / Ecological Plans and Indigenous Fish Rescue / Relocation Plans be prepared in advance of physical works and be implemented in accordance with relevant resource consent requirements (to be determined at the time of consent). This is particularly important to avoid or otherwise minimise adverse effects on the At Risk banded kokopu population in proximity to Exelby Road culvert, and other native fish in the modified watercourses and farm drains throughout the catchment.

8.2.4 Stream channel erosion monitoring

The proposed stream channel erosion monitoring is based on the main assessment findings and recommendations in the reports titled:

- AECOM, 2016. *Rotokauri ICMP - Major Drainage: Options Report* (Appendix C)
- Morphum Environmental Ltd, 2016. *Rotokauri Erosion Susceptibility Assessment* (Appendix C).

The main sites that were identified as either being susceptible to erosion or are already experiencing erosion, include:

- The gully areas in the Waiwhakareke Development Area
- The Rotokauri Drain immediately upstream of Exelby Road outlet
- The Rotokauri Drain between Exelby Road outlet and Lake Rotokauri
- The southern tributary of the Ohote Stream between the lake outlet and Duck Road Bridge.

In this regard it is proposed that monitoring against existing baseline data be undertaken at these sites throughout development, and include:

- Stream morphology and characteristics related to flow, and
- Bank and channel erosion (slumps and slips).

The 'Ecoline' and 'Erosion Hotspot' assessment methodology should be applied unless subsequently updated through the Monitoring Plan. The frequency of monitoring should also be similar to the water and sediment quality monitoring which is dependent on the rate of development in the catchment, i.e. every two or four years dependent on development scenario (10 or 20 years). This may also align with similar monitoring initiatives undertaken in the major stream tributaries, and as per the existing Monitoring Programme.

It is further noted that the gully areas in the Waiwhakareke Development Area, and the Rotokauri Drain between Exelby Road outlet and Lake Rotokauri, will be subject to proactive stabilisation and protection works. Also, the areas which are susceptible to erosion in other areas of the catchment will be subject to proactive stabilisation and protection works where necessary.

8.3 Reporting and Review Process

Monitoring of developer held / site specific stormwater discharge consents will be reported to WRC in accordance with consent conditions, and copies of these reports will also be provided to HCC.

Monitoring of stormwater discharges and related management activities as required under the HCC CSDC (including where this has been extended to include the Rotokauri Catchment) will be presented as part of the Municipal Stormwater Network Operation Annual Report as required by Conditions 38 and 39 of the HCC CSDC. The report will contain recommendations on any changes that may be needed to the Monitoring Plan.

WRC and HCC will liaise in order to review and, where necessary, alter the Monitoring Plan in scale and/or method and/or location after having regard to the consistency and significance of the monitoring data collected, or any other information relating to the stormwater diversion and discharge activities authorised.

HCC will be responsible for the review of guidelines and procedures for the implementation, performance evaluation, operation and maintenance of stormwater treatment systems and other site practices which are consistent with the ICMP, including on-lot stormwater measures where these form part of the overall stormwater network. HCC will also be responsible for reviewing the level of subdivision and development occurring in the Rotokauri Catchment relative to the land use assumptions underlying the ICMP and the BPOs / stormwater management solutions determined, with particular emphasis on:

- Coordinating infrastructure staging and the controlled release of land for development
- Establishing the major drainage and stormwater treatment train infrastructural solutions
- Compliance with (and performance of) erosion and sediment controls for residential building sites
- Compliance with (and performance of) on-site stormwater management measures (private and public)
- Restoration and management of riparian and aquatic habitat which is either integrated into stormwater conveyance and/or treatment infrastructure (for example Secondary Green Corridors/conveyance swales) or is downstream of discharge points (including the Central Green Corridor receiving environment).

HCC may also direct immediate intervention where significant effects are identified. This may include, but is not limited to:

- Building site management enforcement
- Remedial stream and riparian works for scour and erosion
- Additional site and compliance auditing
- Riparian vegetation management
- Maintenance or retrofitting of stormwater devices.

8.4 Other Monitoring Initiatives

8.4.1 Asset monitoring

Asset monitoring is carried out on all three networks including condition assessment and capacity reviews. A list of this type of monitoring is provided in respective Activity Management Plans.

