Ōtākaro-Avon Stormwater Management Plan

letstalk.ccc.govt.nz

Christchurch City Council

Ōtākaro-Avon Catchment

Stormwater Management Plan

Draft

Three Waters Unit
Christchurch City Council

February 2024

Table of Contents

List of Figures

List of Tables

List of Abbreviations

Abbreviation	Definition
ANZECC	Australian and New Zealand Environment and Conservation Council
ARI	Average recurrence interval; long-term average interval between floods
BMP	Best Management Practice
CCC	Christchurch City Council
CHI	Cultural Health Index
CLM	Contaminant Load Model
DIN	Dissolved Inorganic Nitrogen
DRP	Dissolved Reactive Phosphorus
ECan	Environment Canterbury
E. coli	*Escherichia coli*
GIS	Geographic Information System
GWL	Groundwater Level
HAIL	Hazardous Activities and Industries List
IGSC	Interim Global Stormwater Consent
IPCC	Intergovernmental Panel on Climate Change
ISQG	Interim Sediment Quality Guidelines
LLUR	Listed Land Use Register
LTP	Long Term Plan
LWRP	Land and Water Regional Plan
ppb	parts per billion
PAH	Polycyclic Aromatic Hydrocarbon
QMCI	Quantitative Macroinvertebrate Community Index
RMA	Resource Management Act
SMP	Stormwater Management Plan
UDS	Greater Christchurch Urban Development Strategy

1 Executive Summary

A Stormwater Management Plan for the Ōtākaro-Avon River catchment is required by the Comprehensive Stormwater Network Discharge Consent (CRC231955). Its purpose is to reduce the adverse effects of stormwater discharges on surface water quality and quantity. The stormwater management plan sets out methods the Council will implement to meet water quality and quantity targets in the consent.

Water quality and ecological health in the catchment vary between Good in some western tributaries such as Waimairi Stream to Poor in Dudley Creek. Waterway values have declined as a result of changes in the catchment including urban and industrial activities.

Because the catchment is largely developed there are fewer opportunities in this catchment than in most others to treat stormwater in basins and wetlands. Stormwater from new developments will be treated, and the SMP proposes to retrofit stormwater treatment for the three already developed areas of Addington, Riccarton and Upper Dudley Creek. Proposed biofilters for Addington and Riccarton will provide a high standard of treatment for particles (sediment), copper and zinc. In the longer term metals, which mainly come from unpainted roofs, vehicle tyres and vehicle brakes would be better controlled at source, but it will be some time until the Council can effect such controls.

Most developed areas are adequately protected from flooding by the drainage network but into the future it will become increasingly important that buildings are elevated above flood levels rather than that flood water is quickly removed. This is because the river upstream of and within the city centre has limited ability to accept additional peak flows. The Council will need to plan for stormwater detention within built-up areas in order to manage the effects of ongoing infill development.

Information used in developing this SMP suggests that controlling contaminants at source is more sensible than removing them from stormwater through treatment systems. However, the control or elimination of contaminants at source will affect our buildings, means of transport, household products and the ways we do things. Source control is a journey we will need to travel together to protect the environment; tangata whenua, community groups, regulators, researchers, and local, regional and central government.

PART ONE:
Plan Initiation

2 Background to the Stormwater Management Plan

2.1 Purpose and Scope

The purpose of a Stormwater Management Plan (SMP) is defined in condition 6 of the Comprehensive Stormwater Network Discharge Consent (CSNDC), CRC231955, and includes contributing to meeting contaminant load reduction standards, setting (and meeting) additional contaminant load reduction targets and demonstrating the means by which stormwater discharges will be progressively improved toward meeting receiving environment objectives and targets.

The aim of the CSNDC is to limit the adverse effects of stormwater discharges on surface and groundwater quality and quantity. The CSNDC promotes progressive water quality improvement toward targets in the Land and Water Regional Plan through the use of best practicable options for stormwater quality improvement and peak flow mitigation.

Stormwater management plans set out the means by which the Council will comply with the conditions in the CSNDC. However, due to governance processes, the SMP cannot address all environmental improvement targets signalled in the consent. The SMP is given effect through the Council's Long Term Plan (LTP), which is a statutory process. The relative timing of LTP processes and the SMP do not permit this SMP to commit to unfunded, new initiatives to achieve aspirational targets.

The SMP process includes:

1. Identify the existing state of the environment in the catchment.
2. Identify the contributions by existing and future activities to stormwater quality and quantity.
3. Estimate trends on water quality and quantity from urban growth, technology, lifestyle, climate, etc.
4. Develop measures to control or mitigate effects (including planning, education, enforcement, source control, etc as funded in the LTP).
5. Estimate the effectiveness of chosen mitigation measures through contaminant load and flood modelling.

Over time a Surface Water Implementation Plan (SWIP) will be developed encompassing a wider range of water quality goals and activities. The SWIP process will include:

1. Prepare a plan that is aimed at improving environmental outcomes and the health of the district's water bodies by a range of measures including education, collaboration and controlling contaminants at source.
2. Engage with Council teams and external stakeholders responsible for contaminant generating activities; obtain agreement about improved control measures.

2.2 Stormwater Management Plan Catchments

This SMP is one of seven plans being prepared over the period 2020 to 2024 for the Ōpāwaho-Heathcote, Huritini-Halswell, Ihūtai-Estuary and Coastal and Ōtūkaikino catchments, Settlements of Te Pātaka-o-Rākaihautū-Banks Peninsula, and Ōtākaro-Avon and Pūharakekenui-Styx catchments. Figure 1 illustrates the boundaries for each SMP catchment.

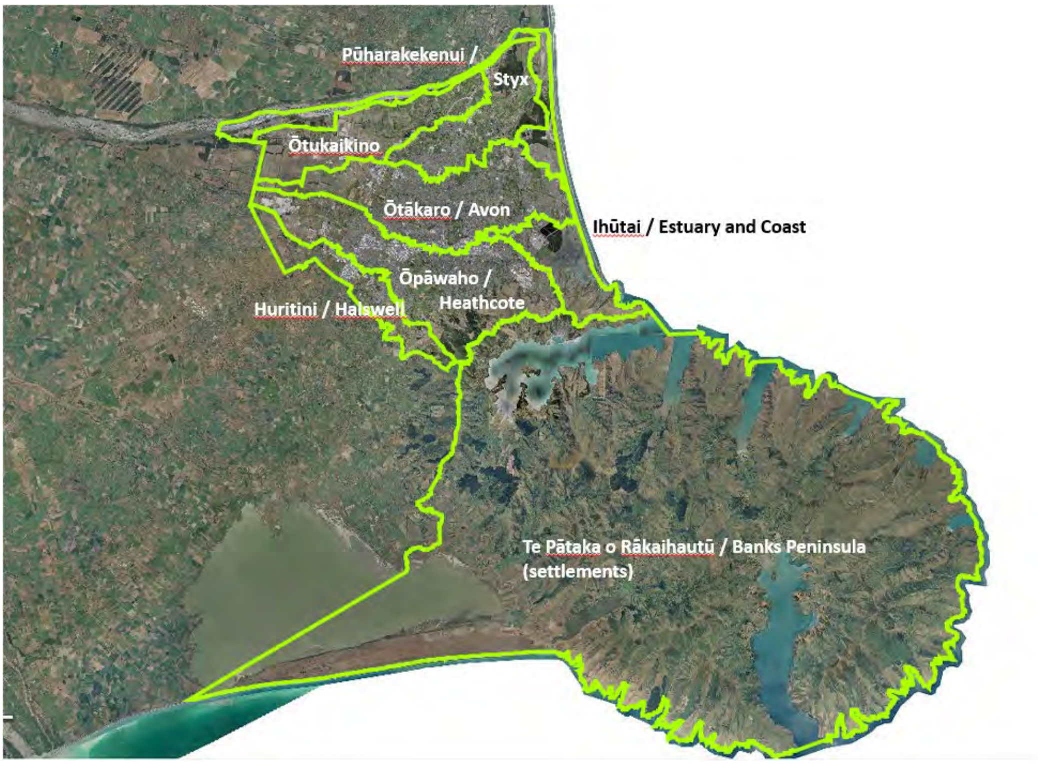

Figure 1: Area covered by the Comprehensive Stormwater Network Discharge Consent

2.3 Regional Planning Requirements

2.3.1 Canterbury Regional Policy Statement

The Canterbury Regional Policy Statement (CRPS) sets out how natural and physical resources are to be sustainably managed in an integrated way. The needs of current and future generations can be provided for by maintaining or improving environmental values. The CRPS requires that objectives, policies and methods are to be set in regional plans, including the setting of minimum water quality standards.

2.3.2 Land and Water Regional Plan

The Land and Water Regional Plan 2015 encourages the development of stormwater management plans under Rule 5.93. The intention of the rule is that SMPs will be developed to show how a local authority will meet the relevant policy on water quality.

2.3.3 Greater Christchurch Urban Development Strategy

The Greater Christchurch Urban Development Strategy (UDS) Partnership has been working collaboratively for over a decade to tackle urban issues and manage the growth of the city and its surrounding towns.

The strategy was prepared under the Local Government Act 2002 and it is to be implemented through various planning tools, including:

- Amendments to the Canterbury Regional Policy Statement (CRPS);
- Changes to regional and district plans to reflect the CRPS changes;
- Stormwater planning to give effect to the Land and Water Regional Plan (LWRP); and
- Outline Development Plans for new development areas ('Greenfield areas') and existing re-development areas ('Brownfield areas').

Preparation of this SMP plays a part in implementing the UDS.

2.4 Non-Statutory Documents

- Integrated Water Strategy 2019
- Surface Water Implementation Plan (to be developed)
- Mahaanui Iwi Management Plan 2013
- Ngai Tahu Freshwater Policy Statement (Te Rūnanga O Ngai Tahu 1999)
- Infrastructure Design Standard (Christchurch City Council 2010)
- Waterways, Wetlands and Drainage Guide (Christchurch City Council 2003)
- Erosion and Sediment Control Toolbox for Canterbury (Environment Canterbury)
- Estuary Management Plan 2020 – 2030 (Avon-Heathcote Estuary Ihutai Trust)

2.5 The Council's Strategic Objective for Water

The Christchurch City Council has adopted community outcomes to promote community wellbeing.

The Water Outcome Healthy Environment includes:

Healthy water bodies: *"Surface water quality is essential for supporting ecosystems, recreation, cultural values and the health of residents."*

2.6 The District Plan

The Christchurch District Plan promotes responsible stormwater disposal through Policy 8.2.3.4 – Stormwater Disposal, which states:

- District-wide:
- Avoid any increase in sediment and contaminants entering water bodies as a result of stormwater disposal.

- Ensure that stormwater is disposed of in a manner which maintains or enhances the quality of surface water and groundwater.
- Ensure that any necessary stormwater control and disposal systems and the upgrading of existing infrastructure are sufficient for the amount and rate of anticipated runoff.
- Ensure that stormwater is disposed of in a manner which is consistent with maintaining public health.
- Outside the central city:
- Encourage stormwater treatment and disposal through low-impact or water-sensitive designs that imitate natural processes to manage and mitigate the adverse effects of stormwater discharges.
- Ensure stormwater is disposed of in stormwater management areas so as to avoid inundation within the subdivision or on adjoining land.
- Where feasible, utilise stormwater management areas for multiple uses and ensure they have a high-quality interface with residential activities or commercial activities.
- Incorporate and plant indigenous vegetation that is appropriate to the specific site.
- Ensure that realignment of any watercourse occurs in a manner that improves stormwater drainage and enhances ecological, mahinga kai and landscape values.
- Ensure that stormwater management measures do not increase the potential for bird-strike to aircraft in proximity to the airport.
- Encourage on-site rain-water collection for non-potable use.
- Ensure there is sufficient capacity to meet the required level of service in the infrastructure design standard or if sufficient capacity is not available, ensure that the effects of development are mitigated on-site.

District Plan Policies 8.9.2.2 and 8.9.2.3 make earthworks subject to a consent. Conditions of consent for earthworks over a threshold include the requirement for an Erosion and Sediment Control Plan (ESCP). An ESCP is submitted and approved with a consent application and its implementation is verified by building consent officers.

2.7 Bylaws

The draft Stormwater and Land Drainage Bylaw (in preparation) will restrict discharges of any material, hazardous substance, chemical, sewage, trade waste or other substance that causes or is likely to cause a nuisance, into the stormwater network.

The Traffic & Parking Bylaw 2017 allows the Council to require an offender to remove material spilled onto roads.

2.8 Building Act

The Council can use powers under the Building Act to require ESCPs to be submitted when an associated land use consent is not required.

2.9 Integrated Water Strategy

Objectives 3 and 4 of the Christchurch City Council’s draft Integrated Water Strategy are summarised as *“enhancement of ecological, cultural and natural values and water quality improvement.”*

The preferred strategy option for achieving the objectives is to *"continue … the implementation of the current approach to stormwater management (embodied by the development of the Stormwater Management Plans) …"*

2.10 Mahaanui Iwi Management Plan

The Mahaanui Iwi Management Plan *"… is an expression of kaitiakitanga and rangatiratanga…(It) provides a values-based, … policy framework for the protection and enhancement of Ngāi Tahu values, and for achieving outcomes that provide for the relationship of Ngāi Tahu with natural resources across Ngā Pākihi Whakatekateka o Waitaha and Te Pātaka o Rākaihautū (the Canterbury Plains and Banks Peninsula)"*. The Ōtākaro-Avon SMP acknowledges the Iwi Management Plan policies and can contribute to policies which fall within the scope of a stormwater management plan (SMP).

2.11 Infrastructure Design Standard

The Infrastructure Design Standard 2016 (IDS) is the Council's development code and is a revision of the Christchurch Metropolitan Code of Urban Subdivision 1987. The IDS promotes environmental protection via a values-based design philosophy and consideration of biodiversity and ecological function (IDS, section 5.2.3 Four Purposes)

2.12 Goals and Objectives for Surface Water Management

The Ōtākaro-Avon Stormwater Management Plan and the Surface Water Implementation Plan will together be consistent with the *Integrated Water Strategy 2019* which identifies overall goals and objectives for surface water management. Jointly these plans will support so far as is practicable the *Mahaanui Iwi Management Plan* objectives for the Ihutai/Avon-Heathcote Estuary catchment (Jolly et al, 2013).

The Council's high-level goals in the Integrated Water Strategy are:

GOAL 1: The multiple uses of water are valued by all for the benefit of all;

GOAL 2: Water quality and ecosystems are protected and enhanced;

GOAL 3: The effects of flooding, climate change and sea level rise are understood, and the community is assisted to adapt to them; and

GOAL 4: Water is managed in a sustainable and integrated way in line with the principles of kaitiakatanga.

Te Rūnanga o Ngāi Tahu Freshwater Policy (Ngāi Tahu, 1999) lists several water quality and water quantity policies that apply throughout the Ngāi Tahu Takiwā. The *Iwi Management Plan* (Jolly et al, 2013) has objectives for the Ihūtai catchment that are directly relevant to the Ōtākaro SMP. These are objectives numbered:

4) Discharges of wastewater and stormwater to waterways in the urban environment are eliminated, and a culturally appropriate alternative to the discharge of urban wastewater to the sea is developed.

7) Urban development reflects low impact design (LID) principles and a strong commitment to sustainability, creativity and innovation with regard to water, waste and energy issues.

The CSNDC sets freshwater outcomes based on Land and Water Regional Plan targets. The CSNDC Environmental Monitoring Programme (EMP) will assess the ecological and cultural health of waterways and coastal areas, and progress made under the SMP. The EMP assesses a range of parameters, and progress can be measured against LWRP guidelines for macroinvertebrate indices, macrophytes, periphyton, siltation and a range of water quality parameters.

The SMP programme will contribute toward delivery on these objectives through improving water quality in the rivers and streams. Other plans and programmes must play a part in restoring riparian margins, and protecting and restoring springs and mahinga kai site in order to deliver on tangata whenua and LWRP objectives.

Stormwater quantity effects considered in this SMP include mitigation of additional runoff generated by urban intensification and the potential for reduction in network level-of-service in the east of the catchment as sea levels rise.

Other sources and reports that have informed the SMP include:

- State of the Takiwā;
- Surface water and sediment quality monitoring;
- Listed Land Use Register (contaminated sites database, ECan);
- Groundwater and springs study;
- Ecological survey;
- Contaminant load model.

3 Principal Issues

Waterways in this catchment are spring fed and predominantly urban. Water quality and ecological health in the Ōtākaro and its tributaries have declined greatly in during 160 years of urban development. Metals in stormwater can harm many instream species, sediment smothers habitat for biota and can be anoxic or contaminated, and E. coli poses a risk to human health during contact recreation.

Failure to meet indicator values in the LWRP for urban spring-fed plains rivers is reported in annual monitoring reports and in water quality, sediment quality and ecological surveys carried out for the SMP (Section 5). Contaminants of concern include sediment, zinc, copper and *E. coli* (an indicator of faecal contamination). Suspended sediment, zinc and copper levels are high especially during wet weather. Elevated levels of the nutrients nitrogen and phosphorus, which are partially derived from sources other than stormwater, can result in excessive aquatic weed growth.

Contaminants of concern at the levels recorded have an adverse effect on biota, result in excessive aquatic weed growth, or pose a risk to contact recreation, depending on the contaminant. A significant challenge to the SMP is how to reverse the decline in surface water quality and ecological health of waterways in the Ōtākaro-Avon catchment despite continuing urban development.

The Ōtākaro-Avon River is connected to and is a major contributor of contaminants into Ihūtai – the Estuary. There is commentary on the state of the estuary in the Ihūtai-Estuary and Coastal Stormwater Management Plan 2022. Reduction or capture of contaminants within the catchment can be expected to improve the ecological state of the estuary.

Land subsidence during the 2010/11 earthquakes increased the flooding vulnerability of many properties, particularly properties on the eastern side of the city, and properties near the river. Impacts of the earthquakes on increasing vulnerability to flooding have been investigated through the Land Drainage Recovery Programme with the aim of returning the flooding risk to houses to levels that existed before the earthquakes. A floodplain and river model continues to be developed to improve understanding of the risks to houses on the floodplain. The model will better represent the effects of sea levels rise over the SMP planning period.

Rezoning to permit increased housing density will lead to increased imperviousness in some areas, more so near the city centre, and stormwater runoff will increase unless it is detained at or near source.

PART TWO:
The Catchment

4 Catchment Description

4.1 Geography

The Ōtākaro-Avon Catchment covers an area of approximately 10,000 hectares. The river begins at a spring-fed source in Avonhead and discharges to the sea via the mouth of Te Ihūtai / The Estuary of the Heathcote and Avon Rivers.

The catchment has traditionally been a significant source of mahinga kai, and a focus of natural, cultural and heritage values since earliest settlement over 600 years ago.

Ongoing development and extensive settlement within the catchment over the last two centuries, combined with the more recent earthquakes of 2010/2011 has seen a degradation of catchment values including reduced water quality due to pollution and siltation, reduced hydraulic capacity, loss of terrestrial vegetative cover and decreased in-stream habitat for fish and invertebrates.

The catchment is partly urbanized, which accounts for 84% of the total area, in a mix of residential, industrial, amenity, and transportation land uses. A small percentage (16%) of the catchment is rural, mostly west of the airport but including a small area in MarshlandOkeover.

4.1 Catchment extent

The river extends for approximately 26 kilometres from its spring-fed source in Avonhead to its mouth at Te Ihutai / the Estuary. There are several spring-fed tributaries in the upper catchment, including the, Wairārapa, Waimairi and Okeover), that combine at Mona Vale to create the main stem of the Ōtākaro-Avon River. The main downstream tributaries (St Albans Creek, Dudley Creek, Shirley Stream and Waikākāriki / Horseshoe Lake) contribute to the river's lower reaches below Fitzgerald Avenue.

In addition to spring-fed tributaries there are 74 kilometres of stormwater drains that contribute to both the quality and quantity of water the river receives.

4.1 Geology

4.1.1 Canterbury Plains

The Canterbury Plains are a complex of coalescing fans deposited by eastward-flowing rivers emerging from the foothills of the Southern Alps. During glacial periods valley glaciers reached almost to the foothills, and meltwater rivers built alluvial fans.

The Canterbury Plains are formed on more than 500 m of gravel deposited during the late Tertiary and Quaternary periods (the last 5 million years). At the coast the gravel is shallower, being underlain at 240 m by clay, sand, silt, peat and interbedded gravel deposited in an ancient coastal environment. Basement rock is generally at a depth of 1.5 to 2 km, although rock occurs at shallower levels near the Banks Peninsula hills.

Accumulating progressively downstream, the alluvial fans extended to a coast which was several kilometres east of the present shoreline. Successive glaciations deposited gravel layers that are generally 10 – 20 m, but up to 40 m thick. During interglacial periods the rising sea created deposition areas for blue, brown and yellow sand, silt and clay with inter-bedded shell, peat and wood layers in the vicinity of the present-day city. Successive climate cycles have laid down six or more gravel layers separated by significantly less permeable fine sediment. Layers can be identified in some of the 10,711 well logs in the area. Inland from Christchurch the impermeable layers dwindle and disappear.

The Fendalton gravel lobe is identified with a geological model of Holocene gravel and marine sediments under Christchurch City in the geographic area that includes the locations of most Avon River springs. The Waimakariri River probably deposited the Fendalton gravel lobe after flowing through the areas of the Harewood and Airport Floodways. Avon River spring flow is supported by recharge from the Waimakariri River and by recharge from rainfall. (White, 2005)

4.1.2 Soils

Ōtākaro-Avon catchment soils vary greatly, from typical light, silty Canterbury Plains soils in the west, to deep, wet soils in the centre, and sandy soils near the coast. West of about Ilam are Waikakariri soils which are stony and can be shallow, in north-west/south-east trending strips separated by abandoned water courses that mark ancient overflow channels of the Waimakariri River. The soils are freely to excessively draining according to the depth of fine material that lies over the gravels and the abundance of stones in the profile.

Between Upper Riccarton and Linwood is a large block of Kaiapoi deep sandy loam with areas of wetter Taitapu deep silt loam in a wide band from Riccarton to Phillipstown and a flattish basin (Richmond and Shirley) north of the city centre. These soils become progressively wetter as the land surface and the water table start to converge.

Much of the soil in Dallington and Linwood, and a band along the Ōtākaro-Avon River to Ihutai-the Estuary is Taitapu deep silt loam.

Burwood, Parklands, Westhaven and Bromley are elevated areas built up from of sand dunes as the sea retreated approximately 6000 years ago. The soil is Waikuku loamy sand formed on dune sand accumulated during this phase of dune building. A coastal strip including North and South New Brighton, Wainoni and Aranui consists of Kairaki sand. Kairaki sand is formed on raw dune sands devoid of colloid coatings and does not have a distinct topsoil. Near the shore the dunes support marram grass and pingao. A large area of Kairaki sand has been built over mainly for housing.

4.2 Drainage Network

4.2.1 Streams and Drainage Channels

The upper Avon stream network developed with water emerging from gravel fans deposited by the Waimakariri River. Gravel-bed tributary streams converge into the Ōtākaro-Avon mainstem west of Hagley Park. Further east are several remnant basins where wetlands (e.g. the Riccarton Basin) and swamps with not-very-well defined waterways were developed and drained as settlement progressed. Numerous open drains have been created, and these mostly became lined or piped to facilitate urban development. The capacity of these tributaries is limited to between a 5 and 10 year average recurrence interval (ARI) event, so surface flooding can occur, infrequently, on the flat floodplains.

4.2.2 Stormwater System

The public stormwater network starts in road-side channels which receive discharges from private property and the carriageway. The primary function of side channels is to maintain dry traffic lanes. Side channels lead to street sumps (catchpits) which discharge into the pipe network. The pipe network's level of service is that road drainage will avoid traffic hazards in a 5 year average recurrence interval rainfall. Occasional road and property flooding occurs due to sump blockage or system capacity.

Most stormwater discharges within the Ōtākaro SMP Area are to surface water.

4.1 Groundwater – Physical

The Christchurch aquifer system has been formed from glacial and river-derived gravels, deposited during the alternating glacial and inter-glacial periods over the last 500,000 years. Deposition of gravels during ice advances (glaciations) formed fans of unsorted outwash on the inland Canterbury Plains. During the warmer interglacial periods, rivers reworked these outwash deposits and deposited them further down the Plains as more permeable gravel strata, including deposits within the Christchurch area.

Along the coastline, rises in sea level during interglacial periods have resulted in the deposition of finer grained (clay, silt and sand) marine and estuarine deposits. These deposits are thickest at the coast and become progressively thinner inland. Alluvial gravels occur near the surface in the west of the catchment and extend toward the coast along the lines of old river channels. These typically represent the most permeable near-surface strata. Alluvial sand and silt deposits of lower pemeability occur through central and eastern parts of the catchment and are present between river channels. The surface low permeability layer is referred to as the Christchurch Formation.