Similarly, the HCC Stormwater Management Plan sets out various stormwater network operation and maintenance procedures, inclusive of a Stormwater Quality Improvement Programme (Condition 28). It is therefore envisaged that the Stormwater Management Plan will be reviewed and updated to fully support the implementation of the Rotokauri ICMP as discussed in Section 8.1.1 of this document. A 'future action' pertaining to this is included in Section 5.5.3 / Table 5-8.

8.4.2 Complementary monitoring initiatives

It is understood that an 'integrated constructed wetland' is proposed to be constructed in the Waiwhakareke Natural Heritage Park between the upstream Waiwhakareke Development Area and Lake Waiwhakareke.[67] The proposal is currently in development stage but will possibly incorporate some latest design technologies and be monitored to determine optimum treatment efficiencies and maintenance requirements. The results of this monitoring will be of particular interest to HCC given the extent of central sub-catchment wetlands to be developed in the Southern Development Area.

It is further noted that any monitoring proposals to be implemented by other stakeholders in the catchment will also be of interest to HCC, in particular, monitoring undertaken in Lake Rotokauri. It is observed from the water quality assessment work undertaken by Streamlined Environmental Ltd (2015) that whilst phytoplankton levels are relatively insensitive to lake hydrology, nevertheless, understanding the hydrology remains the largest impediment to fully understanding lake dynamics. Therefore, any lake hydrology monitoring via the installation of flow recorders on the inlet and outlet of the lake would help to reduce this uncertainty and augment with the groundwater modelling undertaken in support of this ICMP.

[67] This is to assist in achieving the WNHP Management Plan goal of a dystrophic Lake Waiwhakareke. It does not relate to the water quality targets and contaminant load limits as determined through this ICMP for new stormwater discharge activities (refer to Table 5.4 / Design Parameters for Stormwater Management).

9 ICMP Review

This ICMP is a living document. The need to review it will be assessed on a priority basis. In general, priority is given if/when one or more of the following triggers have been observed:

- Substantial changes in major infrastructure development that is likely to result in different ICMP outcomes
- Changes in the legal framework (Waikato Regional Policy Statement, Waikato Regional Plan, District Plan, central government legislation e.g. National Policy Statement for Freshwater Management)
- New information (e.g. LIDAR, further catchment investigations and assessments undertaken by HCC and/or other agencies)
- Review, renewal or replacement of the HCC CSDC and subsequent requirements

In addition, this ICMP will provide guidance to any future changes in land-use when implementing the current structure plan (for example through consent processes), and when preparing and processing formal plan changes. Ideally a future plan-change and a future update of this ICMP should be aligned to avoid any water related issues being generated which will be more difficult and expensive to address retrospectively.

The ICMP will be reviewed periodically to ensure that it remains relevant to current policy settings and considers the results of any ongoing monitoring and changes within the catchment which will occur through development.

10 Glossary

Average Recurrence Interval (ARI): A statistical estimate of the average period in years between the occurrences of an event of a given size or larger.

ARC TP10: A design guideline document that outlines and demonstrates the (ex) ARCs preferred design approach for stormwater management devices. Specifically, this includes design guidance for water quality and water quantity. This document is under review by Auckland Council and the new documents will automatically apply as the new guide to support this CMP.

Best Practicable Option (as defined by the RMA 1991): In relation to a discharge of a contaminant … means the best method for preventing or minimising the adverse effects on the environment having regard, among other things, to:

- The nature of the discharge or emission and the sensitivity of the receiving environment to adverse effects; and
- The financial implications, and the effects on the environment, of that option when compared with other options; and
- The current state of technical knowledge and the likelihood that the option can be successfully applied.

Base Flow: The flow in a stream between storm events. This flow is supplied by groundwater.

Buffer: A vegetated strip immediately adjacent to a water body. The primary function of buffers is to protect the receiving water from sediment and pollutants derived from upstream areas. Ancillary benefits may include infiltration of rainfall and habitat enhancement.

Catchment: The area of land drained by a stream or river system, or the boundary of an area where all surface water drains to a common point.

Catchment Management Plan: A management plan devised to manage land, its environmental and social resources on a catchment basis.