The gravel aquifers are primarily recharged by seepage from the Waimakariri River in the area to the north-west of the city and by infiltrating rainfall on the plains to the west of the city resulting in a pattern of lateral groundwater flow in the shallowest aquifer is plotted in Figure **7**.

The sequence of glacial and interglacial periods in the Christchurch area has resulted in the formation of permeable glacial and river derived gravel layers originating from the inland area to the west, inter-fingered with low permeability marine and estuarine sediments which thicken in an eastward direction.

4.1.1 Depth to groundwater

Groundwater is generally shallow, between 1 and 3 metres deep over much of the catchment as evidenced by spring flows and areas of wet ground in the central city and east. Groundwater becomes deeper, up to 6 metres deep (PDP 2013) in the west. Regularly measured groundwater level monitoring wells show a stable long-term trend (PDP 2013).

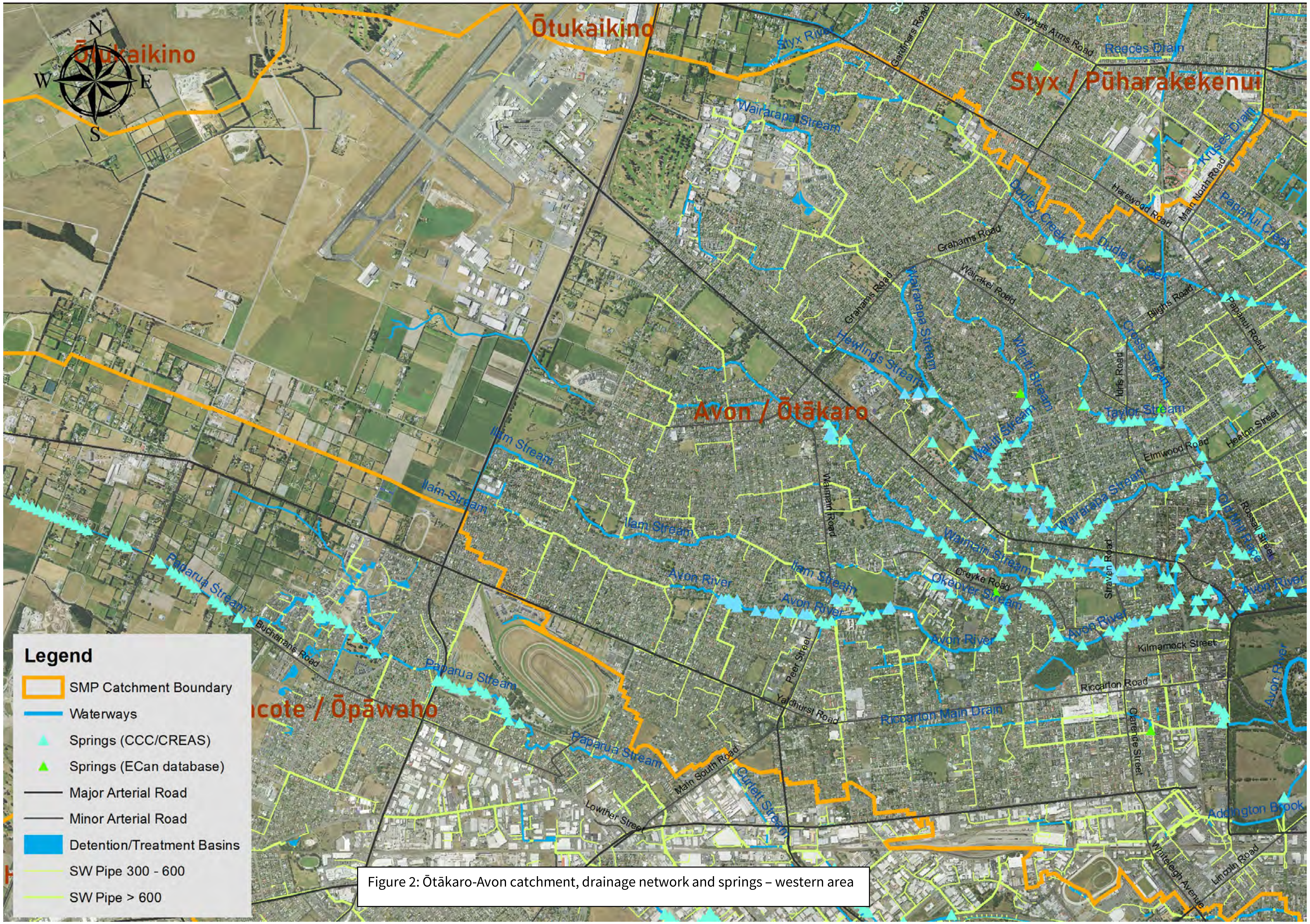

Figure 2: Ōtākaro-Avon catchment, drainage network and springs – western area

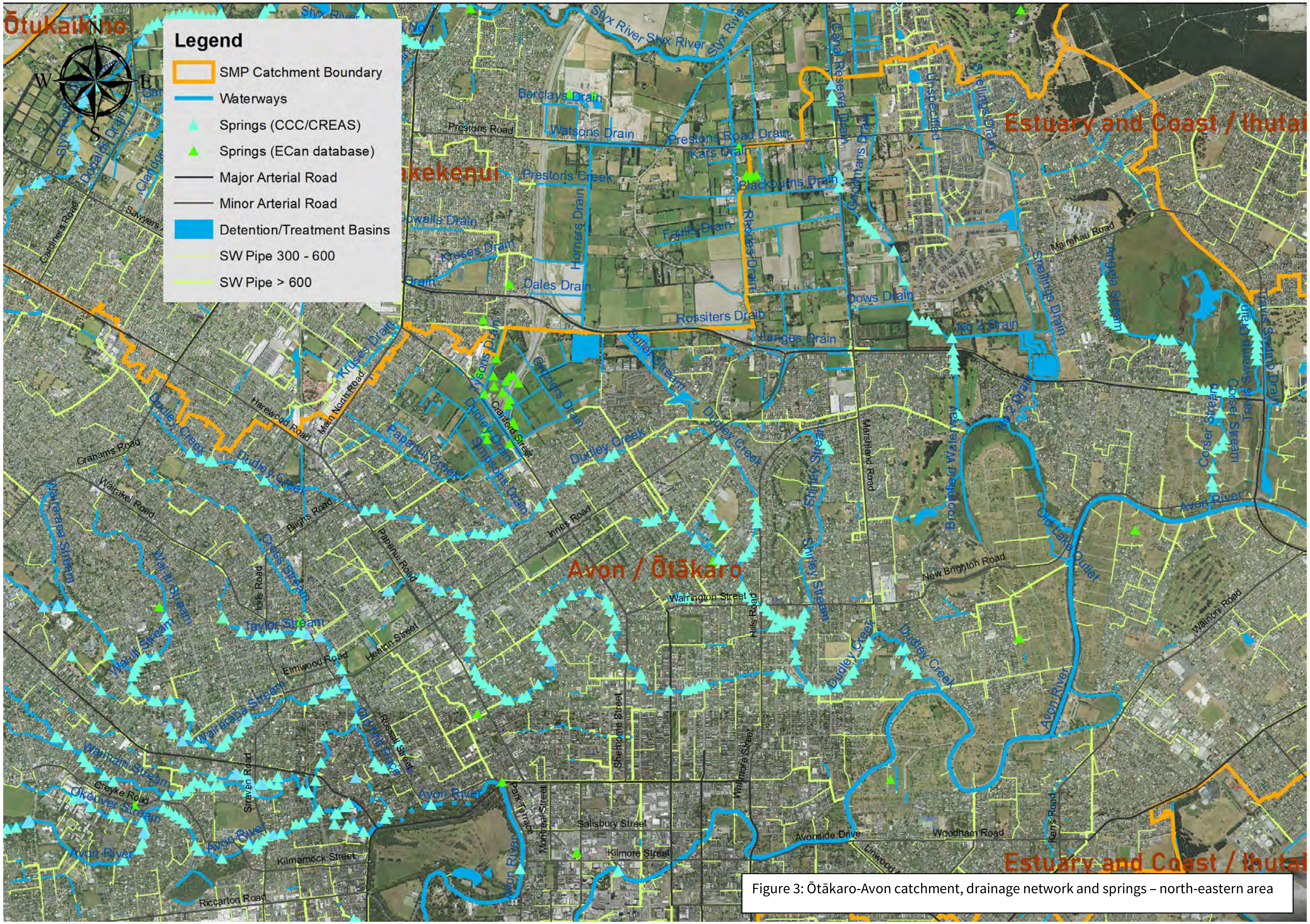

Figure 3: Ōtākaro-Avon catchment, drainage network and springs – north-eastern area

Christchurch City Council

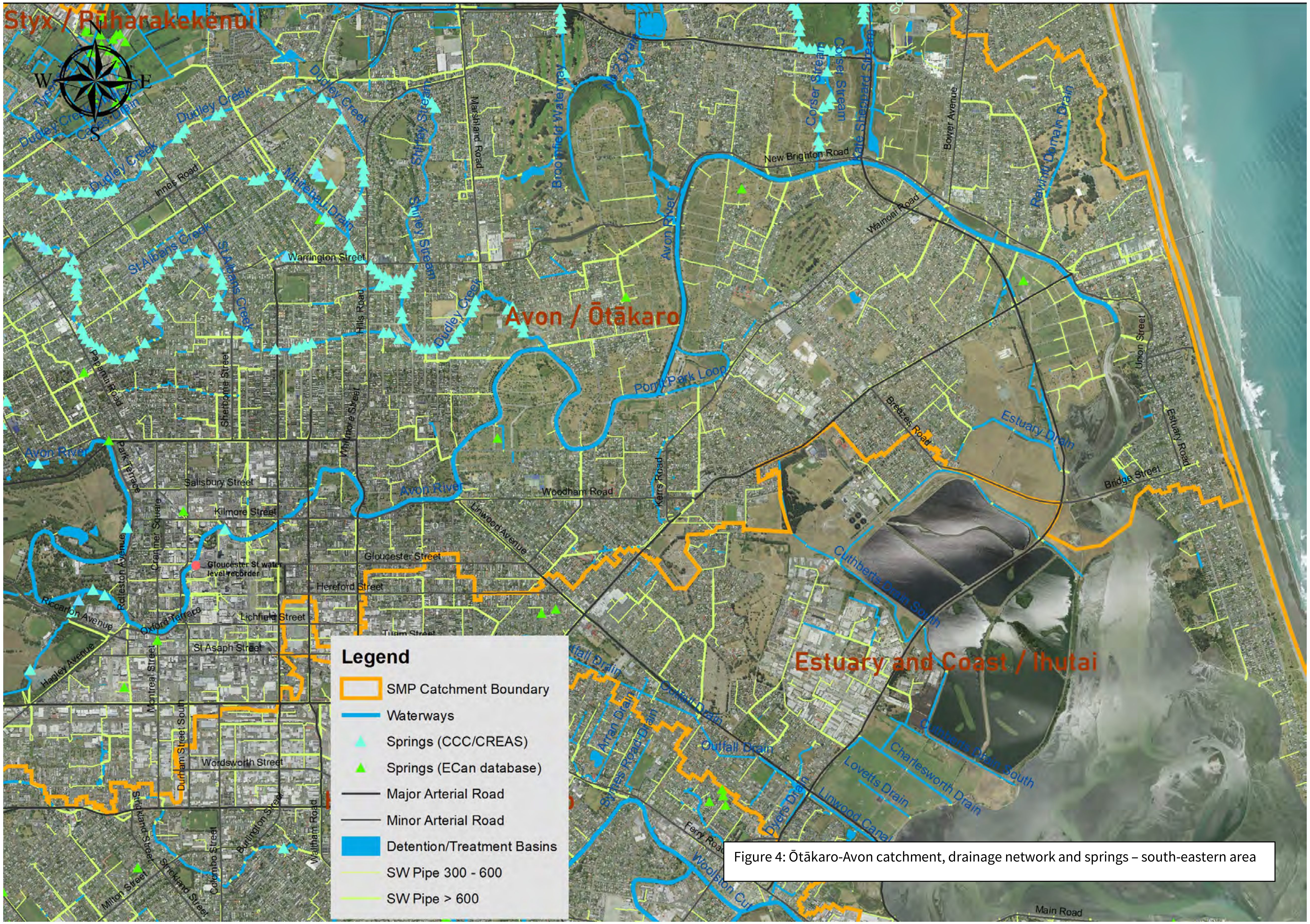

Figure 4: Ōtākaro-Avon catchment, drainage network and springs – south-eastern area

4.1.2 Springs

Shallow (unconfined) groundwater mostly emerges into spring-fed waterways. Groundwater levels respond to the rate of recharge entering the groundwater system and the permeability of the aquifers. It is deepest at the western end of the catchment (typically around 6 m deep) and becomes shallower moving east, coming within 1.5 to 2 metres of ground level where springs feed the tributaries, and shallower nearer the coast. Groundwater levels are thought to be maintained artificially low by seepage into gravel bedding around the city's pipe network.

The distribution of springs is controlled by the distribution and characteristics of the confining layer over the upper confined aquifer. Artesian pressure can force groundwater up through this layer until it emerges as springs. Numerous springs in some tributaries and the Cranford Basin maintain base flows.

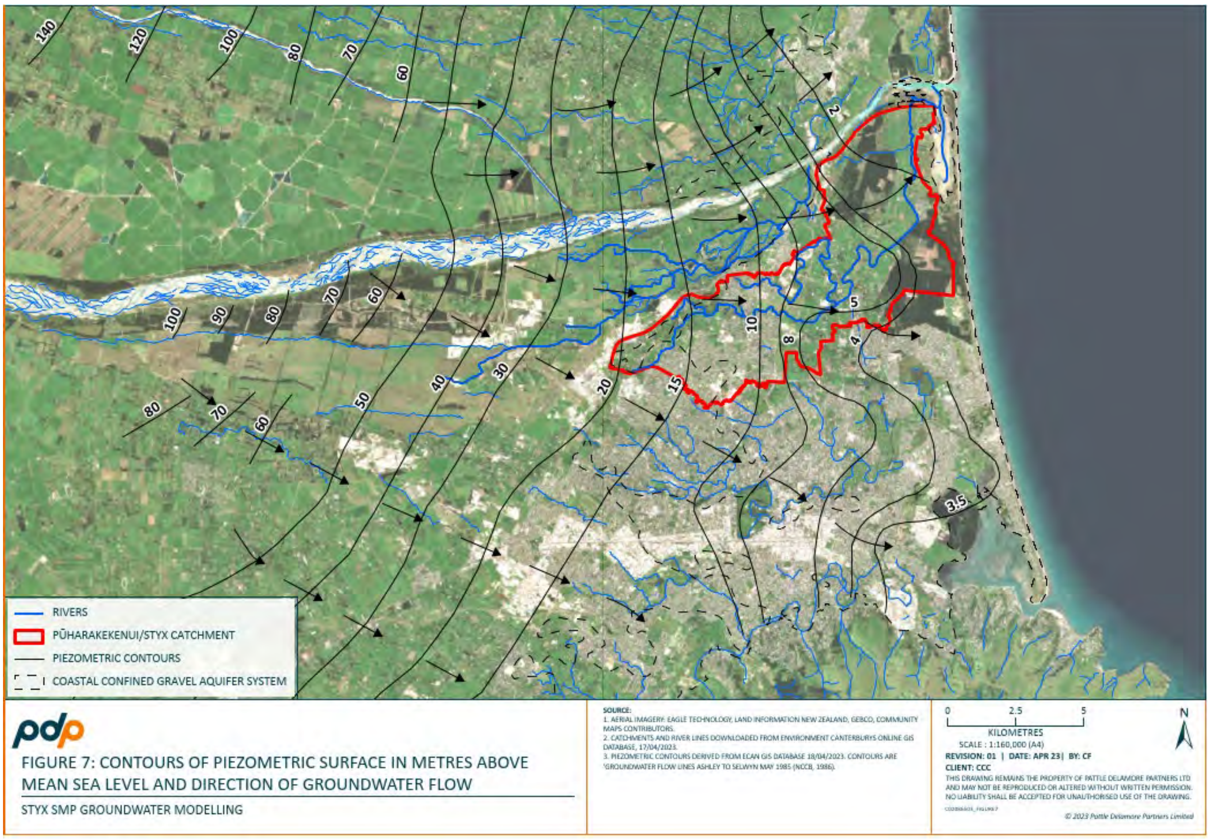

Figure 5: Groundwater Flow Pattern (PDP, 2023)

4.1.3 Baseflow

A stage recorder and rated flow record at Gloucester Street Bridge is the continuous flow recorder site for the Ōtākaro-Avon River. The location of this recorder is shown in Figure 4. This recorder is maintained by NIWA and data are available from 1980 onwards.

A baseflow analysis for the Avon River undertaken by GNS (GNS Science, 2007) considered the flow record and inflow from tributaries downstream of Gloucester Street. They estimated a baseflow of approximately 2,200 L/s at the Avon River Mouth (at the estuary), made up of 1,669 L/s at Gloucester Street and 531 L/s from tributary contributions (such as Dudley Creek) flowing into the Avon River downstream of Gloucester Street.

5 Tangata Whenua Cultural Values

5.1 Wai Maori

Ko te wai te oranga o ngā mea kātoa

Water is the life giver of all things

Water is a significant cultural element that connects Ngāi Tahu to the landscape and the culture and traditions of tūpuna. All water originated from the separation of Rangi and Papatūānuku and their mourning for one another. Rain is Rangi's tears for his beloved Papatūānuku and mist is regarded as Papatūānuku's tears for Rangi.

For tāngata whenua, the current state of cultural health of the waterways and groundwater is evidence that water management and governance in the takiwā has failed to protect freshwater resources. Surface and groundwater resources are over-allocated in many catchments and water quality is degraded as a result of urban and rural land use. This has significant effects on the relationship of Ngāi Tahu to water, particularly with regard to mauri, mahinga kai, cultural wellbeing and indigenous biodiversity.

A significant kaupapa that emerges from (the Mahaanui Iwi Management Plan) is the need to rethink the way water is valued and used, including the kind of land use that water is supporting, and the use of water as a receiving environment for contaminants such as sediment and nutrients. Fundamental to tāngata whenua perspectives on freshwater is that water is a taonga, and water management and land use should reflect this importance. Because of the fundamental importance of water to all life and human activity, Ngāi Tahu maintain that the integrity of all waterways must be jealously protected. This does not preclude the responsible use of water, but merely states the parameters which Ngāi Tahu believe any such use should remain within. The utilisation of any resource for the benefit of the wider community is encouraged, providing that it is done with the long-term welfare of both the community and the resource in mind."

(Mahaanui Iwi Management Plan, Part 5.3 Wai Māori).

5.2 Ngāi Tahu Site Specific Cultural Values

5.2.1 Historic Values

Waitaha were the first people to settle the South Island. They were followed by Ngāti Mamoe, and Ngāi Tahu, who migrated from the East Coast of Te Ika a Maui/The North Island. It was highly regarded as a mahinga kai by Waitaha, Ngāti Māmoe and Ngāi Tahu.

The Waitaha pā of Puari once nestled on its banks. In later years, Tautahi (the chief after whom our city takes its name) made kai gathering forays down Ōtākaro from Koukourarata on Horomaka (Banks Peninsula) to take advantage of the abundant bounty offered up by its waters.

Pātiki (flounder) were speared, eels (tuna), ducks, whitebait (inaka) and native trout were also caught.

Ōtākaro, meaning the place of a game, is so named after the children who played on the river's banks as the food gathering work was being done. In Tautahi's time few Māori would have lived in the Ōtākaro area itself. Those that did were known to Māori living outside the region as Ō Roto Repo (swamp dwellers). Most people were seasonal visitors to Ōtākaro. Fish and birds were preserved for use over the winter months when fresh kai was in short supply.

Springs feeding into the river were used by tohunga for healing purposes. These were sited in the Ōrakipaoa (Fendalton) area in the Wairarapa and Waiwhetū streams.

5.2.2 Whakapapa

The concept of whakapapa underpins all others and gives rise to the context in which all other Maori life-ways find their meaning. Whakapapa may be loosely translated as the genealogical relationships that bind and connect both human and non-human worlds. It establishes the origins of all things and connects people to their ancestors and the land and natural resources around them. Natural elements including people are believed to have originated from the atua (gods); all parts of the Māori world are unified by spiritual connections and common ancestry, binding tangata whenua to the natural environment.

Whakapapa binds tangata whenua to the mountains, lands, waters, and other resources in their rohe. Impacts on any element or resource connected with tangata whenua have a cultural impact.

The whakapapa of a waterway determines its use in Tohunga (spiritual), Waiwhakaheketupapaku (burial sites), Waitohi (Tohunga use i.e. removal of Tapu), Waimataitai (coastal mix of fresh and salt water, estuaries), Waiora (Tohunga healing water), and Mahinga kai (food source).

5.2.3 Mauri

Mauri is the physical life force inherent in each element of the natural world. The mauri of individual entities is inter-dependent on the mauri of the greater system. A Māori view of environmental management sees that protection of the mauri of natural systems is essential for their survival. It is also seen as reflecting on the mana of the people who are associated with it. Mauri can be harmed by the actions of people. The overall purpose of resource management for Ngāi Tahu is the maintenance of the mauri of natural and physical resources, and to enhance mauri where it has been degraded by the actions of humans.

5.2.4 Ki Uta Ki tai

Ki Uta Ki Tai (from the mountains to the sea) is a holistic approach to resource use by Ngāi Tahu. It is best expressed by considering the environment as a whole rather than discrete parts. From a Māori perspective this also includes cultural and spiritual dimensions.

5.2.5 Past and Current Values

The Ōtākaro-Avon is a significant waterway and was once an important mahinga kai for Ngāi Tūāhuriri. Foods gathered from the river include tuna (eel), kanakana (lampreys), Kēkewai (freshwater crayfish), as well as other native fish, plants and waterfowl. Mahinga kai practices within the catchment continue today.

Ihutai-The Estuary is a significant part of the catchment and an important mahinga kai where a variety of shellfish, fish and plants can be gathered. In 1868 the High Court created 10 mahinga kai reserves (“Fenton Reserves” after Justice Fenton) in Canterbury in response to a claim by Ngai Tahu about the insufficiency of reserves and the loss of wetlands and food-gathering territory. Ihūtai Reserve (MR 900) located near the mouth of the Ōtākaro - Avon River was one such reserve. Ihūtai Reserve was acquired by the Christchurch Drainage Board in 1956 under the Public Works Act, against the owners’ will, and used for a wastewater treatment pond.

5.3 Te Ngāi Tūāhuriri Rūnanga Position Statement / Cultural Impact Assessment

Te Ngai Tuahuriri Rūnanga is the papatipu rūnanga for the Pūharakekenui-Styx catchment. Te Ngai Tuahuriri Rūnanga neither approves nor criticises the SMP, but provides a statement of the rūnanga’s views and position (a Position Statement) on matters specific to this catchment that arise from the Mahaanui iwi Management Plan.

A Position Statement will be delivered after the final SMP has been considered by the rūnanga.

5.4 Cultural Monitoring

Cultural monitoring enables the Council and Ngāi Tāhu to compare present and potential future conditions against the State of the Takiwā Report (Ngāi Tahu, 2007). Cultural monitoring will be carried out as part of the Environmental Monitoring Programme. Sites will be sampled five-yearly in conjunction with the monitoring of surface water quality, instream sediment quality and aquatic ecology.

The first round of cultural monitoring in Pūharakekenui-Styx Catchment is expected to start in 2023 and depending on report writing and approval by Te Ngai Tuahuriri Rūnanga may be ready for inclusion in the final SMP.

6 The Receiving Environment

6.1 Monitoring Sites

The Council monitors water quality monthly at 13 sites in the Ōtākaro-Avon Catchment as outlined in Table 1 and Figure 6. All sites are located within waterways classified in the Land and Water Regional Plan as 'spring-fed – plains'.

Table 1: Water Quality Monitoring Sites

Site Name	Site ID	Monitoring Instigated
Avon River at Pages/Seaview Bridge	AVON01	January 2007
Avon River at Bridge Street	AVON02	January 2007
Avon River at Dallington Terrace/Gayhurst Road	AVON03	January 2007
Avon River at Manchester Street	AVON04	July 2008
Wairarapa Stream	AVON05	January 2007
Waimairi Stream	AVON06	January 2007
Avon River at Mona Vale	AVON07	January 2007
Riccarton Main Drain	AVON08	October 2008
Addington Brook	AVON09	October 2008
Dudley Creek	AVON10	October 2008
Horseshoe Lake Discharge	AVON11	October 2008
Avon River at Carlton Mill Corner	AVON12	October 2008
Avon River at Avondale Road	AVON13	October 2008

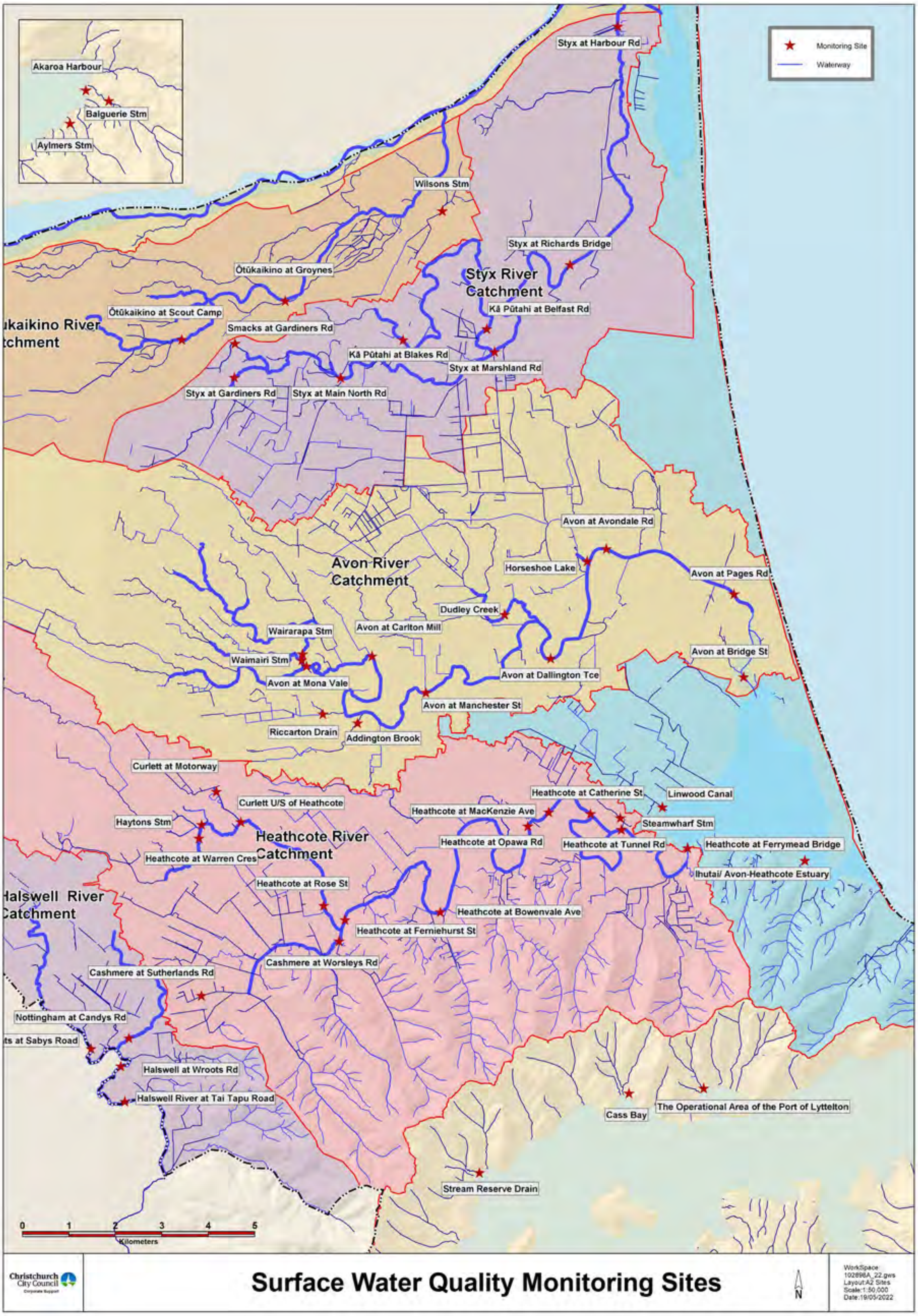

Figure 6: Council Water Quality Monitoring Sites (Burrell, 2023)

6.2 Water Quality

The Council monitors water quality monthly at 47 waterway sites across the district, including 13 sites in the Ōtākaro-Avon catchment (Figure 1). Most sites have been monitored since approximately 2007. The most recent summary of monitoring data was presented by Margetts and Poudyal (2023) which covered data up to the end of 2022. The following paragraphs summarise relevant results from Margetts and Poudyal (2023).

Council water quality samples are analysed for over 20 individual water quality parameters. Council uses a Water Quality Index (WQI) to summarise data from 11 individual water quality parameters into a single index value that ranges from 0 to 100, with 100 representing high water quality. The WQI is comprised of the following parameters: dissolved copper, dissolved zinc, pH, total suspended solids, dissolved oxygen, temperature, 5-day biochemical oxygen demand, total ammonia, nitrate-nitrogen, dissolved reactive phosphorus, and the faecal pollution indicator Escherichia coli (E. coli).

In 2022, WQI scores in the Ōtākaro catchment ranged from 59.1 in Dudley Creek, indicative of 'poor' water quality, to 89.5 in Waimairi Stream, indicative of 'good' water quality (Figure 2). Overall, the median WQI score across all sites in the Ōtākaro catchment was 76, down from 83 in 2021 (Margetts and Poudyal 2023), reducing the median score from 'good' to the 'fair' water quality category. Of the five major catchments monitored by Council in Christchurch City, the Ōtākaro scored the second highest WQI in 2022, second only to the Ōtukaikino catchment, which recorded a median score of 82. Of the 47 waterway sites regularly monitored by Council, only two showed significant trends in the WQI, including a site on Dudley Creek in the Ōtākaro catchment, where the WQI showed a significant deteriorating trend. The WQI at the Dudley Creek site declined, on average, 2% per year, over the analysed period of 2016–2022.

The WQI is affected by the number of component water quality parameters that exceed guidelines. Within the Ōtākaro catchment, the E. coli guideline of ≤550 CFU/100 ml (95th percentile) was not met at all 13 sites, the dissolved reactive phosphorus guideline of ≤0.016 mg/L was not met at seven sites, the dissolved copper guideline of ≤0.0018 mg/L (95th percentile) was not met at six sites, the dissolved zinc guideline of ≤0.02951 mg/L (95th percentile) was not met at four sites, and the dissolved oxygen guideline of ≥70 % was not met at two sites.

The CSNDC EMP requires that Council assesses monitoring results for key urban stormwater contaminants against the consent Objectives and Attribute Target Levels (ATLs), namely total suspended solids, copper, lead, and zinc. Failure to meet any of the ATLs triggers investigations to determine whether the water quality is due to stormwater inputs. In total, 36 of the sites monitored across the district did not meet at least one the ATLs in 2022, including 10 of the 13 sites in the Ōtākaro catchment. Of these 10 sites, five failed to meet multiple ATLs. All non-compliances with ATLs in the Ōtākaro catchment in 2022 were due to elevated concentrations of the dissolved metals copper and zinc, which are common urban contaminants.

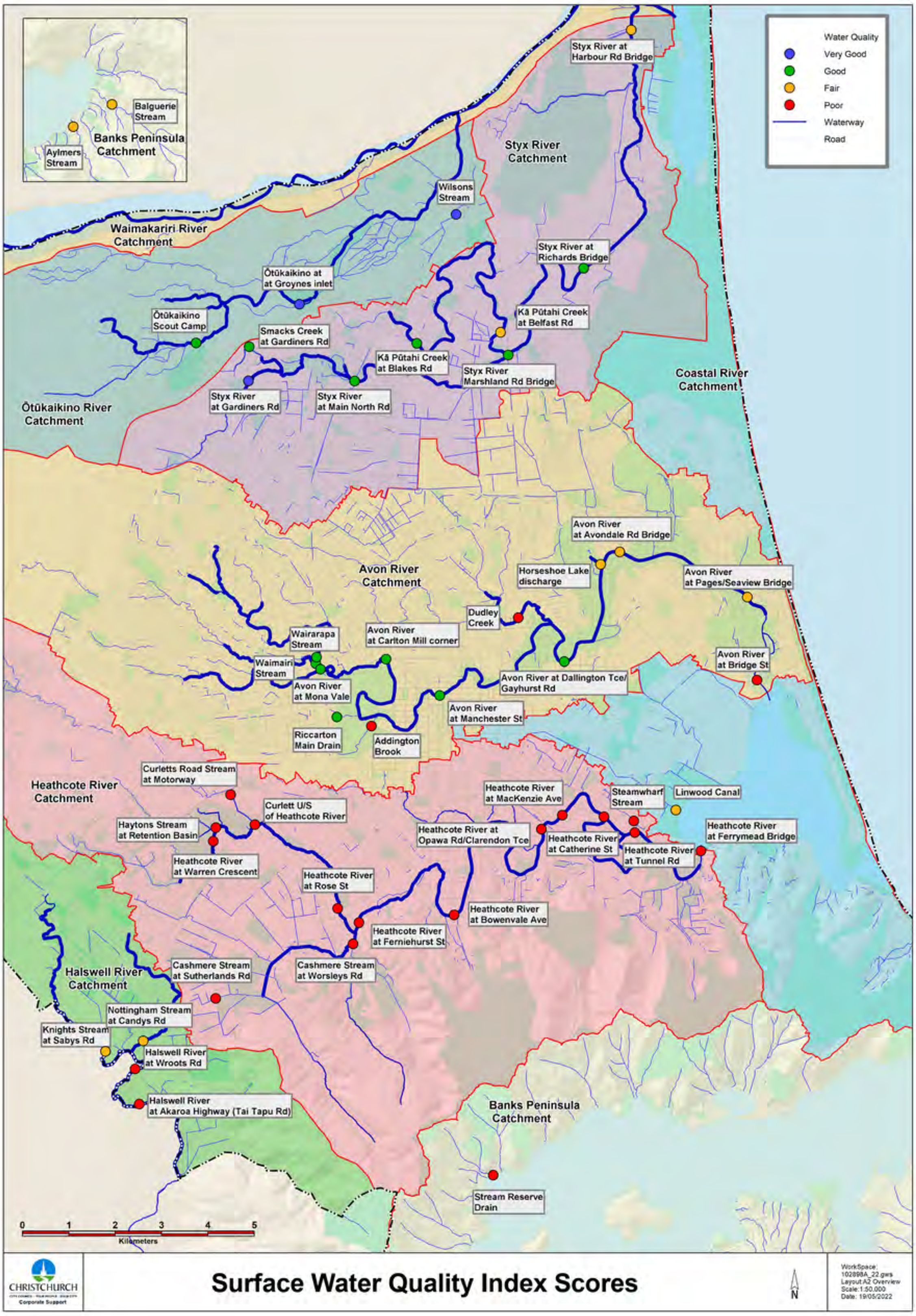

Figure 7 Water Quality Index Scores of Councils Sampling Sites (Burrell, 2023)

6.3 Sediment Quality

Stormwater contaminants such as metals can accumulate in stream bed sediments and can adversely affect the health of invertebrates and fish. The most recent summary of sediment monitoring data from the Ōtākaro catchment was presented by Instream Consulting (2019), which included data collected from 14 sites at varying intervals from 1980 to 2019. Sediments were analysed for common stormwater contaminants, including copper, lead, zinc, and Polycyclic Aromatic Hydrocarbons (PAHs). While concentrations of these contaminants exceeded ANZECC & ARMCANZ (2020) guidelines at 13 of the sites in 2019, there was no indication of increasing trends at most sites.

Lead and zinc were the most elevated sediment contaminants, exceeding guidelines at most of the sampling sites (Figure 3), whereas exceedances for copper (one site) and PAHs (four sites) were rare. Sediment lead concentrations have greatly reduced at most sites since 1980, reflecting the banning of leaded petrol for cars. Instream Consulting (2019) identified zinc as the contaminant of greatest concern in Ōtākaro catchment sediments, as zinc was elevated at most locations and was the only sampled parameter to exceed the high guideline value. Sediment zinc concentrations exceeded the high guideline value at three locations; Addington Brook, Avon River at Armagh Street, and Avon River at Manchester Street, which are worthy of further investigation. High concentrations of zinc in the sediments of the Ōtākaro catchment can be attributed to a legacy of untreated stormwater discharges, as well as ongoing contamination from unpainted and poorly galvanised steel roofs, and road runoff containing zinc abraded from tyres.

6.4 Aquatic and Riparian Habitat

The most recent comprehensive monitoring of the aquatic and riparian habitat condition of the Ōtākaro catchment was the five-yearly monitoring completed in 2019 (Instream Consulting 2019). This involved sampling 18 sites across the Ōtākaro catchment, including 15 wadeable and three non-wadeable sites, with results compared to the two previous survey rounds (2009 and 2013). Instream Consulting (2019) concluded that there were few habitat changes at the monitoring sites since the previous round, with the Ōtākaro continuing to provide poor quality habitat, when compared to the less urbanised Pūharakekenui–Styx River and Ōtūkaikino catchments.

Surrounding land-use is a mixture of residential properties, reserves, and roadsides, as in the previous monitoring round. Riparian buffers are minimal (at <2 m) and often highly maintained for aesthetic reasons. The upper reaches of the Ōtākaro mainstem, as well as its tributaries, are generally narrow and shallow, and often lined with stone or timber. Overhead shade is variable at the monitored sites in these reaches, with the highest shading recorded in Okeover Stream, provided by a near-complete canopy of native trees and shrubs. In comparison, the lower Ōtākaro mainstem is broader and deeper, with natural banks and low levels of shading. The most downstream, tidally-influenced, reaches of the river are bordered by stopbanks, which confine the riparian zone to an artificially narrow strip.

Substrates are generally coarse at the upper catchment sites, dominated by cobbles and pebbles. Bed cover with fine sediment is also low at most of the upper catchment sites, with 10 of the 15 wadeable sites complying with the ATL of ≤30% cover.

Figure 8: Lead and zinc in sediments

This was an improvement from the 2013 survey round, where only 5 out of 15 of the wadeable monitoring sites complied with the same guideline. Total macrophyte cover and long filamentous algae was also low at the wadeable sites, with 11 of the 15 wadeable sites complying the ATL of ≤60% for total macrophyte cover, and all 15 complying the ATL of 30% for long filamentous algae cover. Artificial widening and a lack of shade is associated with nuisance aquatic weed growth in the lower river. Consequently, Council contractors remove aquatic weed from the river 2 to 3 times per year.

Localised improvements to habitat quality have occurred in the catchment through numerous enhancement and restoration projects. Projects have often involved riparian planting, with some also including instream habitat additions and realignments of lengths of waterway. Specific examples of such projects include, but are not limited to: Avon River Precinct, involving instream habitat additions, riffle creation, sediment removal, and native plantings (Boffa Miskell 2020); Dudley Creek, involving channel reshaping, native plantings, and installation of constructed eel habitats; Buller Stream, involving replacement of the timber lining with natural banks and addition of instream habitat features; and No. 1 Drain, involving naturalisation and realignment of the concrete channel, riparian planting, instream habitat additions, and the creation of an inline pond system (Instream Consulting 2023). In addition, restoration of Addington Brook in Hagley Park is scheduled for 2023–24, and it will involve channel realignment, riparian planting, and instream habitat additions.

6.5 Aquatic Invertebrates

Invertebrates are animals that lack backbones, such as worms, snails and insect larvae. Some aquatic invertebrates are sensitive to pollution, so their relative abundance can be used as an indicator of waterway health. Examples of pollution-sensitive invertebrates include the 'EPT taxa', which are the larvae of aquatic insects belonging to the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). The Quantitative Macroinvertebrate Community Index (QMCI) measures the relative abundance of pollution-sensitive species at a site, with higher QMCI scores reflecting higher dominance of pollution-sensitive species, and therefore water and habitat of better quality. The CSNDC has an ATL of 3.5 for QMCI scores in the Ōtākaro catchment, however, the National Policy Statement for Freshwater Management (Ministry for the Environment 2020) has set a National Bottom Line of 4.5. As such, this ATL will need to be updated to comply with the National Bottom Line in the future.

The most recent round of routine aquatic invertebrate monitoring in the Ōtākaro catchment was carried out in 2019, involving 18 sites across the catchment, including the mainstem and seven of its tributaries (Instream Consulting 2019). Instream Consulting (2019) recorded an invertebrate community dominated by pollution-tolerant snails and crustaceans, consistent with the previous 2013 monitoring round. Calculated QMCI scores ranged from 2.3 at Avon River at Pages/Seaview Bridge to 4.7 in Dudley Creek. The QMCI ATL of 3.5 was met at 14 of the 18 sites, however, most sites had QMCI values indicative of poor to fair quality (i.e., score less than 5; Figure 4). Furthermore, only nine of the 18 monitored sites meet the more stringent QMCI National Bottom Line of 4.5. There were no clear trends in QMCI values, when compared to the previous two monitoring rounds (2009 and 2013).

A total of 12 EPT taxa were recorded across the monitoring sites in 2019, represented solely by caddisflies (Instream Consulting 2019). Caddisflies have consistently been the only EPT taxon recorded in the Ōtākaro over the last decade (McMurtrie 2009; Boffa Miskell Limited 2014; Instream Consulting 2019; Boffa Miskell 2020), since the local extinction of mayflies, which were last recorded in the late 1980s (Robb 1992). Abundance and diversity of EPT taxa in the Ōtākaro catchment in 2019 was lower than in the less urbanised Ōtūkaikino and Pūharakekenui–Styx River, but slightly higher than the Ōpāwaho–Heathcote River. Recent efforts to enhance habitat and aquatic values in the Ōtākaro catchment have had limited success at substantially improving macroinvertebrate values, which may be attributed to a lack of source populations for locally extinct taxa, including mayflies, and ongoing water quality issues (Boffa Miskell 2020; Instream Consulting 2023).

Kākahi – freshwater mussels (Echyridella menziesii) are an At Risk (Grainger et al. 2018) macroinvertebrate species that are present in the Ōtākaro catchment. In the Ōtākaro mainstem, kākahi have been recorded as far upstream as Mona Vale, and as far downstream as the Waikākāriki–Horseshoe Lake outlet (Instream Consulting 2021). Kākahi are relatively sparse and patchy in the mainstem, compared to other known populations in Christchurch City, such as the Pūharakekenui or Cashmere Stream. However, a substantial population of kākahi is known to exist in Waikākāriki (Instream Consulting 2020b). The Council has recently established a monitoring programme for kākahi in Christchurch City, including monitoring of the Ōtākaro population. Wai kōura – freshwater crayfish (Paranephrops zealandicus) are another At Risk macroinvertebrate (Grainger et al. 2018), which have been recorded in all other major catchments in Christchurch City, including the Ōtukaikino, Pūharakekenui, Ōpawaho, and Huritini–Halswell Rivers, however, there are no records of this species in the Ōtākaro.

6.6 Fish

Instream Consulting (2019) reported a total of 10 fish species in the Ōtākaro catchment, comprising nine native species and one introduced species (brown trout; *Salmo trutta*). Shortfin eel (*Anguilla australis*) was the most widespread species, recorded at 16 of the 18 sampled sites. Longfin eel (*Anguilla dieffenbachii*) was the second most widespread species, recorded at 15 sites, but they were less abundant. Bullies were widespread and abundant, represented primarily by common bullies (*Gobiomorphus cotidianus*) and upland bullies (*Gobiomorphus breviceps*). In general, the fish community composition was comparable to that in other major Christchurch City catchments.

Fish species reported by Instream Consulting (2019) with an At Risk or Threatened conservation ranking (Dunn *et al.* 2018) included longfin eel, inanga (*Galaxias maculatus*), giant bully (*Gobiomorphus gobioides*), and bluegill bully (*Gobiomorphus hubbsi*), which all have an At Risk threat status. In addition to these species, low numbers of kanakana – lamprey (*Geotria australis*), torrentfish (*Cheimarrichthys fosteri*), and smelt (*Retropinna retropinna*) were also recorded in 2017 during monitoring associated with the Avon River Precinct restoration project, however, none of these species were recorded in the latest monitoring round (Boffa Miskell 2020). Torrentfish have an At Risk conservation status, while kanakana have a Threatened status (Dunn *et al.* 2018).

Factors affecting the distribution and abundance of fish in the Ōtākaro catchment include distance from the coast, barriers to fish passage (e.g., tide gates, weirs, and culverts), access to suitable habitat for adults, juveniles and spawning, water quality, and river flows. Instream Consulting (2019) reported that fish species richness was higher closer to the coast. Fish species richness naturally declines with distance from the coast, due to the dominance of diadromy (i.e., species that migrate between marine and freshwater habitats to complete their life histories) in New Zealand's freshwater fish fauna. However, fish migration barriers are also a factor contributing to this distribution. Identification, prioritisation, and remediation of such barriers in the Christchurch District is being addressed by the Council through an ongoing programme of fish passage projects (e.g., Instream Consulting 2020a; Instream Consulting 2022). In the Ōtākaro catchment, this programme has most notably resulted in the remediation of the Mona Vale weir, involving the replacement of the existing step weir with a fish-friendly rock riffle in early 2023. Follow-up monitoring has not yet been conducted to assess the success of this remediation, and thus, impacts on fish distributions in the catchment are not yet known. Similarly, the tide gates associated with the outlet to Waikakariki–Horseshoe Lake were also remediated in January 2019, including the installation of a fish-friendly tide gate. Unrelated monitoring upstream in No. 1 Drain has reported high abundances of migratory species, including inanga, indicating that the fish are able to successfully pass through these gates (Instream Consulting 2023).

The Ōtākaro catchment is known to provide habitat for species with specialised spawning habitat requirements, including inanga and brown trout. Inanga spawn amongst riparian vegetation that is inundated during spring high tides. In the Ōtākaro catchment, inanga spawning currently occurs along a section of the river between Anzac Drive bridge and Niven Street along Kerrs Reach, although with sea level rise, the limits of the spawning reach are likely to migrate upstream to include the Porritt Park Loop area (Orchard and Measures 2017). Brown trout spawn in stream gravels by excavating an oval gravel mound in which the eggs are laid, and where they develop until hatching (Taylor *et al.* 2012). Trout spawning in the Ōtākaro catchment is common in the mainstem upstream of Barbadoes Street, but also occurs in upstream tributaries, including Wairarapa Stream and Waimairi Stream (Taylor *et al.* 2012). The Council holds records of inanga and trout spawning areas in Christchurch City, which they use to update a publicly accessible database[1]. Waterway maintenance activities such as aquatic weed removal and riparian vegetation control are avoided in these areas during critical fish spawning periods.

Few trends in fish populations have been reported in the Ōtākaro catchment in recent years. Instream Consulting (2019) reported that the fish community remained largely unchanged in 2019, when compared to the previous 2013 monitoring round. The notable exception to this was the distribution and abundance of brown trout in the catchment, which had appreciably declined. The decline of brown trout in the Ōtākaro catchment has been tracked since the 1990s via spawning surveys, with the siltation of spawning habitat suggested to be a factor to the local decline of this species (Taylor *et al.* 2012). Conversely, monitoring associated with enhancement projects in the catchment provide some evidence that native fish values may be improving in some areas. Boffa Miskell (2020) reported increased native fish abundance at monitoring sites associated with the Avon River Precinct enhancement project, especially at sites where riffle habitat had been enhanced, when compared to control reference sites. Similarly, increases in fish diversity and abundance have been reported in No. 1 Drain, following a restoration project involving naturalisation of flowing reaches and the installation of a pond system including floating wetlands (Instream Consulting 2023b).

6.7 Actions to Improve Waterway Health

The ecological information reviewer comments as follows. The overall ecological health of the Ōtākaro catchment can, at best, be considered 'fair'. All aspects of the ecology in the catchment are impacted by the surrounding urban landuse to varying degrees. However, there are localised examples of improving ecological values associated with enhancement projects completed in the catchment. Ongoing investment is needed to further enhance ecological values, while protecting those that remain.

Areas where further investment can be considered include:

---

[1] https://gis.ccc.govt.nz/portal/apps/webappviewer/index.html?id=a3486dbd58d7426b85bfd4b63d481c3

- Increasing the length and width of riparian vegetative buffers to improve stream shading, filtering of contaminants in surface runoff, providing habitat for fish and invertebrates, and reducing the reduce the need for mowing grass down to the water's edge.
- Promoting the protection and enhancement of riparian corridors on private land, through public education, and either a strengthening of District Plan rules, or better adherence to existing waterway setback rules.
- Ongoing commitment to restoration and enhancement projects, including monitoring of new, existing, and historic waterway restoration projects, to better inform future decisions about where to invest restoration money.
- Investigating sources of contamination in waterways with impacted water and/or sediment quality.
- Monitoring of locally significant species and their habitats.
- Continued identification, prioritisation, and remediation of migratory fish barriers, including monitoring of remediation success to inform future decision making.

It is worth mentioning the major ecological restoration projects currently being planned within the Ōtākaro–Avon River Corridor. These projects are within former residential land along the lower river that was 'red zoned' – cleared of houses and deemed unfit for rebuilding on – following the Canterbury earthquakes of 2010–11. Chapter 13.14 (Ōtākaro-Avon River Corridor Zone) of the Christchurch District Plan has a priority outcome of significant areas of restored natural environment and a predominance of natural and open spaces in this area. The 'Green Spine' overlay of the District Plan follows the river and envisions an area '…largely free of built development, providing a continuous area of public open space with trails, paths and footbridges, extending from the central city to the sea.' Significant restoration projects currently being planned or underway within the Green Spine include: Dallington Landing (native forest and wetland restoration); Avon Park wetland restoration; and Bexley wetland restoration.