Extended Detention Pond: A stormwater facility that temporarily detains part of stormwater runoff for up to 24 hours after a storm by using a fixed orifice.

Filter Strip: A vegetated boundary characterized by uniform mild slopes. Filter strips may be provided downslope of developed areas to trap sediment and sediment-borne pollutants and to reduce imperviousness. Filter strips located adjacent to waterbodies are called buffers.

Flood Hazard Mapping: Defines flood hazard areas using flood levels established as part of flood hazard studies.

Flow Attenuation: The process of reducing the peak flow rate by redistributing the same volume of flow over a longer period of time, i.e. by using detention structures.

Green roof (or eco-roof or living roof): A roof of a building that is partially or completely covered with vegetation and planted over a waterproofing membrane. The sustainable design method treats storm water runoff, reduces heat transfer and energy consumption.

Groundwater Recharge: Increasing the amount of groundwater in storage via percolating rainwater.

Hydraulic Model: A computer model of a watercourse used to evaluate the hydraulic conditions of water flow through natural rivers and other channels.

Impervious surface: Those surfaces in the landscape that cannot infiltrate rainfall, such as rooftops, road pavements, footpaths, driveways and compacted earth.

Infiltration: The downward movement of water from the surface of the land to subsoil.

Integrated Catchment Management Plan: A management plan devised to manage natural resources on catchment basis to achieve sustainable use which provides for social and economic benefit.

Mauri: The essential quality and vitality of a being or entity including a water body.

Perennial stream: A stream that has water flow all year.

Rain garden: A planted depression or raised enclosed bed that is designed to absorb contaminants in stormwater runoff which are generated from impervious areas such as roofs, roads, paving, and lawn areas. The water will percolate through the rain garden prior to discharge, which is either through natural soakage, to low velocity overland flow or a piped network.

Riparian Corridor: Generally, the vegetated land adjacent to a watercourse.

Sand filter: A concrete chamber with graded sand that is designed to absorb contaminants in stormwater runoff. The water will percolate through the sand layer prior to discharge through a piped outlet.

Swale: A drainage depression along which stormwater flows. It is usually grassed and regularly mowed. It collects and treats water by slowing the flow and allowing solids to drop out of the water prior to discharging via a cesspit to a piped network.

Treatment Train: A "Treatment Train" approach to stormwater management consists of sequential components that contribute to the **treatment of stormwater before it discharges to natural watercourses.**

Water-sensitive techniques: include a variety of methods that aim to achieve better outcomes for water related issues. They include many techniques referred to under other names e.g. Low Impact Design (LID), Water Sensitive Urban Design (WSUD), Low Impact Urban Design and Development (LIUDD), Sustainable Urban Drainage Systems (SUDS) "natural", "green" and "sustainable" A primary aim of water-sensitive techniques is to maximise the achievement of multiple benefits rather than a single engineering technical efficiency measure. Recognised water-sensitive techniques include:

a) For water supply:

   i) Rainwater tanks for tanks for replacing potable use e.g. toilet flushing and landscape irrigation

   ii) Low flow fixtures and fittings

   iii) Greywater reuse systems

   iv) Drought resistant landscaping (e.g. Xeriscape) with low water requirements

   v) Conservation education

For stormwater:

   i) Rainwater tanks/chambers/ponds for reuse or detention

   ii) On-site Soakage

   iii) Green or living rooves

   iv) Reed beds/ Wetlands

   v) Rain gardens

   vi) Vegetative filter strips

   vii) Swales and depression landscaping

   viii) Gross pollutant traps

   ix) Permeable paving

   x) Requiring buildings to be built above the freeboard of 100 year ARI storm

For Wastewater:

   i) Low flow fixtures on water supply

   ii) Greywater reuse systems

   iii) Best practice inflow and infiltration reduction methods

Biodiversity:

   i) Reed beds

ii) Wetlands

iii) Ponds

iv) Rain gardens

v) Green or living rooves

vi) Water quality protection and improvement devices

vii) Maintenance or restoration of natural flow regimens

Cultural:

i) Traditional food and fibre plants within riparian areas

ii) Water quality protection and improvement devices

iii) Facilitation of appropriate water body access

iv) Maintenance or restoration of natural flow regimens

10.1 References

TRIM #[68]	document name	Version	Date	Author
-	Comprehensive Stormwater Discharge Consent #105279, 2013/14 Monitoring Report	-	2014	Tonkin & Taylor – prepared for HCC
D-2230270	Ecological investigations of the Rotokauri, Te Rapa and Te Kowhai catchments	-	2006	Kessels and Associates – prepared for HCC
D-1126695	Effects of urbanisation of the Rotokauri catchment on nutrient loads. Phase 4 report: Predicted changes to nutrient loads after implementation of the Rotokauri Structure Plan	-	July 2012	Diffuse Sources – prepared for HCC
D-1523798	HCC 2015-2025 Activity Management Plan-Stormwater	Rev 3	May 2015	HCC
D-1479904	HCC 2015-2025 Activity Management Plan-Wastewater	Rev 3	May 2015	HCC
D-1483257	HCC 2015-2025 Activity Management Plan- Water	Rev 3	May 2015	HCC
D-240056	HCC 2015-2025 Long Term Council Community Plan	-	June 2015	HCC

[68] TRIM is the HCC data management system.

D-1250182	HCC Comprehensive Stormwater Discharge Consent #105279	-	June 2011	Hartland Environmental - prepared for WRC
-	HCC Hamilton Urban Growth Strategy	On-line website	2008	HCC
-	HCC Infrastructure Technical Specifications	On-line website	October 2010	HCC
-	HCC Partly Operative District Plan (incl. Rotokauri Structure Plan)	-	October 2016	HCC
D-974909	HCC Standard Stormwater Modelling Methodology	1	May 2013	AECOM – prepared for HCC
D-1717683	HCC Water Take Consent (#113941)	-	March 2009	WRC
D-283284	HCC Wastewater Discharge Consent #114674	-	September 2007	WRC
D-1618181	Lake Rotokauri Ecological Enhancement Plan	-	2014	Kessels Ecology – prepared for Waikato DC
-	National Policy Statement for Freshwater Management	-	August 2014	MfE
D-1435587	Preliminary Stormwater Investigation Lake Rotokauri Catchment Development Area – Part 2	-	June 2014	Beca Infrastructure – prepared for HCC
D-1969497	Pukete Reservoir Bulk Water Main – Conceptual Design Report	-	2015	Opus – prepared for HCC
D-594846	Rotokauri CMP – Preliminary Hydrogeological Impact Assessment	-	December 2009	MWH – prepared for HCC
D-2006869	Rotokauri Development – Factual Geotechnical Report	-	2010a	Beca Infrastructure – prepared for HCC
D-565518 D-565521	Rotokauri Development – Interpretive Geotechnical Report	-	2010b	Beca Infrastructure – prepared for HCC
D-594846	Rotokauri Development – Preliminary Hydrogeological Assessment	-	2011	Beca Infrastructure – prepared for HCC
D-2230277	Rotokauri Erosion Susceptibility Assessment	-	June 2016	Morphum Environmental – prepared for HCC
D-1009023	Rotokauri Growth Cell - Planning & Design Summary Report	-	January 2013	Beca Infrastructure – prepared for HCC