6.8 Groundwater Quality

Groundwater quality has been considered with reference to nitrate N, electrical conductivity, bacterial indicators and metals.

1.11 Nitrate

Nitrate concentrations generally increase in a southerly direction, with the lowest values occurring in bores north of the Ōtākaro-Avon catchment, and the highest values occurring to the south and west of the catchment. Two bores have nitrate concentrations that exceed the NZDWS of 11.3 mg/L, both of which are located close to Hornby, to the west of the city.

This pattern of concentrations reflects both land-use activities upgradient of the catchment and the source of groundwater recharge; the bores located to the north of the catchment have low nitrate concentrations due to the greater influence of seepage of high quality water from the Waimakariri River, whereas the bores located to the south and west of the Avon catchment are affected by nitrate leaching from agricultural activities further inland. The two bores with the highest concentrations occur in the vicinity of waste pits associated with the former Islington freezing works. Higher nitrate concentrations are restricted to bores less than 60 m deep.

1.12 Electrical conductivity

Electrical conductivity has a broadly similar distribution to nitrate concentrations with higher values to the south and west of the catchment, and lower values closer to the Waimakariri River. Some isolated occurrences of high conductivities are present close to Ihūtai-the Estuary and are related to seawater intrusion. Other higher values are also present in shallow bores located close to the headwaters of the Heathcote River. ECan (2011) indicate that discharges from a closed landfill at Wigram in this area are the cause of higher conductivity readings.

Higher conductivities are generally seen in shallower bores. Deeper bores (>60 m) typically show conductivities of less than 20 mS/m, with the exception of bores around the estuary.

1.13 Bacterial indicators

Faecal coliform / E.Coli distributions have a broadly similar pattern to nitrate and electrical conductivity; the highest number of faecal coliform and E.Coli detections are typically observed in bores located to the south and west with generally lower, or no counts observed in bores located to the east. Any detections are generally seen in shallower bores, less than 30 m deep, reflecting that bacterial decay and die-off occurs during the longer travel times required to reach deeper bores.

7 Land Use

7.1 Present Situation

The majority of the Ōtūkaikino Catchment is residential (58%). Other land zonings include commercial and industrial 6%, airport 5%, parks and open space 15% and rural 16%.

7.2 Development and Trends

Christchurch City's population is expected to grow by around 23,000 people between 2015 and 2025 and by a further 40,300 people between 2025 and 2046 (Price, 2014). In the 2015 to 2025 period household growth is expected to be 18,000 households.

7.2.1 Residential Growth

Information available for the draft SMP are city-wide growth projections by StatsNZ Monitoring & Research, 2023). A city growth model is in development and results are expected in 2024. Between 2024 and 2034 the population of the city is projected to grow by around 32,560 people (+8%) and 11,621 households (+6%) reaching an estimated population of 432,920. Growth is occurring in both greenfields and developed areas but the split is unable to be quantified at this time. Continuing infill growth within the Ōtākaro-Avon catchment can be anticipated.

7.2.2 Industrial Growth

An industrial area near the airport is the only developing industrial land in the catchment.

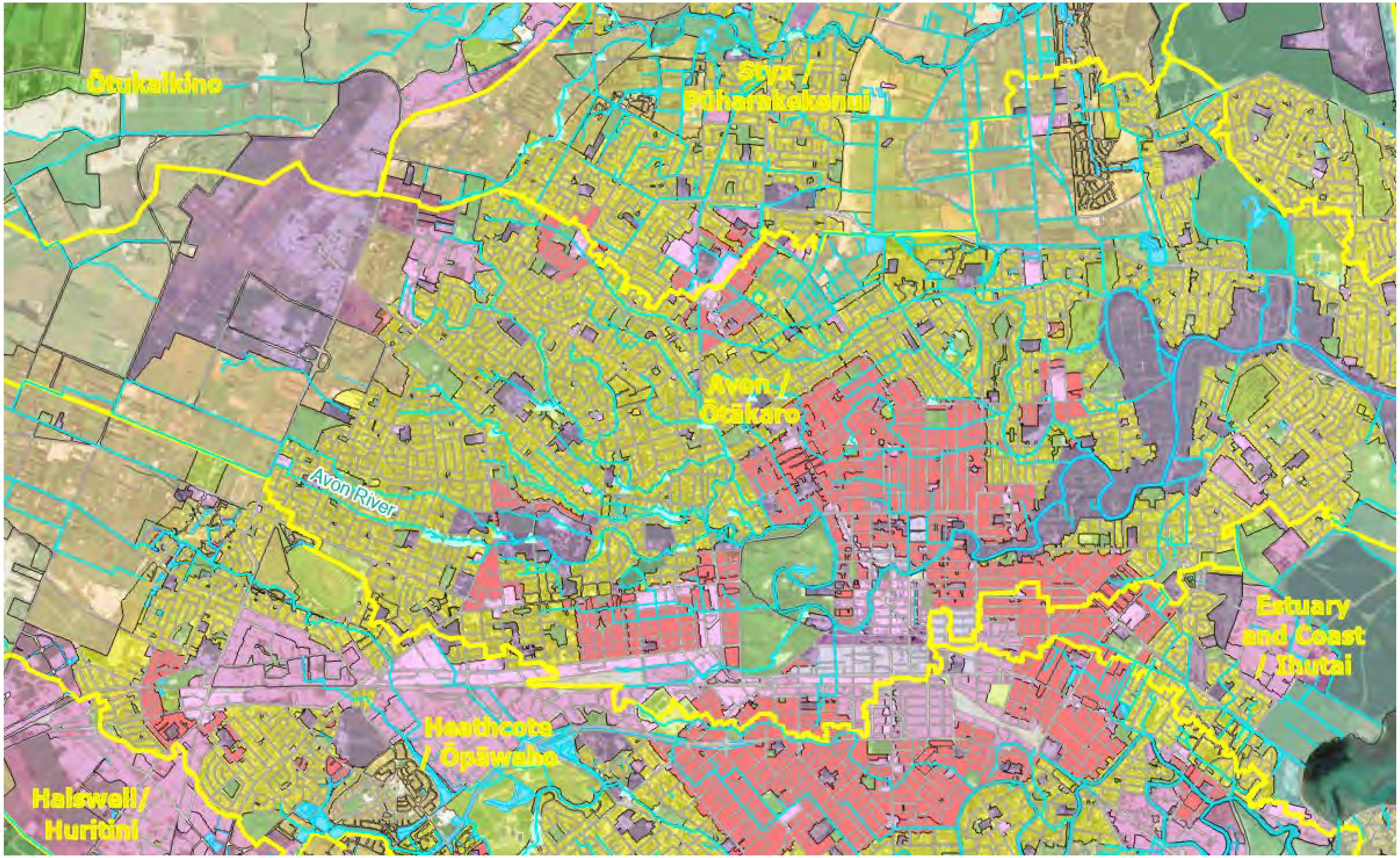

Figure 9: District Plan Zones

7.3 Contaminated Sites and Stormwater

7.3.1 Background

Contaminants may be released from two types of sites:

- Sites with in-ground contaminants that may be entrained in stormwater, typically when soil is disturbed and;
- Sites where on-site activities, usually industrial in nature, may release chemical or metal contaminants into stormwater (or into the ground).

The National Environmental Standards for Assessing and Managing Contaminants in Soil to Protect Human Health Regulations (NES) help to identify potentially hazardous activities and industries which are listed in the Hazardous Activities and Industries List (HAIL).

Such sites are listed in a Listed Land Use Register when they become known to the Regional Council either through a consent application (to ECan or the CCC) or through investigations. Sampling, excavation, subdivision, removal of fuel storage tanks and changing land use on these sites may require a resource consent and remedial action.

7.3.2 Low Risk Sites

A Memorandum of Understanding (MoU) was agreed between the Council and ECan in July 2014 to allow stormwater discharges from low-risk residential rebuild sites listed on the LLUR and/or identified as having had HAIL activities to be processed by the Council rather than ECan. It is anticipated that as confidence grows over time in the operation of the MoU, the list of "low risk" situations that the Council can process will be extended. For example, sites on the LLUR, where only a portion of the site has had a hazardous activity and the construction will not disturb that part of the site, are considered low risk.

A site at low risk will have contaminants 'at or below background concentrations' or 'below guidelines for residential use'. The determination must be made by a qualified person.

Parts of the Ōtākaro-Avon Catchment are listed on the LLUR because of old landfills, asbestos in residential properties and chemical storage. Persistent chemicals may be associated with those sites, however they are generally at low risk of discharging contaminants into stormwater unless the sites are disturbed (e.g., during development). Many of these sites have been investigated as part of subdivision and site development and remediated as necessary.

7.3.3 Higher Risk Sites

"High risk" is generally a reference to sites with persistent or hazardous chemicals in the soil or in use on site. High-risk sites include contaminated sites and some industrial sites.

Many contaminants adhere to sediments and can be mobilised into surface or groundwater when soils are disturbed. These contaminants can be managed by maintaining a stable site, using good sediment control during earthworks and taking care with where soil is disposed of. More specific measures, including on-site treatment, may be needed for more mobile contaminants that cannot be controlled by typical sediment control practices.

All land-use consent applications are checked against the LLUR. Where development is proposed on a site listed in the Listed Land Use Register the application is referred to the Council's Environmental Health Team. Conditions are attached to the resource consent to deal with short term and long-term exposure of contaminants, often requiring site remediation.

7.3.4 Industrial Sites

Industrial sites will be managed in accordance with CRC231955 Conditions 47 and 48 in a process that will occur in parallel to SMPs. The Council will:

- Gather information about and develop a desktop-based identification of industrial sites, ranking sites for risk relative to stormwater discharge;
- Audit at least 15 (principally high-risk) sites per year;
- Inform audited industries of the results of audits and work closely with these industries to achieve outcomes in line with the Stormwater Bylaw;
- Communicate with industries about stormwater discharge standards and the means of meeting these standards.

The Council will be empowered to do these actions by the Stormwater and Land Drainage Bylaw 2022.

7.3.5 Historic Landfills

There are approximately 30 closed landfills in the Ōtākaro catchment, spread across the area from Pound Road in the west to the coast (Tonkin & Taylor, 2014)

The nature (size, depth and likely materials) of the closed landfills means that the risks to groundwater quality associated with groundwater mounding are likely to be low. It is not anticipated that large-scale infiltration basins will be installed near the old landfills. An exception to this is a future stormwater treatment facility planned in the vicinity of Waikakariki – Horseshoe Lake where landfilling occurred historically.

7.3.6 Facilities Built Near Contaminated Sites

The CSNDC requires consideration of soil contamination from landfills or industrial or farming activities (e.g. industrial or agricultural chemicals) and lead paint or asbestos associated with old buildings .

Table 14, Appendix C contains comments about the proximity of proposed mitigation facilities to sites where land contamination might be present.

8 Contaminants in Stormwater

8.1 Introduction

Urban activities cause environmental effects either by shedding more or faster stormwater runoff or by discharging contaminants into stormwater that are harmful to the environment. Most urban surfaces have some form of coating (e.g. paint or galvanising) and a transient layer of wind-blown dust, combustion products, cleaning compounds, etc. Most of these substances are soluble or slightly soluble in rainwater and are transported in dissolved and particulate form into the stormwater network.

8.2 Contaminants and Contaminant Sources

The Christchurch City Council and Environment Canterbury monitor rivers, streams and stormwater for a range of water quality indicators. These include total suspended solids (dust, sediment, grit, and particles of all types), heavy metals, a range of hydrocarbons, bacteria and dissolved oxygen among other indicators. From time to time the Council samples for newly discovered ("emerging") contaminants, and both councils are aware of the likelihood that there are unknown, harmful substances in stormwater.

The Council's monitoring programme is largely based on the Land and Water Regional Plan's

- Schedule 5 Table S5A and Table S5B Indicators and Toxicants, and
- Schedule 8 Region-wide Water Quality Limits

Contaminants of most concern in the Christchurch District are:

- Dust, sediment, grit and particles of all types capable of being transported in stormwater, referred to as total suspended solids (TSS). TSS include metal particles, aggregates of metallic compounds, and charged (e.g. clay) particles with attached metal ions.
- Dissolved and particulate zinc
- Dissolved and particulate copper
- Polycyclic aromatic hydrocarbons (PAHs)
- Pathogens
- Nutrients (mostly phosphorus)

Lesser contaminants, which generally do not exceed guidelines, are:

- Hydrocarbons (oil and grease)
- Cadmium and lead

8.3 Suspended Solids

Particle sources include streambank erosion, animal waste, construction activity, land cultivation, combustion, industrial products, tyre and brake wear and paint coating breakdown. Some particles are natural and some such as paint chips are artificial. Natural soil particles contain metals and may carry adsorbed chemicals.

Suspended solids are damaging because they deposit on stream beds and fill the spaces between stones, greatly reducing the refuge options for instream life. Fine particles can release attached toxic compounds which harm the food chain.

The most important sources of particles in waterways in this catchment are likely to be road surface abrasion, wind-blown dust, vehicle emissions, construction site discharges.

8.1 Zinc

Zinc is used as a protective coating for steel on corrugated iron roofs, rooftop ventilators, chain link fencing, lighting poles and various barriers and fences. Although a zinc layer is long-lived it is slowly being dissolved by rainwater. Industrial and farm buildings often have unpainted galvanised roofs and can be large sources of zinc. Residential areas typically have painted or tile roofs, but many of these have older paint coatings in poor condition and can be a significant source of zinc.

Roofs create approximately 75% of urban zinc. Roads create approximately 25%, much of which is from tyres. Zinc makes up about 0.8% by weight of tyres in which zinc oxide is a vulcanising catalyst. Zinc released onto roads is very fine which can dissolve easily and be transported readily in stormwater. Other zinc sources include galvanised fencing and posts, fungicides, paint pigments and wood preservatives.

Many sources such as Timperley et al (2005) report that tyre-derived zinc is transported onto other surfaces, including roofs, by wind. Stormwater sampling in Christchurch supports this, showing zinc runoff from nominally zinc-free surfaces such as concrete tile roofs.

8.2 Copper

The predominant copper source in urban stormwater is thought to be vehicle brake pad wear. Copper exceeds guidelines at a number of monitoring sites during some rainfalls.

8.3 Polynuclear aromatic hydrocarbons

Polycyclic Aromatic Hydrocarbons (PAHs) are created when products like coal, oil, gas, and garbage are incompletely burned. PAHs are a concern because they do not break down very easily and can stay in the environment for long periods of time. PAHs may come from coal tar sealants and diesel or industrial combustion.

8.4 Pathogens

This section is for information. *E. coli* are not required to be controlled under the consent. *E. coli* counts are usually caused by waterfowl (ESR, 2015). Potential sources in this catchment could include farm animals and dogs.

8.5 Nutrients

This section is for information. *E. coli* are not required to be controlled under the consent.

International research indicates that important nutrient sources include decaying leaves, sediment, fertiliser and bird and animal faeces. Nutrients can lead to excessive aquatic plant growth (Margetts, Poudyal, 2023).

9 Waterway Capacity and Flooding

9.1 History

As development in this catchment progressed its swamps were drained, firstly with open drains and later with pipes. Fewer flooding problems were experienced than in the Ōpāwaho-Heathcote catchment because the main river is considerably larger, but parts of Mairehau and St Albans were notable for being inundated by prolonged rainfall. The Christchurch Drainage Board began to give greater attention to stormwater control in the 1960s, after significant floods, and various flood control projects were built. The Dudley Creek Diversion, completed in 1989, routed water from the Upper Dudley Creek and Papanui through Cranford Basin and into the Dudley Creek Diversion Pipe via a pumping station. Pipelines to relieve flooding in St Albans and Merivale were installed in the 1980s. Stopbanking along the lower river, from Dallington to Bexley, was constructed between the late 1970s and mid 1980s to alleviate the threat of tidal inundation to developing areas such as Avondale and Wainoni.

The stopbanks subsided in places during the 2010-11 earthquakes and were temporarily raised in early 2011. Planning for stopbank replacement is proceeding in tandem with the Ōtākaro Avon River Corridor plan. The width of the Corridor will permit stopbanks to be moved to more stable ground further from the river and to be landscaped.

9.2 Flood Modelling

An earlier Avon hydraulic (flood) model underwent a rebuild in 2016-2018 with the objective of incorporating the entire drainage network and developing an accurate picture of flooding on the floodplain. The model is now highly detailed and features roads, all pipes 300 mm diameter and larger, pumping stations, and infiltration into the ground.

The model software is DHI version 2020 3-way coupled in Mike Flood.

During 2016-2018 the model was configured to represent the 2014 catchment condition and was acceptably calibrated to the March 2014 flood event (and validated for the June 2013 flood event). Since 2018 the infiltration methodology has been improved from a simpler Hortons infiltration to a more realistic ‘infiltration with capacity’ model with a constant infiltration rate, but finite infiltration capacity.

Significant model updates were completed during 2020-2022 to resolve gaps and inconsistencies in the mapped flood extents and include major stormwater infrastructure projects since 2014. These projects included Cranford Basin enlargement, Lower Dudley Creek Improvements, improvements to six pumping stations, new flood mitigation basins, as-built stopbank levels and inclusion of Southshore bunds (following some planned work to complete this protection). Modelled floodplain levels were updated from 2018 LiDAR ground levels. The new Prestons subdivision and Northern Corridor motorway were partially represented from the limited data available. Detailed flood results in these two areas remain to be improved but the large-scale flooding patterns around them are expected to be valid.

Design rain event modelling uses HIRD v4 rainfall intensities and a range of storm durations with a ‘max of max’ summarisation of flood risks for ARI’s of 10, 50, 200 and 500 years. This latest work is summarised in the “LDRP097 Multi-Hazard Baseline Modelling Report”, 15 July 2022 and in the “Model Status Report – Avon/Estuary” Rev 7, July 2022.

In the 10 year ARI current (c2020) situation, flooding is commonly restricted to the road reserves, greenspaces, waterways and wetlands. Areas with worse than normal flooding include;

- near the airport, west of Russley Road, (although this western area may have much higher infiltration rates than are modelled)
- Riccarton, Kyle St (noting this area is presently under further investigation with historic evidence that the model is overpredicting flood risks here)
- St Albans, Flockton Ave area (the improvement projects are not predicted to fully resolve the 10 year flood risks here with some deep road flooding and probable floor level flooding still predicted there)
- Edgeware, Canon St southeast of Fresh Choice and its small commercial precinct.

In the present day 50 year ARI event flooding patterns generally reflect the 10 year ARI, but with greater water depths.

Flood results have also been prepared for future conditions out to year 2150. Modelling of future conditions is based on forecast spatial changes in urban housing density and population projections. For areas with capacity for greenfield development, developments are expected to fully mitigate their effects on runoff and flooding, up to 50 year ARI, with consequently minimal change in flood risk up to that level. For areas of brownfield intensification, development mitigation is generally not expected to be practicable and is assumed not to occur, with consequently greater change in flood risks. Future modelling to date does not anticipate any future infrastructure upgrades, where infrastructure includes pipes and stopbank crest levels. Future modelling follows current government guidance on sea level rise and a RCP8.5 climate change scenario.

Inspection of the future 50 year ARI results at 2060 shows generally minor incremental worsening in flood risk (due to the increased rainfall and imperviousness).

9.3 Flooding Levels of Service

The city's drainage systems are principally designed to serve the expectations of safe vehicle travel and flood free housing. Stormwater networks of side channels, pipes and drains keep traffic lanes free of ponded water in frequent events. In more extreme rainfalls the lower lying parts of roads and private properties store water in excess of system capacity until it can be drained away. Houses are expected to be built sufficiently high to remain dry in all but the most extreme events.

The following are standards from the Infrastructure Design Standard and Waterways Wetlands and Drainage Guide which incorporate or provide the Council’s drainage levels of service.

- Road drainage, pipes and minor drains are designed so that the 5 year annual recurrence interval rainfall does not cause a nuisance to traffic.
- Hillside drainage must ensure that a 20 year annual recurrence interval rainfall does not endanger property.

- Stopbanks along the lower river currently (temporarily, in the repair phase following earthquake damage) are at a height of the 100 year ARI extreme tide plus an additional “freeboard”.
- Within Flood Ponding Management Areas minimum floor levels are set 400mm above the 200 year annual recurrence interval flood level. FMAs are those areas covered by the 200 year ARI flood level plus a 250mm safety margin (freeboard). (400 mm floor height above flood level includes the 250 mm freeboard plus an assumed 150 mm minimum foundation height above the natural ground.)
- There are proposed development restrictions for "High Flood Hazard Management Areas" (HFHMA) defined as areas where, in a 500 year annual recurrence interval flood the water would be more than 1m deep or the product of velocity times depth is greater than 1.
- Otherwise a 50 year annual recurrence interval event is used to set the minimum floor levels as required by the Building Act.

9.4 In the Future

Developing greater resilience to flooding and maintaining well-functioning urban environments

Flooding in the Ōtākaro-Avon catchment can arise in three main ways:

1. Rainfall can exceed the capacity of side channels and pipes and accumulate on streets, greenspace and private property. As the pipe network generally has capacity to drain a 5 year ARI storm, surface flooding can be expected during more severe rainfalls.
2. Water that reaches waterways during and after rain can be conveyed for some distance and then leave the waterway at a bottleneck which may be a culvert or a channel or floodplain partially filled as a result of development. On leaving the waterway the flood water is likely to flow through private properties and may cause flooding.
3. High tides flow into the lower river through the estuary to a level that is higher than some surrounding land. Extreme tides would flood tens of hectares adjacent to the lower river if not excluded by stopbanks.

Planning for growth in Otautahi Christchurch is prioritising greater intensification of existing neighbourhoods to reduce the need for further significant expansion into rural areas and to achieve greater infrastructure efficiencies. Without good planning more intensive housing and business areas can exacerbate flood risk. A hydraulic model[2] of the entire built-up catchment estimates water levels in a range of rain events and indicates network capacity. The model accounts for spatial changes in urban housing density and resulting increases in impervious surfaces and rates of urban runoff. Model results indicate a mostly acceptable situation in the present day with heavy rainfalls tending to pond on streets. The model confirms vulnerabilities to heavy rainfalls in some areas, typically shallow depressions where water from surrounding areas can accumulate. Of note is ponding (shown as darker blue areas > 100 mm depth in Figure 10) in

[2] A hydraulic (flow) model replicates water flow in pipes and waterways and over land as closely as possible.

Edgeware business area, Flockton Basin and Rowses Road. Ponding indicated around Kyle Street, Riccarton is not historically verified and indicates a need to adjust the model.

Potentially greater risks will develop if infill housing increases rates of stormwater runoff. Increased stormwater runoff from infill can be difficult to mitigate because normal forms of on-site storage (e.g. raintanks) are of limited use in prolonged rainfalls, and improving network capacity would transfer greater peak flows into already full waterways.

A natural catchment responds to excess rainfall by storing water on its floodplain; likewise in urban areas excess rainfall is discharged from properties to accumulate on streets, low-lying land and secondary flow paths. On-land ponding is inconvenient but is mostly temporary; and houses are made safe through provision of adequate floor levels. Increases in stormwater runoff can be difficult to mitigate at-source because forms of on-site storage, such as rain tanks, are of limited use in prolonged rainfalls. Increased runoff may cause network capacity exceedances or transfer greater peak flows into already full waterways.

On-street and on-property flooding may become deeper in large storms as neighbourhoods densify. An alternative, which has not been judged costs-effective to date, is to purchase residential property and construct stormwater storage basins. To assist the Council's response to current and future potential flood risk, more detailed network and local area planning will be undertaken, specifically to test a range of development scenarios and infrastructure and land development solutions. Solutions may include elevating floor levels, pumping, and storage basins constructed within neighbourhoods, with such mitigation options being considered through an integrated approach with planning and investment for greenspace, recreation and transport, and alongside improvements to meet sustainable surface water objectives. Local area and more detailed network planning will be undertaken in a prioritised manner, having regard to need, growth demand and alignment with other Council planning and investment programmes as identified under the Long Term Plan.

9.5 Measuring Flood Level Compliance

Compliance in water quantity management is measured against Schedule 10 in CRC231955. "Compliance" means that the Council uses best practicable options to manage stormwater in such a way that the 50 year ARI flood level (estimated by the flood model) should not increase by more than 50 mm at the Gloucester Street water level recorder. Schedule 10, Appendix G, has more detail. A version of the Avon hydraulic model model to measure compliance is still in development; in the interim compliance is measured between 2020 and 2045 model years in the Citywide model, with results summarized in Table 2.

Schedule 2(s) requires that the SMP propose 'key water level monitoring locations' in addition to Gloucester Street to provide more opportunities to monitor effects over time and additional checks on compliance.

Table 2 shows key monitoring locations and proposes three sites on important tributaries where modelled assessments of water levels and volumes will be made.

Table 2: Key monitoring locations for Schedule 10 Water Level Compliance

2020 – 2045 Ōtākaro-Avon River hydraulic model (GHD Ltd).					
The development scenario is predicted development levels at 2020 and 2045. Sea level: allowance for RCP 8.5 sea level rise.					
Receiving Environment	**Monitoring Location**	**Baseline Year**	**Annual Exceedance Probability**	**Maximum allowable increase**	**Modelled increase**
Ōtākaro-Avon River	Gloucester Street Bridge	~~2014~~ 2020-2045 interpolated	2%	50 mm	130 mm
Ōtākaro-Avon River	Railway corridor	~~2014~~ 2020-2045 interpolated	2%	80 mm (placeholder)	60 mm
St Albans Stream	Stapletons Road	~~2014~~ 2020-2045 interpolated	2%	100 mm (placeholder)	50 mm
Wairarapa Stream	Railway corridor	~~2014~~ 2020-2045 interpolated	2%	100 mm (placeholder)	150 mm

9.6 Managing risks to dwellings

Properties within the District Plan Flood Management Area are required to build their floor level to provide protection from the predicted 1 in 200 year flood level. The Flood Management Area locations were identified during the District Plan process though modelling of the highest flood impacted locations.

Since 2014 all new house floors have been assigned floor levels safe from flooding, as determined from hydraulic modelling.

The flooding risk from waterways and drains is dealt with by:

- Avoidance: built-up areas are located on high ground or on the outer side of stopbanks.
- District Plan rules.
- New builds within Flood Hazard Management Areas are required to have a floor level above the 200 year average recurrence interval (ARI) flood level plus 400 mm. (A full definition including tidal influences found in the Christchurch District Plan section 5.4).
- Rules under the Building Act 2004

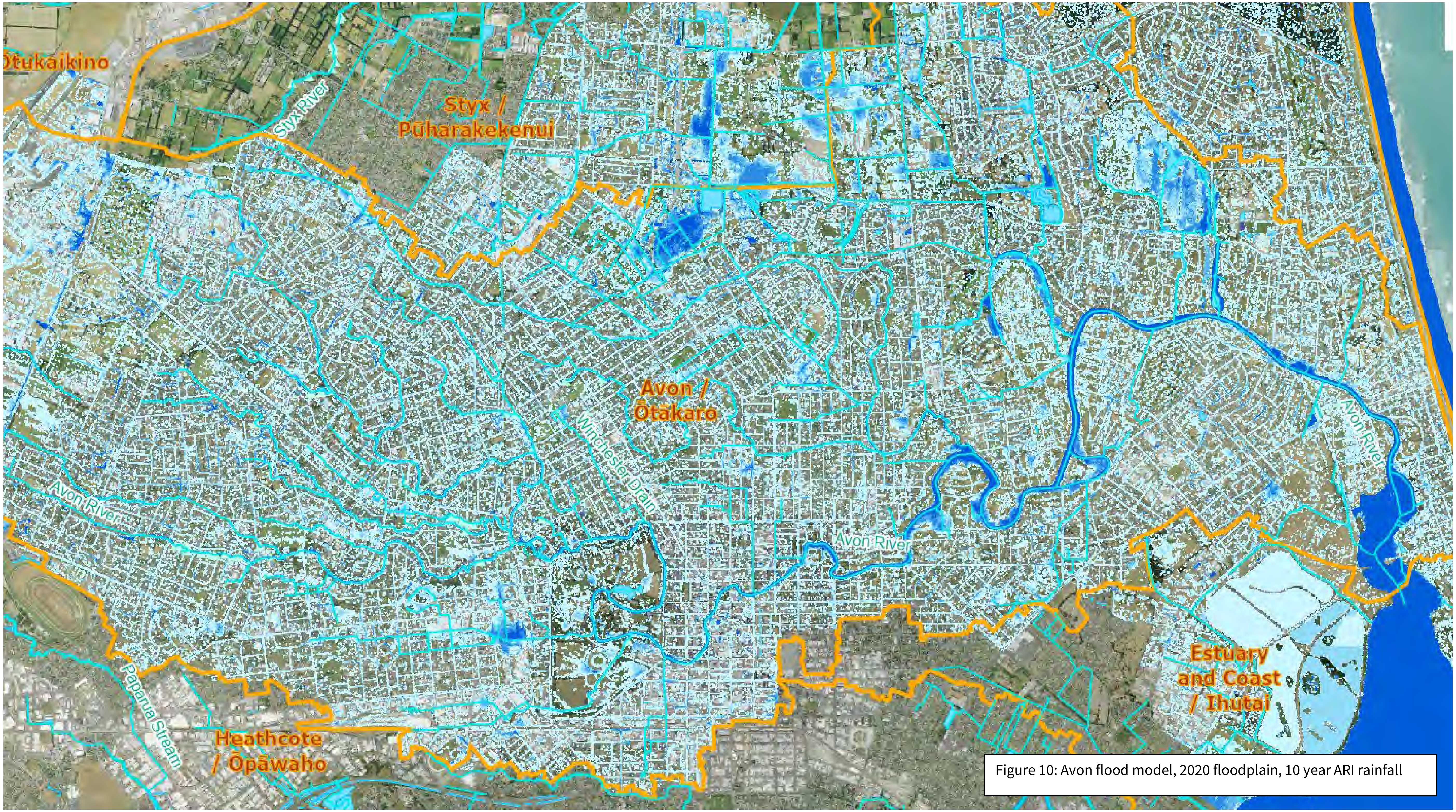

Figure 10: Avon flood model, 2020 floodplain, 10 year ARI rainfall

- Outside the Fixed Minimum Floor Level Overlay all new builds are required to have a floor level that is above the 50-year ARI flood level plus 400 mm.
- An appropriately designed and managed stormwater network where pipes and drains should have capacity to convey a 20% annual exceedance probability rain event.

9.1 River Defences

The river east of Fitzgerald Avenue is tidal and some riverside land is near or below the level of high tides. Stopbanks were built during the 1970s and 1980s to protect riverside roads and to permit reclamation and development of pre-existing wetlands in Avondale/Wainoni/Bexley areas. In general the stopbanks were located on the river edge. The original stopbank height provided protection against a nominal 100 year ARI tide, although consolidation of foundations and sea level rise reduced that level of protection over time. By the time of the 2010/11 earthquakes the stopbank crests were providing protection against a 50 year ARI tide, with a safety margin.

The earthquakes caused parts of the stopbanks to subside due to riverbank movement and settlement. An urgent programme of temporary repairs re-established the river defence in February and March 2011 before anticipated spring tides. Present day temporary stopbanks extend from the Estuary up to Swanns Road. The temporary stopbanks again approximately contain a 100 year ARI tide, being constructed to a level of at least 11.4m CDD in the lower reaches. In the medium term the stopbanks will be relocated away from the riverbanks and into the Ōtākaro Avon River Corridor.

The Ōtākaro Avon River Corridor (OARC) Regeneration Plan ("the Plan") provides a blueprint for future development and community activities within the area formerly known as the Avon Residential Red Zone. As well as large areas of planting and park-like areas, the plan provides for a new stopbank set back from the river's edge up to and beyond the Fitzgerald Avenue Bridge. The Plan calls for future-proofed stopbanks that can be modified in the future as sea levels rise and the climate changes. The first implementation of the long-term stopbanks is in the Waitaki Street area and is currently being constructed. Once finished it will have a crest level of at least 12.26m CDD and will be wide enough for the crest level to be raised by another 0.5m in the future. The crest level allows for a 1% AEP event, freeboard, future sea level rise, vertical land movement, construction tolerances and a survey tolerance. Depending on the onset of relative sea level rise the stopbank crest will need to be raised within the next 50 years. The future stopbanks will need to be delivered in stages with interim stopbank works to manage flood risk within existing budgets over the life of the temporary stopbanks.

The Plan also shows stormwater management areas on the landward side of the stopbank to improve stormwater quality. Alongside these areas, stormwater pumping will be required to provide ongoing drainage of the areas adjoining the OARC against sea level rise. Long term, most of the outfalls draining into the river will need to be pumped if existing land use is to be maintained without significant modification. Stormwater pumping has already been installed for many of the catchments downstream of Pages Road and elsewhere. Further study on when pumping will be required is underway and planned.

9.2 Sea Level Rise

Chapter 11 *Natural Hazards* in the Canterbury Regional Policy Statement 2013 recommends:

"As of 2012, Ministry for the Environment guidance for local authorities is to plan for the effects of 0.5m sea level rise out to the year 2100 and to assess the effects of 0.8m sea level rise."

Subsequent 2017 MfE advice recommends a risk-based approach considering adaptation pathways over time. The advice also includes the information on rates of sea level rise depending on how climate change is managed worldwide.

Sea level rise trends and post-earthquake land settlement trends are being monitored. High tide statistics have been recently reviewed with the sea level rise trend isolated so that tidal variability and sea level rise can be considered independently

Council operations staff have access to detailed tide forecasting about 2 days ahead enabling tidal flooding preparations to be made.

9.2.1 Effects of Sea Level Rise on Land

The greatest potential impacts of sea level rise include:

- increased risk of storm inundation associated with extreme tidal events,
- the need to progressively raise stopbanks,
- progressive retreat of the shoreline in low lying areas.

9.2.2 Effects of Sea Level Rise on the Stormwater Network

Rising sea levels will reduce the effectiveness of gravity stormwater drainage in tidally influenced areas. Effects are being quantified with the assistance of computer modelling, and have been included within the scope of a city-wide stormwater network model which nearing completion . Sea level rise will be perceived in increased tidal flooding of streets and rising groundwater levels. It will affect the land drainage network by:

- Increasing the requirement for tidal backflow prevention
- Increasing the demand for stormwater pumping stations
- Leading in the long term to a need for pumping to lower groundwater levels

Natural hazard planning processes are under way with the Coastal Hazard Adaptation Planning project and will consider a range of options including engineering solutions, planning solutions and retreat, as the Council has done in several ways to alleviate property flooding in the lower Heathcote. Future retreat may be managed differently according to future circumstances.

PART THREE:
Objectives and Principles

10 Developing a Water Quality Approach

10.1 Introduction

Mitigation options have been considered for contaminants specified in consent conditions:

- TSS (sediment and particulates, by means specified in consent conditions)
- Copper and zinc
- Oils, cleaning compounds, nitrates/nitrites, chemicals, etc in industrial discharges (section 11.4)

Metals typically exceed water quality targets for relatively short periods during and after rainfall. It is generally understood that they affect ecosystem health but the relationship between concentrations, durations and effects has yet to be quantified.

The Environmental Monitoring Programme reports levels of these contaminants against the relevant guidelines in an annual report.

10.2 Contaminant model

An annual contaminant load model (CLM) was developed by Golder Associates for the Comprehensive Stormwater Discharge Consent hearing. That model is used in this SMP to estimate contaminant loads. The model is a version of the Auckland Regional Council CLM adjusted for Christchurch conditions. “Adjusted” means that TSS loads per hectare are judged to be 60% of Auckland loads due to proportionately lower rainfall in Canterbury. (Modelled Christchurch TSS loads were reduced in the ratio of Christchurch annual rainfall to Auckland annual rainfall, nominally 600mm to 1000mm.) The model assigns an annual load of TSS, zinc and copper to each impervious urban surface and calculates the total annual load of the three contaminants for each sub-catchment. Unit annual loads used in the Christchurch contaminant load model (C-CLM) are in Appendix C.

The C-CLM estimates the annual load of three contaminants, total suspended solids (TSS), copper and zinc for each of the 31 sub-catchments mapped in Appendix B. These sub-catchments are the same sub-catchments as defined in the draft 2013 Avon SMP. (Present day sub-catchment outlines are a little altered.) The C-CLM estimates the contaminant load reduction from treatment and the predicted Areas to be renewal of old zinc roofs.

The C-CLM is used as a guide to the expected contaminant load reductions through treatment facilities proposed in this SMP.

Sub-catchments proposed to be treated within the term of this SMP are:

Table 3: Sub-catchments to be treated under this SMP

C-CLM Sub-catchment 2018	Present Day Sub-catchment(s)	Type of Treatment Facility
Addington	Addington	Biofilter
Riccarton	Riccarton	Biofilter
Cranford	Dudley Creek Above Diversion, and Middle Dudley Creek west of Philpotts Road	Basins and wetlands

C-CLM results are reported in Table 12 Appendix D. Load reductions by proposed treatment facilities are separately counted for the 3 sub-catchments to be treated.

The Council is developing a new contaminant model and has commissioned DHI to develop a MEDUSA[3] model for every catchment in the Christchurch District. Development has taken longer than expected because of complications with defining the catchments of treatment facilities. Results from the new model will be available for subsequent SMPs.

10.3 Contaminant Load Model Results

The C-CLM indicates that facilities modelled by the C-CLM in Addington, Riccarton and Cranford sub-catchments will reduce annual contaminant loads in the Ōtākaro-Avon catchment by:

TSS 6.2%

Zinc 4.0%

Copper 5.8%

Table 12 lists annual contaminant load reductions for a number of subcatchments other than Addington, Riccarton and Cranford (although these three are the only ones within which treatment facilities are proposed in this SMP). The basis for these claims is not always clear. Only the modelled reductions for the three treated sub-catchments are attributed to proposed treatment in this SMP term.

Annual loads of TSS are similar in most sub-catchments, reflecting the assumption that vegetated areas deliver significant amounts of contaminants. In Christchurch, areas with busy roads may generate more TSS than quieter areas. The annual load estimate of zinc is highest from Addington subcatchment, reflecting the predominance of bare zinc or zinc/aluminium commercial/industrial roofs. The annual load estimate of copper is highest from Addington subcatchment, probably reflecting higher vehicle-kilometres per year (and the assumption that copper load is proportional to vehicle-kilometres per year (Kennedy et al, 2002)).

[3] **M**odelled **E**stimates of **D**ischarges for **U**rban **S**tormwater **A**ssessments, by the University of Canterbury

10.4 Lessons from monitoring of treatment basins

Wet weather monitoring of treatment facilities produced encouraging results from its first year. Subsequent years' results are not yet available. Facilities being monitored are first-flush basins followed by a wetland, which are the default large treatment system. Treatment efficiencies obtained from 2020/21 wet weather monitoring of Curletts, Wigram, Prestons and Knights Stream facilities (PDP, 2021; NIWA, 2022; (PDP, 2023 not yet published), indicate the potential for a high percentage of TSS and metals removal. Monitoring will be ongoing. A recent performance assessment of Coxs-Quaifes Facility (Robertshaw, Mercer, 2023) reports encouraging results.

A comment on limited earlier monitoring is made in a memorandum titled Inferences from Performance of Treatment Basins 1993-2020 (TRIM 22/490757).

Treatment efficiencies in the C-CLM (Golder, 2018) are believed to be conservative. These treatment efficiencies were sourced from WWDG guidelines, Auckland Regional Council guidelines, and international research. The Council is also likely to use a conservative version of more recent wet weather results in the MEDUSA model that is being developed.

It is relevant that treatment basins perform both treatment and peak flow limitation functions, both of which are necessary. The dual functions are a reason for preferring detention facilities to flow-through facilities such as filters where there are capacity issues.

10.5 Role of Monitoring and Tangata Whenua Values in Setting Targets

10.5.1 Environmental Drivers

Waterways in the catchment are in fair condition. Sub-catchments containing industrial areas are identified in monitoring by both Councils as the most contaminating. Accordingly Addington and Riccarton sub-catchments have been prioritised to be retrofitted with a high level of treatment, via biofiltration, in the near term. Biofiltration will be carried out by pumping stormwater into on-ground Filterra™ units sized for the sub-catchment. A unit serving Riccarton sub-catchment is provisional pending consent to install it within Hagley Park.

10.5.2 Mahaanui Iwi Management Plan Objectives

This plan recognises and is intended to help support the policies and objectives for water and the environment for the catchment of Ihūtai in the Mahaanui Iwi Management Plan 2013 as detailed in Table 6.

Table 4: Response to the Mahaanui Iwi Management Plan

Iwi Management Plan	Ōtākaro-Avon SMP response
Policy IH3.1 To improve water quality in the Ihutai Estuary catchment by consistently and effectively advocating for a change in	A *Community Water Partnership* programme is being prepared and will carry out an education

Iwi Management Plan	Ōtākaro-Avon SMP response
perceptions of waterways: from public utility to wāhi taonga.	and advocacy role once it is funded and implemented.
Policy IH3.2 To require that waterways and waterbodies (including Te Ihutai) are managed to achieve and maintain a water quality standard consistent with food gathering.	The SMP can contribute toward this to the extent indicated by the Goals in section 12.1.
Policy IH3.3 To require that local authorities eliminate sources of contaminants to waterways in the Ihutai/Estuary catchment, primarily: (a) Sewage overflows in the Ōpāwaho and Ōtakaro Rivers; (b) Stormwater discharges into all waterways, including small headwater and ephemeral streams, and drains; (c) Run-off and discharges into waipuna;	The SMP is a management tool for reducing contaminant discharges into waterways. The Council does not see an alternative to stormwater discharge into waterways in the near term. The Council cannot currently prohibit discharges into a waterway that flows past/over waipuna. Improving stormwater quality generally is the only approach that seems to be open to the Council in the foreseeable future. (It is acknowledged that wastewater overflows affect the mauri of Ōtākaro. Wastewater overflows are consented separately under CRC182203.)
Policy IH3.4 To advocate for the following methods for improving water quality in the catchment: (a) Avoiding the infiltration of stormwater into the sewage systems, which results in overflow discharges to the rivers and estuary; (b) Protect and retain margins and set back areas along waterways, and ensure that these are of appropriate width and planted with indigenous species; (c) Restoration of degraded springs and wetlands; and (d) Requiring on site and closed stormwater treatment and disposal techniques (that do	(Measures are being implemented to reduce wastewater overflows). Waterway margins are generally protected by the District Plan. Restoration of degraded springs is an initiative in the proposed Healthy Water Bodies Plan. High groundwater and impermeable soils seem to make this unfeasible in many parts of the city. Treatment is required for new development, (although the Council is aware that even best practice treatment is not fully effective.) The

Iwi Management Plan	Ōtākaro-Avon SMP response
not discharge to water) for urban developments, public lands and parks.	volume of stormwater seems to make closed systems not practicable: however the Council is working to remove contaminants of stormwater in the long term.
Policy IH5.1 To require that the waipuna in the catchment are recognised and managed as wāhi taonga, as per general policy on wetlands, waipuna and riparian margins (Section 5.3, Issue WM13), with particular attention to:	The SMP may not be the right way to control discharges to waipuna and restoration of waipuna.
(a) Ensuring that waipuna are protected from the discharge of contaminants; (b) Ensuring that there are appropriate and effective setbacks from waipuna, to protect from urban development or re-development; (c) Restoring degraded waipuna; and (d) Enabling flow to return to waterways in naturalised channels.	The Council tries to prevent direct discharges into waipuna through the District Plan: however such discharges are not prohibited by the consent conditions. Management of waipuna is a District Plan and possibly a Bylaw matter. Asset Planning – Stormwater and Land Drainage staff will advocate for this form of protection in District Plan reviews.
IH6.2 To require that any physical works on waterways in the urban environment occurs in a manner that does not reduce the width of margins or riparian plantings, and is consistent with the re-naturalisation of the waterway.	Controls re applied through District Plan waterway setbacks and the Stormwater and Land Drainage Bylaw 2022, rather than through the SMP. However RMA provisions do not always permit full control.

Cultural Impact Assessment

Mahaanui Kurataio is preparing a Position Statement which is Te Ngāi Tūāhuriri Rūnanga's means of providing a cultural impact assessment. The Position Statement will be included in the SMP when it is received.

10.6 Potential controls

Table 5: Contaminant Sources, Significance and Possible Mitigation Methods.

Mitigation methods colours define effectiveness:

Green = Likely to be effective, Yellow = Sometimes effective, Red = Difficult or slow getting effects.

Source	Contribution	Possible Mitigation Methods
Sediment		
Farm animals trample stream banks	Significant	Stock exclusion (fence waterways)
Farm animals' faeces enter waterways	Unknown	Stock exclusion (fence waterways and dense planting)
Construction sites	Unknown, mitigated to some extent	Sediment & erosion controls First flush basins Wetlands As conditions on subdivision, resource or building consents Minimum Requirements for Developed Sites
Road works	Low; often adequately controlled	On-site sediment controls
Atmospheric deposition	Low	Riparian tree cover
Plants (leaves, etc.)	Low (seasonal)	None
Vehicle emissions	Low	Treat road runoff
Visitor activity (stream access)	Medium	Signage
Deposition on roads via vehicles, pedestrians, private property runoff and wind.		Rain Garden (generic in-ground bio-filter) Cartridge filters (e.g. Stormfilter by Stormwater 360) Filterra (proprietary in-ground bio-filter) Catchpit filter (e.g. Litta Trap) Street sweeping

Source	Contribution	Possible Mitigation Methods
Zinc		
Bare galvanised roofs	Relatively few galv. roofs discharging to waterways in this catchment. (High city-wide.)	Replace with alternative roofing Material (clay tile, non-metal roofs or pre-coated Zn-Al or paint with: Low zinc paint) Downpipe filters (e.g. Storminator by University of Canterbury) Divert first flush to the wastewater network
Ageing painted roofs	High city-wide. Could be an issue as new pre-coated roofs age.	Replace with alternative roofing Material (clay tile, non-metal roofs or pre-coated Zn-Al or paint with: Low zinc paint)
Bare Zn-Al[1] roofs	Moderate in this catchment due to limited roof numbers.	Paint roofs
Vehicle tyres	High city-wide. Most road runoff into ground in this catchment	Treat runoff from busiest roads, carparks and manoeuvring areas using: Wetlands First flush basins Rain Garden (generic in-ground bio-filter) Cartridge filters (e.g. Stormfilter by Stormwater 360) Filterra (proprietary in-ground bio-filter) Catchpit filter (e.g. Litta Trap) Street sweeping
Industrial discharges (inferred from monitoring)	Medium	Industrial site management plan Monitoring discharges Enforcement
Copper		
Brake pads	High city-wide. Most road runoff into ground in this catchment	Advocate with NZ Government for legislation change for copper-free brake pads. Copper content of brake pads anticipated to reduce from 2025 following USA legislation.

Source	Contribution	Possible Mitigation Methods
		Educate local auto industry and residents about the value of low/no copper brake pads, noting some low-Cu pads are currently available in NZ market.
Particulate deposition on roads		Treat runoff from busiest roads, carparks and manoeuvring areas using: Wetlands First flush basins Rain Garden (generic in-ground bio-filter) Cartridge filters (e.g. Stormfilter by Stormwater 360) Filterra (proprietary in-ground bio-filter) Catchpit filter (e.g. Litta Trap) Street sweeping
Roofs, cladding, spouting, downpipes	Low but increasing	Advocate with NZ Government for legislation on copper cladding. Investigate the feasibility of a District Plan rule to discourage the use of copper claddings. Divert first flush to the wastewater network Educate residents Onsite treatment of the copper stormwater runoff (e.g. copper sculpture filters thought grass prior to entering SW system, or retrofit planter box to treat runoff) Transparent sealer applied to copper surfaces
Lead		
Paint flakes/chips from old buildings	Unknown but more likely to contaminate soil than water	Site remediation during development
Lead flashings on roofing	Low	Education
Building material in older homes (pipes, roofing)	Low, as homes are renovated, demolished and maintained, the quality of lead is reducing.	Wait for lead to be phased out
Pathogens/ bacteria		

Source	Contribution	Possible Mitigation Methods
Ducks, geese	Major bacteria source	Reduce water fowl numbers. Would need to be implemented outside the SMP. CCC not empowered by the consent to control waterfowl
Wastewater overflows	Major	CCC Wastewater team are actively reducing wastewater overflow with controls such as renewals, capacity upgrades, reduction of vented manhole and code of practice guidelines.
Dog Access	Unknown	Signage and education
Other Organic Material		
Ducks, geese	Major source	Reduce water fowl numbers. Would need to be implemented outside the SMP. CCC not empowered by the consent to control waterfowl
Leaf Litter and Grass Clipping	Minor	Education
Industrial discharges		
Deliberate spills or poorly controlled sites	Unknown	Regulation, monitoring and enforcement
Polynuclear aromatic hydrocarbons		
(Old) coal tar street surfaces.	Some known streets e.g. Shirley area	Encapsulation. Removal.
Combustion	Likely low	Monitor
Nitrate and nitrite		
Probable agricultural sources (via groundwater)	Moderate	Investigate sources Education and enforcement
Fertiliser	Believed low	Education
Phosphate		
Industrial sources	Moderate	Enforcement
Fertiliser	Believed to be a minor source	Education
Leaf Litter and Grass Clipping	Unknown contribution	Education

Table 6: Assessing options as potential Best Practicable Options

Mitigation Option		Contaminants Treated	Assessment as a Best Practicable Option
First flush basins		TSS, Cu, Zn	Combines TSS removal with essential flow detention. Some metals removal. Traditional treatment approach.
First flush basins and wetlands		TSS, Cu, Zn, hydrocarbons	Good removal of TSS, metals and other contaminants. Combines treatment with essential flow detention. Most widely used current method.
Methods above this line more suitable for developments where land is readily available. Methods below this line have smaller footprints and are more suitable for use within redevelopments.			
Rain Garden (generic in-ground bio-filter)		TSS, Cu, Zn, hydrocarbons	Good TSS and metals removal. Appears to be a more expensive means of removing metals than basin + wetland
Cartridge filters (e.g. Stormfilter by Stormwater 360)		TSS, Cu, Zn, hydrocarbons	Good TSS and metals removal. Appears to be a more expensive means of removing metals than basin + wetland Similar metals removal cost to rain garden
Filterra (proprietary in-ground bio-filter)		TSS, Cu, Zn, hydrocarbons	Good TSS and metals removal. Better suited to new or re-development.
Catchpit filter (e.g. Litta Trap)		TSS, some Cu & Zn, litter, organic material	Good removal of particles larger than 100 µm (sand size). Some metals removal. Better suited to new or re-development
Street sweeping		TSS, particulate Cu & Zn	Good removal of particles larger than 100 µm (sand size). Some metals removal.
Downpipe filters (e.g. Storminator™ by University of Canterbury)		Zn, roof-sourced TSS	Very good zinc removal. Council can require downpipe treatment in some cases.
Roof painting		Zn	Very good barrier to zinc discharge. Council does not have powers to require roof painting.