D-1998549	Rotokauri ICMP - Broad Scale Water Quality Assessment	-	October 2015	Streamlined Environmental – prepared for HCC
D-2230270	Rotokauri ICMP – Ecological Assessment and Inputs	-	August 2016	Kessels Ecology – prepared for HCC
D-1896831	Rotokauri ICMP - Desktop Review of Hydrogeological Conditions Influencing Stormwater Design (letter report)	-	July 2015	CH2M Beca – prepared for HCC
D-2006869	Rotokauri - Additional Hydrogeological Investigations	-	December 2015	CH2M Beca – prepared for HCC
D-2230274	Rotokauri: Hydrogeological Interpretive Report to Support ICMP	Rev 2	July 2016	CH2M Beca – prepared for HCC
D-2230265	Rotokauri ICMP - Major Drainage: Options Report	-	September 2016	AECOM – prepared for HCC
D-2230077	Rotokauri ICMP - Major Drainage: Preferred Option & Stormwater Management Solution Report	-	September 2016	AECOM – prepared for HCC
D-2238224	Rotokauri ICMP – Three Water Infrastructure: Integration Report	-	September 2016	AECOM – prepared for HCC
D-2238207	Rotokauri Stormwater Modelling: Flood Hazard Map – Model Build Report	-	September 2016	AECOM – prepared for HCC
D-2200176	Rotokauri ICMP - Water Quality Treatment Concept Development Report	-	August 2016	Morphum Environmental – prepared for HCC
D-119120	Rotokauri Lake Management Plan 2000	-	2000	Waikato DC
D-788927	Rotokauri Stormwater Drainage – Planning Report	-	December 2005	MWH – prepared for HCC
D-1225605	Rotokauri Structure Plan – Phase 1 Report. Environmental Constraints and Urban Needs Assessment (incl. Cultural Assessment by Nga Mana Toopu O Kirikiriroa)	-	June 2001	Beca Carter Hollings and Ferner – prepared for HCC
D-2172097	Rotokauri Water Supply Capacity Assessment (, 2015)	-	2015	Mott MacDonald – prepared for HCC
D-664476	Sub Regional Three Waters Strategy (Future Proof)	-	September 2012	HCC, Waikato DC, Waipa DC
D-126347	Waiwhakareke Natural Heritage Park Operative Management Plan 2011	-	2011	HCC

-	WDC Consent Notice pursuant to Section 221, RMA, 1991, 25 March 1999.	-	March 1999	Waikato DC
-	Waikato Tainui Environmental Plan	On-line website	-	Waikato Tainui
-	WDC Waikato District Development Strategy	-	September 2015	Waikato DC
-	WRA Vision & Strategy	-	July 2011	WRA
-	WRC Integrated Catchment Management Directorate - Resource Consent #120860	-	January 2010	WRC Resource Use Directorate
-	WRC TR 2014/13: Managing land use change and Council's administered drainage areas	-	2014	Wainui Consulting – prepared for WRC
-	WRC Waikato Regional Plan	Operative Plan	September 2007	WRC
-	WRC Waikato Regional Policy Statement	Operative Plan	May 2016	WRC

ICMP PLANS

ICMP Plans	Appendix
Catchment Plans	A1
Flood Extents (100 Year ARI Comparison)	A2
Strategic Infrastructure Plans (Means of Compliance Plans)	A3
Central Stormwater Treatment and Drainage Infrastructure Plan (Means of Compliance)	A4
Main Corridor Concept Plan	A5
Watercourse Classification and Ecological Plans	A6
Stream Channel Erosion & Mitigation Plans	A7
Stream Channel Protection Works (Exelby Road to Lake Rotokauri) – Area of Benefit Plan	A8
Hydrogeological / Existing Resource Use Plan	A9
Existing Stormwater Infrastructure Plan	A10

ROTOKAURI ICMP – THREE WATERS INFRASTRUCTURE - INTEGRATION REPORT

(TRIM D-2238224)

SUPPORTING TECHNICAL REPORTS

Document Author and Title	Appendix
AECOM, 2016. *Rotokauri ICMP - Major Drainage: Options Report* (D-2230265)	C1
AECOM, 2016. *Rotokauri ICMP - Major Drainage: Preferred Option & Stormwater Management Solution Report* (D-2230077)	C2
CH2M Beca, 2016. *Rotokauri: Hydrogeological Interpretive Report to Support ICMP* (D-2230274) (Revision 2-1)	C3(a)
CH2M Beca, 2015. *Rotokauri - Additional Hydrogeological Investigations* (D-2006869) (Factual Report)	C3(b)
Morphum Environmental Ltd, 2016. *Rotokauri Erosion Susceptibility Assessment* (D-2230277)	C4
Streamlined Environmental Ltd, 2015. *Rotokauri ICMP - Broad Scale Water Quality Assessment* (D-1998549)	C5
Morphum Environmental Ltd, 2016. *Rotokauri ICMP - Water Quality Treatment Concept Development Report* (D2200176)	C6
Kessels Ecology, 2016. *Rotokauri ICMP – Ecological Assessment and Inputs* (D-2230270)	C7
Opus, 2015. *Pukete Reservoir Bulk Water Main – Conceptual Design Report* (D-1969497)	C8
Mott MacDonald, 2015. *Rotokauri Water Supply Capacity Assessment* (D-2172097)	C9