Low-copper brake pads		Cu	Potentially the most effective and efficient copper mitigation. Government support needed.

10.7 Option Selection

Options potentially available for consideration as water quality mitigation options are listed in Table 8.

The limited number of new areas (such as Prestons and land at the west end of Memorial Ave) will be treated through basins and wetlands or infiltration. In addition, the Council has purchased Cranford Basin and acquired the Red Zone and set aside land to treat some existing areas in new facilities. Facilities such as basins and wetlands remove TSS effectively although they remove dissolved metals from roofs and roads less effectively. As TSS and metals are discharged in some measure from every impervious urban surface, basins can be useful controls where they treat extensive areas. Biofilters, as are proposed to treat the Addington and Riccarton catchments, appear from testing to remove a high proportion of most contaminants.

The Council has considered various levels of mitigation and has prioritised the three treatment facilities among other expenditure streams in its Long Term Plan. The decision is made pursuant to the Council's powers under the Local Government Act to set funding priorities and rates. The Council considers that the funding allocated to stormwater treatment city-wide is practicable and as such is its best practicable option.

Some sediments are reduced at source by District Plan and best practice controls on subdivision, building sites and road works. Contaminants (including metal contaminants) could in principle be eliminated at source by substitution of non-contaminating materials. This could involve methods in Table 8 such as substitution of building materials, substitution for zinc oxide in tyres, or low-copper brake pads. However, high evidential thresholds must be passed before the Council can deal directly with the effects of building materials, and there is no present-day way forward to remove some vehicle contaminants (Ira, ACC, 2021). The Council's powers to require these forms of treatment are limited, and new legislation may be needed before the Council can use them. Other contaminants could be reduced at or near source by, for example, painting or repainting roofs, or treating roof runoff at the downpipe but are subject to similar constraints.

Street sweeping picks up litter, stones and sand but is less effective at removing fine particles that contain the majority of metal contaminants (Depree, 2011). A street sweeping trial has occurred under Condition 7, Schedule 4 c. and when results are available, they may influence future options selection.

Sump inserts (filter bags) are being trialled. Sump inserts are known to effectively trap litter and stones but have variable effectiveness trapping fine contaminants.

Some contaminant discharges can be reduced voluntarily through education. The Council is developing an education programme through its Community Waterways Partnership. An education programme is expected to have effects in the long term, and to be more effective for some contaminants (e.g. domestic chemicals, dog poo) than others such as vehicle emissions.

Although mitigation at source should be more effective than treatment of stormwater there are significant barriers to implementing source controls. In the present day the government or local and regional authorities are likely to have to demonstrate that source controls to be effected by land owners are both necessary and the best practicable option. The Council proposes an economic analysis of the costs and benefits of stormwater treatment city-wide to try to answer this question.

More information, such as the long-term costs and benefits of maintaining roof coatings, substituting roof materials or installing stormwater filters, will need to be developed for the economic analysis so that the Council can evaluate, consult on and select best practicable options.

10.8 Contaminant Mitigation Targets

Contaminant load reduction targets were developed from the contaminant load model as required by Condition 6b. The target is based on results from the contaminant load model (Appendix D).

Contaminant load reduction targets for this SMP term through proposed facilities in the Addington, Riccarton and Cranford subcatchments are:

TSS	6.2%
Zinc	4.0%
Copper	5.8%

10.9 Other contaminants

Contaminants of lesser significance are sometimes detected at low levels, but do not have a mitigation strategy because they either do not exceed guidelines or have a non-stormwater source. These include:

- E. coli: implies a risk of other pathogens harmful to humans. (There are no pathogen targets in the consent. Pathogen controls are likely to be considered in the Surface Water Inprovement Plan).
- Polycyclic aromatic hydrocarbons (PAHs): no consent targets. Do not exceed LWRP guidelines.
- Nitrate and nitrite: no direct consent targets. Non-stormwater sources.
- Phosphorus: no direct consent target. Believed to be predominantly animal sources in this catchment.
- Ammonia: no consent target. Does not exceed LWRP guidelines.

11 Mitigation Plan

11.1 New Development

The SMP assumes that growth in this catchment is mostly infill housing, and that infill housing is less contaminating than older housing or commercial/industrial areas. Contaminants, particularly sediments, generated by development will be controlled by:

- actions and requirements of this SMP.
- rules in the district plan,
- the Stormwater Bylaw 2021,
- the Erosion and Sediment Control Toolbox for Canterbury

In order to comply with section 8.7.4.3.c in the Christchurch District Plan, stormwater from newly developed large sites (> 1,500 sq.m. area) must be treated and detained so that peak flow discharges do not exceed pre-development.

Stormwater should be discharged into the ground by infiltration where practicable.

11.2 Mitigating individual site stormwater

Individual developments are required to treat stormwater to mitigate any change in quantity or quality arising from the development. The minimum standard for stormwater treatment is in Table 7 which is extracted from (Christchurch City Council, 2021). The guide includes information about on-site storage and treatment for small to medium sites.

Table 7 Minimum Requirements for New Development Sites.

Source of Stormwater Discharge(s)	Total area of disturbance does not exceed 1,000m^2	Total area of disturbance equals or is greater than 1,000 m^2
From/during land disturbance activities	An approved Erosion and Sediment Control Plan is required	An approved Erosion and Sediment Control Plan is required
From new / re-development **residential** roof and hardstand areas	No discharge onto or into land where the slope exceeds 5 degrees. Sumps collecting runoff from new hardstand areas shall be fitted with submerged or trapped outlets wherever practicable. Sites increasing impervious by 150m^2 or more to a total coverage in excess of 70% are required to mitigate water quantity effects according to the Christchurch City Council On-site Mitigation Guide (5 m^3 rain tank installed). An assessment of water quantity effects and provision of on-site stormwater storage or network upgrade may be required for sites in the flat (2). On-site rain water storage is required for new and redevelopment sites on the hills.	No discharge onto or into land where the slope exceeds 5 degrees. First flush treatment is required for stormwater runoff from new hardstand areas in excess of 150m2 and buildings with copper or uncoated galvanised metal roofs or guttering/spouting (1). Sites increasing impervious by 150m2 or more to a total coverage in excess of 70% are required to mitigate water quantity effects according to the Christchurch City Council On-site Mitigation Guide (5 m^3 rain tank installed). An assessment of water quantity effects and provision of on-site stormwater storage or network upgrade may be required for sites in the flat (2). On-site rain water storage is required for new and redevelopment sites on the hills.
From new / re-development **non-residential** roof and hardstand areas	No discharge onto or into land where the slope exceeds 5 degrees First flush treatment is required for stormwater runoff from new hardstand areas in excess of 150m^2, buildings with copper or uncoated galvanised roofs or guttering/spouting and high-use sites	No discharge onto or into land where the slope exceeds 5 degrees First flush treatment is required for stormwater runoff from new hardstand areas in excess of 150m^2, buildings with copper or uncoated (3) galvanised roofs or guttering/spouting and high-use sites

Source of Stormwater Discharge(s)	Total area of disturbance does not exceed 1,000m^2	Total area of disturbance equals or is greater than 1,000 m^2
	Sites increasing impervious by 150m^2 or more to a total coverage in excess of 70% are required to mitigate water quantity effects according to the Christchurch City Council On-site Mitigation Guide. An assessment of water quantity effects and provision of on-site stormwater storage or network upgrade may be required (4) Site management and spill procedures required for sites that engage in hazardous activities (5)	Sites increasing impervious by 150m^2 or more to a total coverage in excess of 70% are required to mitigate water quantity effects according to the Christchurch City Council On-site Mitigation Guide. An assessment of water quantity effects and provision of on-site stormwater storage or network upgrade may be required (4) Site management and spill procedures required for sites that engage in hazardous activities (5)
Any land use with Canterbury Land and Water Regional Plan Schedule 3 activities.	An application for approval under the Stormwater and Land Drainage Bylaw 2022 must be made to authorise connection and discharge into the Council network.	An application for approval under the Stormwater and Land Drainage Bylaw 2022 must be made to authorise connection and discharge into the Council network.

Explanatory notes:

1. *The first flush is the first 25 mm of runoff.*
2. *The Council has discretion to waive the requirement for first-flush treatment of hardstand areas on large residential sites with a low impervious percentage where the amount of pollution-generating hardstand being added is considered to have less than minor effect.*
3. *"Uncoated" means without a painted or enamelled coating. Council has discretion to waive the requirement for first flush treatment of hardstand areas on large residential sites where the amount and type of pollution-generating hardstand being added is considered to have a less than minor effect.*
4. *Quantity assessment and mitigation -The effects of the discharge on the stormwater network capacity and/or the extent or duration of flooding on downstream properties are to be assessed. Where Council considers an increase (including cumulative increases) has a more than minor effect, on-site stormwater attenuation or stormwater network upgrade shall be provided. The details of storage volume and peak discharges or network capacity required to mitigate effects on flooding or network capacity constraints shall be determined by the Christchurch City Council planning engineer.*
5. *Site management and spill procedures –Procedures are to be implemented to prevent the discharge of hazardous substances or spilled contaminants discharging into any land or surface waters via any conveyance path.*

11.3 Operational controls on stormwater and sediment

The management of sites which may experience erosion and/or discharge sediment during development works is controlled by conditions of either resource consents or building consents, as applicable, for earthworks and building. The Stormwater and Land Drainage Bylaw 2022 specifies some standards for activities not controlled by consents.

Standards for sediment discharges are set by the Sediment Discharge Management Plan 2021 (SDMP). The sediment discharge management process should work as follows:

1. Allowable TSS (total suspended solids) concentration trigger levels for discharges to the stormwater network are set by the SDMP.
2. An erosion and sediment control plan (ESCP) is prepared by a 'suitably qualified and experienced professional' as determined by a site risk assessment
3. The TSS concentration trigger levels for the site are included in authorisations or conditions where possible.
4. The ESC measures are implemented on site and monitored.

11.4 Industries and High Risk Site Discharges

The Council will manage industrial sites through its Stormwater and Land Drainage Bylaw 2022. The bylaw requires industrial contaminants to be controlled to meet best practice. The Christchurch City Council's expectation is that stormwater entering its network is managed according to best practice, especially where the discharge occurs directly into a waterway. On-site pre-treatment may be required unless contaminant levels are less than LWRP Schedule 5 standards.

Where industrial site occupiers do not meet the required standards for discharge into the network, the site will be removed from the CSNDC and will require a separate resource consent from ECan for its discharge. A condition is included in the CSNDC for this process and all industrial sites excluded from the resource consent will be listed on Schedule 1 attached to the consent.

In managing high-risk sites the Council will:

- Audit at least 15 high-risk sites per year;
- Inform audited industries of the results of audits and work closely with these industries to achieve outcomes in line with the Stormwater Bylaw;
- Communicate with industries about stormwater discharge standards and the means of meeting these standards.

Change will be sought through a combination of education and enforcement.

- Education will be carried out through an industry liaison group.
- Enforcement will happen as pollution prevention officers identify and visit high-risk industrial sites and work with industries to improve site management.

Contamination risks are limited to a degree by acceptance of trade wastes into the wastewater system. This is authorised through Trade Waste Consents and the monitoring of consents permits a degree of oversight and site control.

Future needs include:

- More interaction with industries by the Council; communication, awareness and education
- Improved knowledge of the environmental effects of compounds discharged by industrial sites
- Ongoing site checks until the Council is confident that all risky sites are controlled adequately
- Upgrades on non-compliant sites

11.5 Expectations for Industrial Area Stormwater Discharges

Where industrial site owners (or occupiers) cannot meet the required standards for discharge into the network, the site will be removed from the CSNDC and will require a separate resource consent from Environment Canterbury for its discharge. A condition is included in the CSNDC for this process and all industrial sites excluded from the resource consent will be listed on Schedule 1 attached to the consent.

11.6 New Treatment Facilities

The catchment is mostly developed, with most future development expected to be infill. Some greenfield development is continuing in Prestons area, and small industrial zones near the airport are yet to develop. Stormwater from new developments will be treated, and stormwater from the west of the city will be discharged into the ground after treatment.

Three major treatment facilities are proposed to treat stormwater from present-day sub-catchments Addington Brook, Riccarton Stream and Upper Dudley Creek + Cranford + Middle Dudley Creek. Addington will be treated via a biological filter located to the west of Deans Avenue. Riccarton is proposed to be treated through a biological filter within Hagley Park, subject to obtaining the relevant consent(s). Dudley Creek sub-catchments could be treated either in Cranford Basin or in a facility near Waikakariki-Horseshoe Lake. The site at Waikakariki currently poses difficulties due to contaminated land, high groundwater and its sensitivity as a cultural site. Currently it appears that treatment within Cranford Basin will be advanced to occur within this SMP term.

Stormwater from any new developments will be treated within those developments.

12 Treatment Facilities

12.1 New facilities sizing and land contamination

A sizing rationale for proposed new facilities is in Table 8 below.

Condition 7, Schedule 2(f) requires a description and justification for separation distances between proposed storm-water facilities and contaminated sites. Contaminated sites are identified as sites appearing in the Environment Canterbury Listed Land Use Register.

There is limited flexibility in where basins and wetlands are sited: basins are typically located in the low point of a sub-catchment or development on land that is available for acquisition. Known or suspected contaminated sites can sometimes be avoided, however appropriate levels of intensive site testing are also undertaken during planning and design. will be undertaken and contaminated soils will be dealt with according to accepted environmental protocols.

A schedule of basins, sites and site descriptions is in Table 11, Appendix E.

Table 8: Sizing rationale for proposed treatment facilities

Sub-catchment	Contributing area	Land Use	Runoff coeff. (1)	Runoff rate from 5 mm/hr rainfall	Indicative Flow Rate for treatment	References / comments
Riccarton	265 Ha	Res Subn 75 ha	0.38	1.9	0.86 m^3/s	
		Res Subn Dens Trans 112 ha	0.47	2.4		
		Res Med Dens 30 ha	0.56	2.8		
		Commercial 30ha	0.73	3.7		
		Park 18 Ha	0	0		
Addington	140 Ha	Res Med Dens 18 ha	0.56	2.8	0.89 m^3/s	
		Commercial 108 ha	0.73	3.7		
		Park 14 ha	0	0		
Dudley Ck Above Diversion	265 Ha	Res Subn 180.3ha Res Med Dens 41.0 ha Commercial 10.9 ha Park 32.8 ha	0.6 0.67 0.95 0	35,900 m^3		

Sub-catchment	Contributing area	Land Use	Runoff coeff. (1)	Runoff rate from 5 mm/hr rainfall	Indicative Flow Rate for treatment	References / comments
Cranford	234 Ha	Res Subn 46.0 ha Res Med Dens 72.0 ha Commercial 10.0 ha Basin 83.0 ha	0.6 0.67 0.95 0	21,300 m^3		
Middle Dudley Ck west of Philpotts Road	110 Ha	Res Subn 108.7 ha Industrial 1.3 Ha	0.6 0.95	16,600 m^3		

Notes:

(1) Runoff volume coefficient from WWDG Table 6-10

(2) Wetlands may be flooded up to an additional depth of 500 mm in events exceeding 10 year ARI. Over-flooding increases effective detention storage without significant compromise to wetland treatment effectiveness.

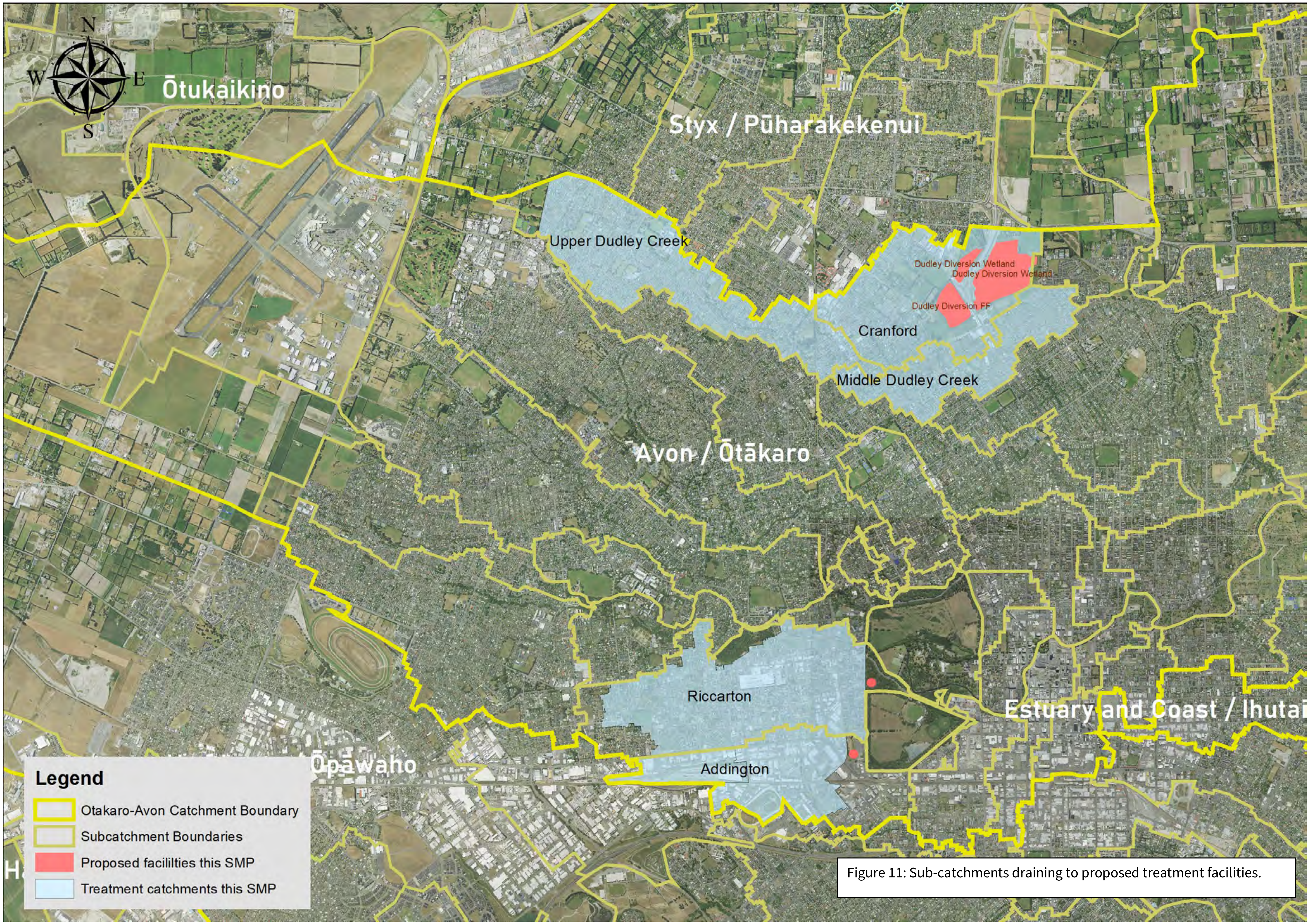

Figure 11: Sub-catchments draining to proposed treatment facilities.

12.2 Designing basins to minimise bird-strike on aircraft

Christchurch District Plan Policy 6.7.2.1.2 – *Avoidance or mitigation of navigational or operational impediments* – is a policy to avoid or mitigate the potential effects of activities that could interfere with the safe navigation and control of aircraft, including activities that could interfere with visibility or increase the possibility of bird-strike. Plan provisions include:

1. 5 Natural Hazards - for activities and earthworks in the Waimakariri Flood Management Area (5.4.3.3 RD3, matter k.);
2. 8 Subdivision - general matters of control in relation to new ponding areas (8.7.4.3(f)) and Policy 8.2.3.4(b., vi.) Stormwater Disposal;
3. 8 Subdivision - Development Requirements for stormwater for South Masham and Yaldhurst ODP areas (Appendices 8.10.5.D(5)(b) and 8.10.28.D(a)(5)(d));
4. 11 Utilities - matters of discretion for new ponding areas (11.10.6(j))

New stormwater facilities within the Christchurch International Airport Bird Strike Management Area, a defined zone extending 3km from airport runway thresholds (mapped in District Plan Appendix 6.11.7.5) must meet activity standards in section 6.7.4.3 of the Christchurch District Plan.

Assessments should consider any actual or potential effects relating to bird strike where relevant to an application, regardless of whether or not the proposal is located within the Bird Strike Management Area (6.7.3(c.)). Depending on the facts of the particular application:

1. Strategic objective 3.3.12 Infrastructure, policy 6.7.2.1.2 Avoidance or mitigation of navigational or operational impediments, and policy 8.2.3.4 Stormwater disposal, are relevant to activities that have the potential to increase the risk of bird strike whether they are within or outside of the Christchurch International Airport Bird Strike Management Area;
2. Chapters 5, 6, 8, 11, 13 & 17 contain matters of assessment or control to manage bird strike risk for particular activities; Bird strike risk may be a relevant consideration when the Council considers a discretionary or non-complying activity.

Basin planners and designers are also required to consider the potential for new water bodies within 13 kilometres of airport runway thresholds to increase the risk of bird strike. New water bodies can provide habitat that will attract waterfowl and high-risk species and bring their flight lines into intersection with aircraft flight lines. The risk potential should be quantified and, where required, managed in a manner indicated via a Bird Strike Risk Assessment carried out by a person with suitable ornithological training. Guidance material is contained as Appendix I. Persons developing stormwater facilities within 13 km of airport runway thresholds (identified in Figure 12) should consult with CIAL.

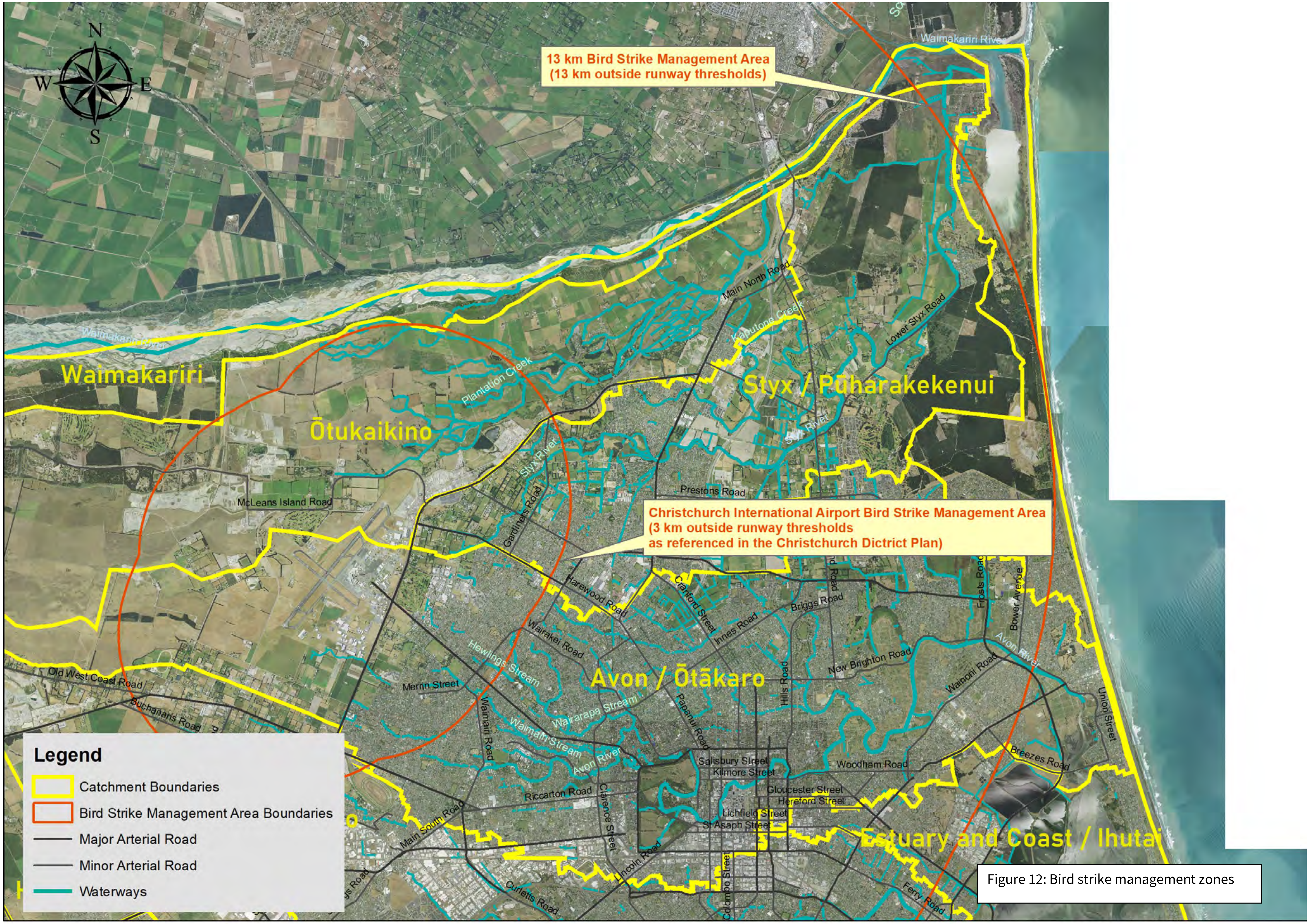

Figure 12: Bird strike management zones

12.3 Avoiding groundwater mounding beneath infiltration basins

It is not expected that substantial infiltration basins will be installed in this catchment. Groundwater mounding is considered not to be relevant to this SMP.

12.4 Effects of stormwater on groundwater

New stormwater management systems created during urban development may be either detention or infiltration basins or flow-through devices such as biofilters. The Council promotes the use of infiltration basins where possible but its new treatment facilities in the centre and east of the catchment will be in areas of poor permeability and high groundwater and will have to discharge to surface water. Current and future private stormwater treatment facilities in the west of the catchment should discharge into the ground. If the infiltration systems are appropriately constructed, and located away from community drinking water supply protection zones and landfills the effects on groundwater are expected to be very limited.

12.5 Changes to springs and baseflow

Anticipated urban growth in this catchment is mostly from intensification/infill, which typically increases the amount of impervious coverage. The consent requires that effects on springs and baseflow be considered.

The major source of groundwater recharge into the catchment is from seepage losses out of the Waimakariri River between Halkett and Harewood Crossbank. Rainfall infiltration on the free-draining gravels to the west of the city provides some recharge, as does rainfall within the catchment boundary. The major loss of groundwater within the catchment occurs through springs feeding the headwaters of streams.

Pattle Delamore Partners (PDP) was asked to estimate the effects of development, both new and infill, on groundwater quantity. Two specified scenarios were considered. Both scenarios are intended to be indicative of trends.

1. All residential areas are infilled from a presumed 50% impervious to a higher level of imperviousness.
2. The Council proactively introduces stormwater treatment facilities that discharge into the ground in permeable areas (typically west of the university).

[Note: At the time of writing an urban growth model for the city is under way but not completed and PDP could not be supplied with time-related infill development projections.]

Because the amount of expansion development is small and is expected to occur on both permeable land (in the west near the airport) and impermeable land (in the east) there is expected to be only a very small decrease in recharge after expansion development. It appears that the Council could offset the decrease by recharging stormwater into the ground from a catchment of less than 20 Ha. This option is being considered as a mitigation scenario.

Infill development, which is provided for in the District Plan, will also increase the amount of stormwater runoff and reduce groundwater recharge.

Within the (10 year) term of the SMP a relatively small amount of infill is expected. PDP's analysis indicates that rainfall recharge could be reduced by less than 1% within the term. As a proportion of total recharge, including inflows from the Waimakariri River the reduction could be of the order of 0.1%. Into the future, beyond the term of this SMP, the reduction in rainfall recharge could ultimately approach 10% and the reduction as a proportion of total recharge (including Waimakariri River inflows) could be 0.4%.

Considerable infill is likely to occur within a few kilometres of the city centre. In this vicinity groundwater is generally shallow and groundwater recharge can have negative effects such as waterlogging. In the central and eastern parts of the catchment reduced infiltration may be beneficial. Less infill will occur to the north-west of Riccarton where groundwater recharge occurs more readily due to permeable ground. In this area it may be of more significance that groundwater recharge sustains baseflows.

The predicted changes are small, but not insignificant, as they represent trends. Over time the Council should mitigate the potential for reduced groundwater recharge by facilitating infiltration into the ground through its Ōtautahi Christchurch Development Plan, by incorporating infiltration into Area Plans where ground conditions are suitable.

12.6 Monitoring baseflows

Although only a minor decrease in baseflow is thought to be likely the council will monitor baseflows at the Gloucester Street recorder site.

12.7 Changes in response to public submissions

This section will be completed after the public consultation period.

12.8 Environmental Monitoring

The Council carries out "state of the environment" monitoring monthly at 46 sites within the Christchurch district. Three sites are within this catchment. State of the environment monitoring is not time or rainfall related and does not often coincide with wet weather.

To better quantify contaminant concentrations and track the effects of contaminant mitigation strategies the Council could increase the amount of monitoring during wet weather. The characteristics of the Christchurch water network are different from other cities and local information is needed. Short term monitoring is needed to refine knowledge about zinc loads from different road types and the difference between first-flush and steady-state concentrations. Long term monitoring of treatment systems is needed to verify the performance of basins, swales, rain gardens and filters.

12.9 Nutrients

Nutrient inputs in this catchment are mostly of rural origin and do not fall within the scope of this plan. The Council will cooperate with Environment Canterbury to develop and implement a catchment management plan for rural parts of the catchment.

12.10 Emerging Contaminants

Potential contaminants known as emerging contaminants are becoming of interest, although they are only occasionally sampled for. Emerging contaminants include microplastics, hormones, herbicides, cleaning products, and 6PPD-quinone (an antioxidant in tyres). Effects of these chemicals have been detected in waterways overseas. It would be desirable if emerging contaminants testing should become part of monitoring programmes.

13 Plan Objectives

These objectives address the issues arising from Sections 3 and 5 through 11.

13.1 Objective 1. Control sediment discharges

Our goals are:

1.1 Ensure the quality of stormwater from all new development sites or re-development sites is treated to best practice (with Table 7, section 11.2, being the minimum standard)

1.2 All stormwater treatment facilities contributing to contaminant load mitigation targets in Section 10.8 (consent condition 6b) are constructed and conform to WWDG standards.

1.3 Sediment from 95% of consented construction activities on the flat is treated to best practice by 2025

1.4 Analyse options for carrying out street sweeping, sump cleaning, and diversion to wastewater trials from 2021-25 (Schedule 4b & d)

Action Plan for Urban Sediment				
Goal	**Action**	**Mechanism**	**Action Components**	**Timing**
Sediment (urban)				
1.1 New developments	Plan and oversee installation of detention basins, wetlands & swales	District Plan (Development contributions) and Long Term Plan	Normal planning processes.	Ongoing
1.2 New treatment facilities	Ensure new facilities are built to best practice	Designs should conform to the Infrastructure Design Standard	Normal Council planning, design and procurement process.	Ongoing
1.3 Construction & excavation sites	On-site sediment and erosion control effected through Erosion and Sediment Control Plans	Council enforcement powers under the Building Act 2004.	Train Building Inspectors. Implement an enforcement process. Contractor(s) on standby for clean-up when breaches occur.	ESC now part of resource consents for earthworks and building

Action Plan for Urban Sediment				
Goal	**Action**	**Mechanism**	**Action Components**	**Timing**
1.4 Road runoff contains sediment	Investigate & develop methods to treat runoff from arterial roads,	Increase frequency of street sweeping, rain gardens	Street sweeping trials. Construct rain gardens where feasible.	Commenced 2021

Recommended for consideration through the Surface Water Implementation Plan

1.5 Road sediment is reduced by a best practicable option determined by the results of street sweeping, sump cleaning and alternative treatment trials (Schedule 4c, f, g & h.)

13.2 Objective 2. Control zinc contaminants

Our goals are:

2.1 [repeats Goal 1.1 & 1.2] All the facilities required to meet the Section 10.8 targets are constructed.

2.2 The Council continues to investigate zinc mitigation measures and works toward carrying out cost/benefit analyses toward identifying their effectiveness as best practicable options.

2.3 By 2028 the Council has consulted with key stakeholders and identified a long-term zinc strategy consistent with current technologies.

2.4 The CCC collaborates with local and regional government in a joint submission to central government seeking national measures and industry standards to reduce the discharge of building and vehicle contaminants.

Action Plan for Zinc				
Goal	**Action**	**Mechanism**	**Action Components**	**Timing**
Zinc				
2.1 Same as 1.1 & 1.2				
2.2 & 2.3 Bare steel roofs emit zinc	Investigate/consult acceptable material for new roofs. (Choices non-metallic or pre-painted zinc/aluminium.)	District Plan rule (if possible) otherwise investigate Regional Rule or legislation	Investigate environmental harm and costs/benefits of alternative materials. Consult widely.	Under way
2.3 Ageing Colorsteel® likely to emit zinc	Research zinc emissions from ageing Colorsteel®	Sampling roof runoff	Sample runoff from ageing roofs, monitor trends, liaise with industry.	
2.4 Vehicle (tyre) zinc	Research and implement best practicable means of zinc removal from busy roads	Catchment scale filtration systems. Wetlands & rain	Research and trials	Under way 2022

Action Plan for Zinc				
Goal	**Action**	**Mechanism**	**Action Components**	**Timing**
		gardens if space is available		
2.4 National measures and industry standards	National measures and industry standards to reduce the discharge of building and vehicle contaminants.	Represent Council position to Ministry for the Environment	Regular meetings with MfE staff	ongoing

Recommended for consideration through the Surface Water Implementation Plan

2.5 The Council engages in research and trials into means of trapping roof-sourced zinc on site.

2.6 The Council adopts a zinc limitation strategy based on identified best practicable options.

13.3 Objective 3. Control copper contaminants

Our goals are:

3.1 The Council consults with the government, through the Ministry for the Environment, about legislation to limit the copper content in vehicle brake pads.

3.2 The Council does not permit stormwater discharges into the network from unprotected copper cladding, spouting or downpipes.

3.3 The Council will investigate the feasibility of a district plan rule to discourage the use of copper claddings.

Action Plan for Copper				
Goal	**Action**	**Mechanism**	**Action Components**	**Timing**
Copper				
3.1 Vehicle brake pads	Request legislation requiring low/no copper in brake pads	Combined regional and local authority approach to government re legislation to apply nation-wide.	Liaison between local and regional councils. Representation to government via NZTA, MfE	Unknown
3.2 & 3.3 Architectural copper (roofs, spouting, downpipes)	Prohibit the use of unprotected architectural copper. Seek to limit or eliminated the use of architectural copper.	District Plan rule; NZ-wide legislation; and possible District Plan rule; other-wise investigate Regional Rule	Liaise with government thru MfE. Investigate and consult.	Unknown

13.4 Objective 4. Control industrial site contaminants

Our goals are:

4.1 A database of industrial sites considered to be medium or high risk is compiled, based on the best available information, by 2025

4.2 High risk industrial sites are audited by the approved procedure under the CSNDC

Action Plan for Industrial Sites				
Goal	**Action**	**Mechanism**	**Action Components**	**Timing**
4.1 Information about industrial sites.	Continue to improve database of industrial site information.	Desktop analysis, questionnaires, Chamber of Commerce	Desktop analysis, mailouts, questionnaires, industry liaison	ongoing
4.2 Industries unaware of effects of discharges to stormwater	Develop awareness among all industries of the harmful effects of contaminated discharges.	Educate via mail-outs. Educate during site audits.	Inspect sites in risk order. Communicate results and expectations	ongoing
4.3 Some industries failing to control harmful substances	Ensure that harmful substances are contained, tracked, and disposed of safely	Audit sites and follow up with education and enforcement.	Protocols for site controls developed jointly by CCC, ECan and industry. Site audits.	ongoing
4.4 Non-compliant discharges	Trace and eliminate discharges	Audit sites and follow up with education and enforcement.	Communicate the issue to industry & visit industries. Generate improvement plan. Engage and obtain compliance.	ongoing

13.5 Objective 5. Engagement and education

Our goals are:

5.1 By 2024 the Council is working with community groups to engage with the public to educate participants about current stormwater practice and enable the public to take action to stop contaminants at source.

5.2 By 2025 the Council will be engaging regularly with the Ministry for the Environment to collaborate on contaminant reduction initiatives.

Action Plan for Engagement and Education				
Goal	**Action**	**Mechanism**	**Action Components**	**Timing**
5.1 Valuing Water Resources	Education and engagement to empower community groups Each new generation values waterways	Joint partnership prog to effectively co-ordinate existing education and engagement of community groups	Partner delivery (Council, ECan, Ngāi Tahu, CWMS) with stream care and other community groups	Ongoing
5.1 Communication strategy	Develop a long term communication strategy	Strategy development	Understand community thinking about waterways. Agree message and means of communicating.	Ongoing
5.1 Promote community action	Encourage supportive community groups	More direct support for active groups. Provide information and involve in planning	Assist groups to develop goals and action plans. Share Council planning. Fund and track funding. Monitor results.	Ongoing
5.2 CCC and MfE engaged re heavy metals reduction.	CCC to seek regular contact with relevant MfE planning team(s).	The anticipated mechanism is regulation or national education campaign.	Council to contact MfE, starting at executive level, progessing to staff level contacts	Ongoing

13.6 Objective 6. Manage flooding

Our goals are:

6.1 The quantity of stormwater from all new development sites or re-development sites will be attenuated to at least the minimum standard of section 11.1 and 11.2.

6.2 Protection for property will continue to be achieved through controls on development and controls on new floor levels.

Action Plan for Flooding				
Goal	**Action**	**Mechanism**	**Action Components**	**Timing**
6.1 Control extra stormwater from new development	Limit the increase in peak stormwater runoff.	Stormwater from new subdivisions is controlled through full storm detention. Stormwater from larger individual sites attenuated on site. New impervious areas > 150 m2 > 70% impervious captured by rain tanks.	Normal planning processes	Ongoing
6.2 Minimise flooding caused by city growth & change	Monitor changes to impervious areas and stormwater network capacity and compensate if necessary	Regular computer-based flood modelling.	Keep models up-to-date as the city changes. Compare models with flood events. Plan for flood mitigation as necessary.	Ongoing

13.7 Objective 7. Maintain Base Flows

Our goals are

7.1 Stormwater will be infiltrated into the ground where practicable, after treatment, to maintain as much as possible the pre-development water balance.

Note: Infiltration of stormwater into the ground, after acceptable treatment, is the Council's preferred means of stormwater discharge.

Action Plan for Springs and Base Flows				
Goal	**Action**	**Mechanism**	**Action Components**	**Timing**
7.1 Maintain base flows	Infiltrate stormwater into ground where practicable.	Prioritise detention and infiltration for stormwater networks in new development.	Incorporate into strategic planning processes	Ongoing

14 Conclusion

The purpose of the Comprehensive Stormwater Network Discharge Consent is to plan for actions that will progressively improve the quality and quantity of stormwater discharges.

Actions the Council can take through the stormwater management plan must be accompanied by other actions if the Council's Community Outcome (Healthy Environment) and the Mahaanui Iwi Management Plan objectives are to be realised. Further actions, by the Council and others, include:

- Raise awareness and educate citizens on how to stop contaminants from entering stormwater at source.
- Eliminate or reduce contaminants at source (e.g. by choosing or specifying non-contaminating building materials).
- Remove contaminants from stormwater before they enter natural water.
- Restore waterway corridors to a natural state.
- Restore and plant riparian margins.
- Improve instream habitat by sediment removal, riparian tree planting (for temperature control, bank stability and shelter).
- Improve biodiversity to improve food sources for instream life.
- Performance monitoring of treatment facilities.

Information used in developing the SMP suggests that controlling contaminants at source is more sensible than removing them from stormwater through treatment systems. However, the control or elimination of contaminants at source will affect our buildings, means of transport, household products and the ways we do things. Source control is a journey we will need to travel together to protect the environment; tangata whenua, community groups, regulators, researchers, and local, regional and central government.

Progressive improvement can occur through further activities in Table 13.

Table 9: Areas for Improvement Outside of the Stormwater Management Plan

Activity	Motivation for the Activity
The Council regulating and acting under regulations to stop the discharge of contaminants.	As required by conditions of CRC231955 (CSNDC)
The Council investigating new means of controlling contaminants at source (e.g. by materials substitution or innovative means of treatment).	As required by conditions of CRC231955 (CSNDC)
The Council and others implementing new or improved contaminant mitigation practices.	Through the proposed Surface Water Implementation Plan (in development - referred to in section 2.1)

The Council and others making progressive environmental improvements such as restoring waterways and their corridors to a natural state.	Community Outcome (Healthy Environment)
Citizen-based awareness and advocacy for clean water and improved biodiversity.	Kaitiakatanga
Advocacy by Ngāi Tahu for the mana of water and waterways.	Kaitiakatanga. Kawanatanga. Mahaanui Iwi Management Plan

15 References

ANZECC & ARMCANZ (2020). 'Australian and New Zealand guidelines for fresh and marine water quality,'. (Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand: Canberra.) Available at: https://www.waterquality.gov.au/anz-guidelines

Boffa Miskell (2020). Avon River Precinct aquatic ecology: Six years' post-rehabilitation activities. Report prepared by Boffa Miskell Limited for Christchurch City Council, July 2020.

Boffa Miskell Limited (2014). Ecological Values of the Avon River Catchment: An ecological survey of the Avon SMP catchment. Report prepared by Boffa Miskell Limited for Christchurch City Council, May 2014.

Christchurch City Council. (2017). Pūharakekenui / Styx River Catchment Vision and Values. Christchurch: Christchurch City Council. Retrieved from TRIM 17/435575

Dunn, N. R., Allibone, R. M., Closs, G. P., Crow, S. K., David, B. O., Goodman, J. M., Griffiths, M., Jack, D. C., Ling, N., Waters, J. M., and Rolfe, J. R. (2018). Conservation status of New Zealand freshwater fishes, 2017. New Zealand Threat Classification Series 24.

Grainger, N., Harding, J., Drinnan, T., Collier, K., Smith, B., Death, R., Makan, T., and Rolfe, J. (2018). Conservation status of New Zealand freshwater invertebrates, 2018. Department of Conservation New Zealand Threat Classification Series 28.

Instream Consulting (2019). Avon River catchment aquatic ecology 2019. Report prepared for Christchurch City Council, August 2019.

Instream Consulting (2022). Christchurch fish barriers update. Draft report prepared for Christchurch City Council, June 2023.

Instream Consulting (2020a). Fish passage barriers in Christchurch city waterways. Report prepared for Christchurch City Council, April 2020.

Instream Consulting (2021). Kākahi (freshwater mussel) monitoring in Christchurch City. Report prepared for Christchurch City Council, December 2021.

Instream Consulting (2020b). Kākahi (freshwater mussels) in Christchurch Waterways. Report prepared for Christchurch City Council, September 2020.

Instream Consulting (2023). No . 1 Drain restoration ecological monitoring 2023. Draft report prepared for Christchurch City Council, August 2023.

Ira, S., Auckland Council (2021) Freshwater Management Tool: A Total Economic Evaluation Approach to Understanding Costs and Benefits of Intervention scenarios - Part 2 Urban Source Control Costs.

Kennedy, P., Gadd, J., Moncrieff, I. (2002). Emission Factors for Contaminants Released by Motor Vehicles in New Zealand.

Manaaki Whenua / Landcare Research. (2023, January 19). S-Maps Online. Online Map. Christchurch, Canterbury, New Zealand: Manaaki Whenua / Landcare Research. Retrieved from https://smap.landcareresearch.co.nz/maps-and-tools/app/

Margetts, B., and Poudyal, S. (2023). Christchurch City surface water quality annual report 2022. Prepared to meet the requirements of CRC231955. Christchurch City Council Report, July 2023.

McMurtrie, S. (2009). Long-term monitoring of aquatic invertebrates in Christchurch's waterways: Avon River catchment 2009. EOS Ecology Report No. 06064-CCC02-02, prepared for Christchurch City Council, October 2009.

Ministry for the Environment (2020). National Policy Statement for Freshwater Management 2020 (NPS-FM).

Monitoring & Research, 2023. Revised Citywide Population & Household Projections for the 2024 Long Term Plan. Monitoring & Research Team, CCC, November 2023.

Orchard, S., and Measures, R. (2017). Sea level rise impacts in the Avon Heathcote Estuary Ihutai. Salinity intrusion and inanga spawning scenarios. Report prepared for Christchurch City Council by Waterlink Ltd, November 2017.

Pattle Delamore Partners Ltd. (2013). Groundwater Quantity Effects for the Avon Catchment. from TRIM 13/1210141

Pattle Delamore Partners Ltd. (2021). Prestons and Knights Stream Stormwater Facility Monitoring 2020-2021 Annual Report. September 2021

Renard, T., Meurk, C., Phillips, C., & Barrabe, A. (2004). Land Cover and Land Use Mapping of the Styx River Catchment. Lincoln: Manaaki Whenua / Landcare Research.

Robb, J. A. (1992). A biological re-evaluation of the Avon River catchment 1989-90. Report prepared by the Christchurch Drainage Laboratory for the Christchurch City Council, May 1992.

Robertshaw, T.J., Mercer, O.M., (2023) Performance Assessment of Cox's Quaifes Stormwater System. TRIM 24/110471

Taikoro Nukurangi NIWA. (2021). Interim report: Weed management and flooding in the Pūharakekenui/Styx River. Hamilton: National Institute of Water & Atmospheric Research Ltd.

Taylor, M., Burdon, F., and Blair, W. (2012). An update on trout spawning in the Avon River, and notes on the effects of seismic activity on physical habitat. Environment Canterbury Report U12/3, February 2012.

Tonkin & Taylor (2014) Closed Landfills in Christchurch, Location Map TRIM 14/708417

Appendix A Schedule 2 Responses

Table 10: Schedule 2 matters to be included in SMPs: CRC231955 Condition 7

No.	Matters for inclusion in SMPs	Addressed in which Section of the SMP
a	Specific guidelines for implementation of stormwater management to achieve the purpose of SMPs;	The SMP is the guideline
b	A definition of the extent of the stormwater infrastructure, that forms the stormwater network within the SMP area for the purposes of this consent;	4.2
c	A contaminant load reduction target(s) for each catchment within that SMP area and a description of the process and considerations used in setting the contaminant load reduction target(s) required by Condition 6(b) using the best reasonably practicable model or method and input data;	10.8
d	A description of statutory and non-statutory planning mechanisms being used by the Consent Holder to achieve compliance with the conditions of this consent including the requirement to improve discharge water quality. These mechanisms shall include: Relevant objectives, policies, standards and rules in the Christchurch District Plan; Relevant bylaws; and Relevant strategies, codes, standards and guidelines;	2.3 through 2.11
e	Mitigation methods to achieve compliance with the conditions of this resource consent including the requirement to improve discharge water quality under Condition 23, and to meet the contaminant load reduction targets for each catchment as determined through the SMPs and the standards for the whole of Christchurch set in Condition 19. These methods shall include: Stormwater mitigation facilities and devices; Erosion and sediment control guidelines;	11

No.	Matters for inclusion in SMPs	Addressed in which Section of the SMP
	Education and awareness initiatives on source control systems and site management programmes; Support for third party initiatives on source control reduction methods; Prioritising stormwater treatment in catchments: that discharge in proximity to areas of high ecological or cultural value, such as habitat for threatened species or Areas of Significant Natural Value under the Regional Coastal Environment Plan (Canterbury Regional Council, 2012); and areas with high contaminant loads;	
f	Locations and identification of Christchurch City Council water quality and water quantity mitigation facilities and devices; including a description and justification for separation distances between mitigation facilities or devices and any contaminated land;	Figure 11, 11.6
g	Identification of areas planned for future development and a description of the Consent Holder's consideration to retrofit water quality and quantity mitigation for existing catchments through these developments where reasonably practicable;	9.4 (quantity), 11.1-11.6 (quality)
h	Identification of areas subject to known flood hazards;	9.4, Figure 10
i	A description of how environmental monitoring and assessment of tangata whenua values have been used to develop water quality mitigation methods and practices;	10.5
j	Results from and interpretation of water quantity and quality modelling, including identification of sub-catchments with high levels of contaminants;	10.3 and Appendix C
k	Mapping of existing information from Canterbury Regional Council and the Consent Holder showing locations where discrete spring vents occur;	Figures 2, 3 and 4
l	Consideration of any effects of the diversion and discharge of stormwater on base-flow in waterways and springs and details of monitoring that will be undertaken of any waterways and	12.5

No.	Matters for inclusion in SMPs	Addressed in which Section of the SMP
	springs that could be affected by stormwater management changes anticipated within the life of the SMP;	
m	A cultural impact assessment;	10.5.3
n	A summary of outcomes resulting from any collaboration with Papatipu Rūnanga on SMP development;	MKT advised that the Position Statement is sufficient.
o	An assessment of the effectiveness of water quality or quantity mitigation methods established under previous SMPs and identification of any changes in methods or designs resulting from the assessment;	10.4
p	Assessment and description of any additional or new modelling, monitoring and mitigation methods being implemented by the Consent Holder;	10.2
q	A summary of feedback obtained in accordance with Condition 8 and if / how that feedback has been incorporated into the SMP;	Awaiting feedback from public consultation
r	If the Consent Holder intends to use land not owned or managed by the Consent Holder for stormwater management, a description of the specific consultation undertaken with the affected land owner;	Not applicable; no non-Council or non-vested land to be used for stormwater management.
s	Identification of key monitoring locations in addition to those identified in Schedule 10 where modelled assessments of water levels and/or volumes shall be made. For all monitoring locations, water level reductions or tolerances for increases shall be set for the critical 2% and 10% AEP events in accordance with the objective and ATLs in Schedule 10 and shall be reported with the model update results required under Condition 55;	9.5, Table 2
t	Procedures, to be developed in consultation with Christchurch International Airport Limited, for the management of the risk of bird strike for any facility owned or managed by the Christchurch City Council within 3 kilometres of the airport;	7712.2, Appendix G

No.	Matters for inclusion in SMPs	Addressed in which Section of the SMP
u	A description of any relevant options assessments undertaken to identify the drivers behind mitigation measures selected; and	10.7
v	An assessment of the potential change to the overall water balance for the SMP area arising from the change in pervious area and the stormwater management systems proposed.	12.5

Appendix B Sub-catchments Map for the C-CLM

Figure 13: Ōtākaro-Avon sub-catchments in the C-CLM (2018)

Appendix C C-CLM Unit Contaminant Loads

Table 11: Unit Contaminant Loads used in the C-CLM

Source Area		TSS ($g/m^2/year$)	Zinc ($g/m^2/year$)	Copper ($g/m^2/year$)
Grass land	Urban	27	0.0016	0.0003
	Rural	12.6	0.0007	0.0001
Roofs	Concrete	9.6	0.02	0.0033
	Galvanised Steel (unpainted)	3	2.24	0.0003
	Galvanised Steel (poorly painted)	3	1.34	0.0003
	Galvanised Steel (well painted)	3	0.2	0.0003
	Decramastic	7.2	0.28	0.0017
	Color Steel	3	0.02	0.0016
	ZincAlume	3	0.2	0.0009
	Unknown	6	0.02	0.002
Roads	Private Road	12.6	0.0044	0.0015
	Local Road	16.8	0.0266	0.0089
	Collector	31.8	0.1108	0.0369
	Minor Arterial	57.6	0.2574	0.0858
	Major Arterial	94.8	0.4711	0.157
Paved	Residential	19.2	0.195	0.036
	Commercial	19.2	0	0.0294
	Industrial	13.2	0.59	0.107
Construction		1500	0.088	0.018

Appendix D Contaminated Load Model (C-CLM) Results

Table 12: C-CLM results

Ōtākaro-Avon Catchment		**No treatment**						**CSNDC Base Case (2018)**						**10 year case with proposed mitigation**					
	Area	TSS no treatmt	Zn no treatmt	Cu no treatmt	TSS no treatmt	Zn no treatmt	Cu no treatmt	TSS in base case	Zn in base case	Cu in base case	TSS in base case	Zn in base case	Cu in base case	TSS in 10 yr case	Zn in 10 yr case	Cu in 10 yr case	TSS in 10 yr case	Zn in 10 yr case	Cu in 10 yr case
Sub-catchment	(Ha)	(t/yr)	(kg/yr)	(kg/yr)	(t/Ha/yr)	(kg/Ha/yr)	(kg/Ha/yr)	(t/yr)	(kg/yr)	(kg/yr)	(t/Ha/yr)	(kg/Ha/yr)	(kg/Ha/yr)	(t/yr)	(kg/yr)	(kg/yr)	(t/Ha/yr)	(kg/Ha/yr)	(kg/Ha/yr)
Addington	289	85.2	635.6	111.9	0.29	2.20	0.39	75	572	94	0.26	1.98	0.33	47	431	54	0.16	1.49	0.19
Airport	518	1.1	5.6	2.4	0.00	0.01	0.00	1	5	2	0.00	0.01	0.00	1	5	2	0.00	0.01	0.00
Antigua	174	48.9	463.3	64.3	0.28	2.66	0.37	43	417	54	0.25	2.40	0.31	31	349	40	0.18	2.01	0.23
Avon A	149	43.2	218.9	29.8	0.29	1.47	0.20	38	197	25	0.26	1.32	0.17	37	179	24	0.25	1.20	0.16
Avon B	537	150.0	826.7	133.3	0.28	1.54	0.25	132	744	112	0.25	1.39	0.21	126	699	108	0.23	1.30	0.20
Avondale	106	31.8	94.4	13.1	0.30	0.89	0.12	28	85	11	0.26	0.80	0.10	28	85	11	0.26	0.80	0.10
Avonside	293	89.8	464.4	79.8	0.31	1.59	0.27	79	418	67	0.27	1.43	0.23	71	385	59	0.24	1.31	0.20
Brittans	345	97.7	705.6	97.6	0.28	2.05	0.28	86	635	82	0.25	1.84	0.24	85	613	81	0.25	1.78	0.23
Burwood	95	26.1	161.1	21.4	0.28	1.70	0.23	23	145	18	0.24	1.53	0.19	23	134	18	0.24	1.41	0.19
Cranford	798	211.4	993.3	107.1	0.26	1.24	0.13	186	894	90	0.23	1.12	0.11	127	739	73	0.16	0.93	0.09
Cross	200	55.7	315.6	29.8	0.28	1.58	0.15	49	284	25	0.25	1.42	0.13	48	261	25	0.24	1.31	0.13
Dallington	235	76.1	176.7	25.0	0.32	0.75	0.11	67	159	21	0.29	0.68	0.09	67	145	21	0.29	0.62	0.09
Diversion	262	77.3	340.0	50.0	0.29	1.30	0.19	68	306	42	0.26	1.17	0.16	36	188	24	0.14	0.72	0.09
Dudley	270	73.9	510.0	57.1	0.27	1.89	0.21	65	459	48	0.24	1.70	0.18	48	373	37	0.18	1.38	0.14
Estuary	318	88.6	386.7	78.6	0.28	1.22	0.25	78	348	66	0.25	1.09	0.21	70	330	63	0.22	1.04	0.20
Frees	277	80.7	620.0	91.7	0.29	2.24	0.33	71	558	77	0.26	2.01	0.28	71	520	77	0.26	1.88	0.28
Hewlings	84	26.1	106.7	16.7	0.31	1.27	0.20	23	96	14	0.27	1.14	0.17	23	94	14	0.27	1.12	0.17
Ilam	310	71.6	354.4	41.7	0.23	1.14	0.13	63	319	35	0.20	1.03	0.11	63	317	35	0.20	1.02	0.11
Knights	183	52.3	296.7	51.2	0.29	1.62	0.28	46	267	43	0.25	1.46	0.23	41	243	40	0.22	1.33	0.22
New Brighton	433	108.0	745.6	98.8	0.25	1.72	0.23	95	671	83	0.22	1.55	0.19	92	640	82	0.21	1.48	0.19
No 2 Drain	267	56.8	91.1	20.2	0.21	0.34	0.08	50	82	17	0.19	0.31	0.06	17	51	6	0.06	0.19	0.02
Park	85	31.8	22.2	7.1	0.37	0.26	0.08	28	20	6	0.33	0.24	0.07	28	20	6	0.33	0.24	0.07
Riccarton	321	86.4	613.3	71.4	0.27	1.91	0.22	76	552	60	0.24	1.72	0.19	34	382	27	0.11	1.19	0.08
Richmond	149	42.0	293.3	34.5	0.28	1.97	0.23	37	264	29	0.25	1.77	0.19	37	232	29	0.25	1.56	0.19
Shirley	181	52.3	202.2	26.2	0.29	1.12	0.14	46	182	22	0.25	1.01	0.12	42	158	21	0.23	0.87	0.12
Snellings	439	77.3	341.1	47.6	0.18	0.78	0.11	68	307	40	0.15	0.70	0.09	66	305	39	0.15	0.69	0.09
St Albans	235	59.1	555.6	53.6	0.25	2.36	0.23	52	500	45	0.22	2.13	0.19	51	470	45	0.22	2.00	0.19

Travis	319	105.7	256.7	42.9	0.33	0.80	0.13	93	231	36	0.29	0.72	0.11	88	228	36	0.28	0.71	0.11
Waimairi A	262	79.5	388.9	45.2	0.30	1.48	0.17	70	350	38	0.27	1.34	0.15	70	324	38	0.27	1.24	0.15
Waimairi B	329	77.3	177.8	19.0	0.23	0.54	0.06	68	160	16	0.21	0.49	0.05	68	157	16	0.21	0.48	0.05
Winchester	88	22.7	150.0	20.2	0.26	1.70	0.23	20	135	17	0.23	1.53	0.19	20	116	17	0.23	1.32	0.19
Whole catchment (as reported by the C-CLM)	8551	2186.364	11513.33	1589.286				1924	10362	1335				1656	9173	1168			
Addington + Riccarton + Cranford (only these 3)	1408	253.4	1922.2	290.4				337	2018	244	Annual load after 67% of Addington + Riccarton + Cranford treated			217	1598	167			
											Reduction through Addington + Riccarton + Cranford facilities as % of whole catchment Base case (2018)			6.2%	4.0%	5.8%			

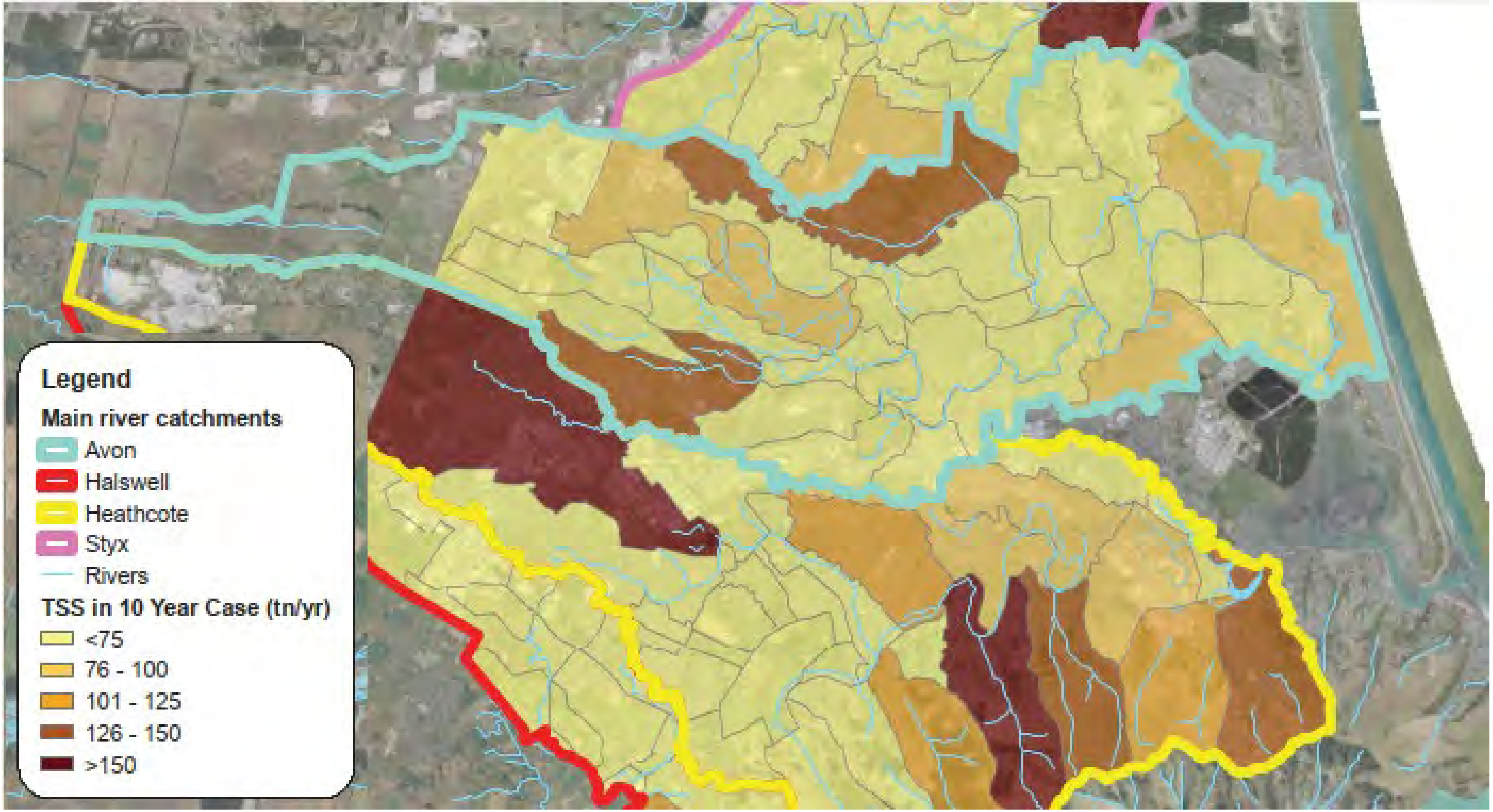

Figure 14 Annual TSS load, tonnes/year, for Ōtākaro-Avon sub-catchments, as estimated by the Christchurch Contaminant Load Model for year 2028, after mitigation with proposed facilities.

(Note that colours represent total annual load not unit load. Some larger sub-catchments are coloured darker for this reason)

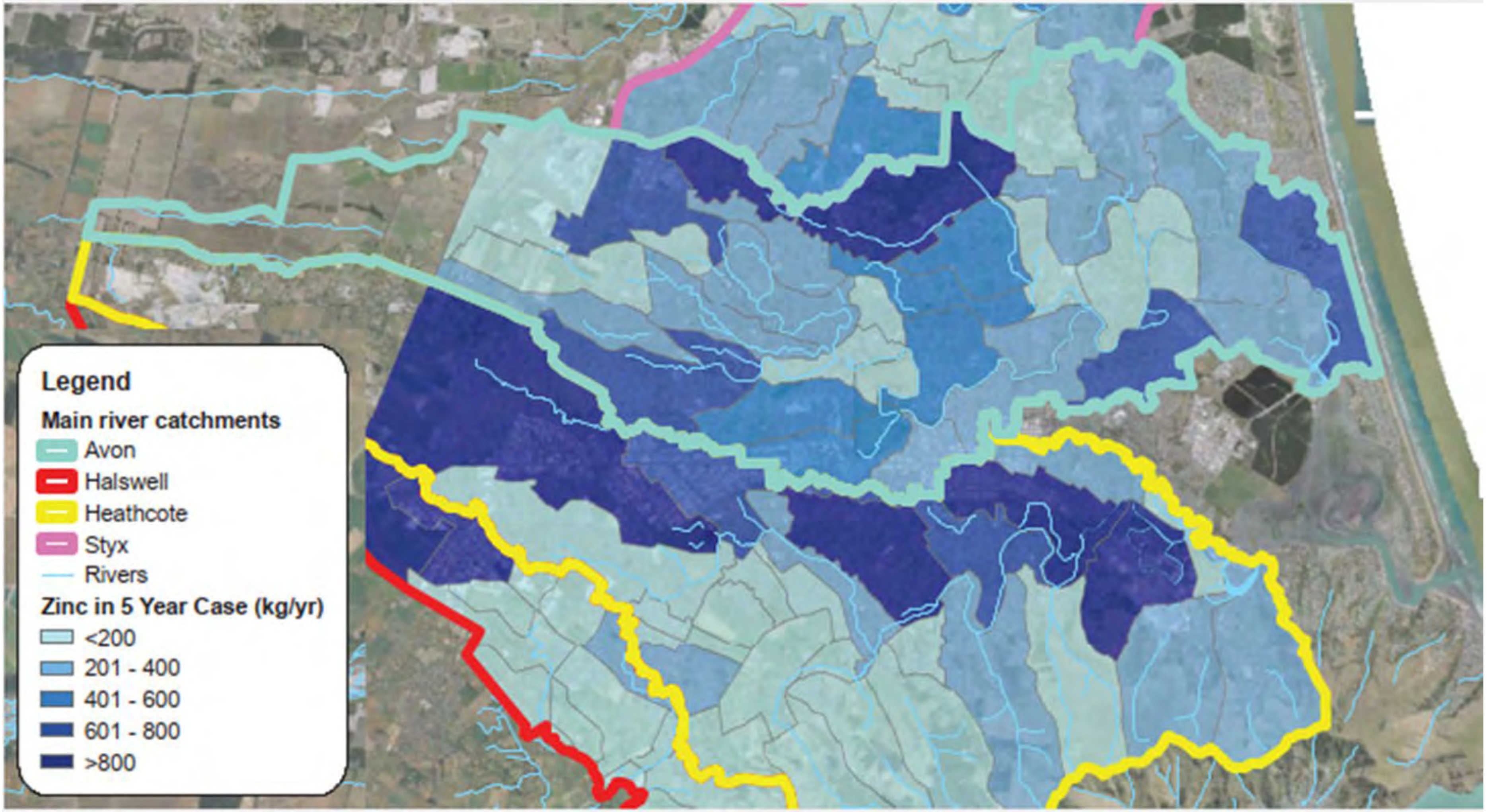

Figure 15: Annual zinc load, kilograms/year, for Ōtākaro-Avon sub-catchments, as estimated by the Christchurch Contaminant Load Model for year 2028, after mitigation with proposed facilities.

(Note that colours represent total annual load not unit load. Some larger sub-catchments are coloured darker for this reason)

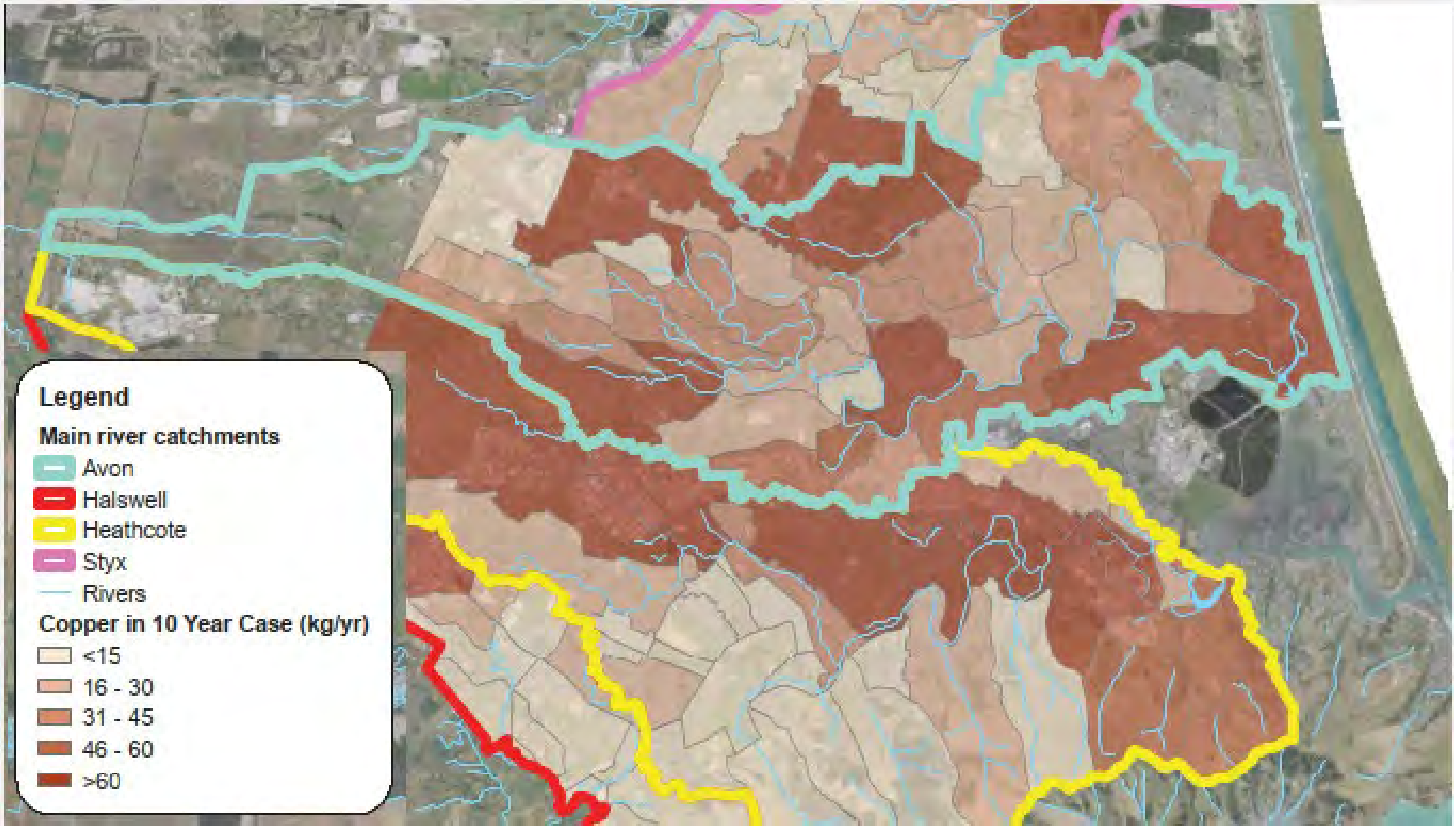

Figure 16: Annual copper load, kilograms/year, for Ōtākaro-Avon sub-catchments, as estimated by the Christchurch Contaminant Load Model for year 2028, after mitigation with proposed facilities.

(Note that colours represent total annual load not unit load. Some larger sub-catchments are coloured darker for this reason)

Appendix E Basins and Land Contamination

Table 13: Proposed Basins and Land Contamination Information for the Basin Site.

Basin ID	Name & Address	Investigation report	Report Date	Findings	Justification for siting basin
No ID assigned	Addington Brook Biolfilter South Hagley Park	No HAIL information		No entry in LLUR	No known contamination. Likely no significant contamination. Site will be investigated and remediated if necessary during basin construction.
No ID assigned	Riccarton Stream Biolfilter Provisionally in South Hagley Park	No HAIL information		No entry in LLUR	No known contamination. Likely no significant contamination. Site will be investigated and remediated if necessary during basin construction.
1063, 1064, 1119	Dudley Diversion FF Basin, Dudley Diversion FA Wetland North, Dudley Diversion FA Wetland South	No HAIL information.		Contamination possible; some contaminants of likely horticultural origin found in motorway corridor during Northern Arterial Extension construction	Cranford Basin is a natural ponding basin and low point naturally susceptible to holding water. Detention value is too high to ignore. Basins will be constructed subject to any remediation that is necessary.

FF = first flush (basin)

FA = flood attenuation (i. e. total storm detention basin)

Appendix F Treatment Efficiencies

Table 14: Treatment efficiencies used in the C-CLM[4]

Treatment system	TSS treatment efficiency (% removal)				Zinc treatment efficiency (% removal)				Copper treatment efficiency (% removal)			
	Roofs	Roads	Paved Surface	Grassland	Roofs	Roads	Paved Surface	Grassland	Roofs	Roads	Paved Surface	Grassland
Single treatment systems												
Basin & wetland	50.0	80.0	80.0	80.0	25.0	60.0	60.0	60.0	30.0	70.0	70.0	70.0
Rain garden	70.0	80.0	80.0	80.0	60.0	70.0	70.0	70.0	70.0	75.0	75.0	75.0
Stormfilter	50.0	75.0	75.0	75.0	15.0	40.0	40.0	40.0	20.0	65.0	65.0	65.0
Wet pond	10.0	75.0	75.0	75.0	5.0	30.0	30.0	30.0	5.0	40.0	40.0	40.0
Basin	10.0	60.0	60.0	60.0	5.0	20.0	20.0	20.0	5.0	30.0	30.0	30.0
First flush Basin	10.0	60.0	60.0	60.0	5.0	20.0	20.0	20.0	5.0	30.0	30.0	30.0
Wetland	50.0	80.0	80.0	80.0	25.0	60.0	60.0	60.0	30.0	70.0	70.0	70.0
Soil adsorption basin	89.0	89.0	89.0	89.0	71.0	71.0	71.0	71.0	71.0	71.0	71.0	71.0
Swale	30.0	75.0	75.0	75.0	15.0	40.0	40.0	40.0	20.0	50.0	50.0	50.0
Combined treatment systems												
Basin and basin & wetland	55.0	92.0	92.0	92.0	28.8	68.0	68.0	68.0	33.5	79.0	79.0	79.0
Basin and First flush basin	19.0	84.0	84.0	84.0	9.8	36.0	36.0	36.0	9.8	51.0	51.0	51.0
Rain garden and basin and wetland	85.0	96.0	96.0	96.0	70.0	88.0	88.0	88.0	79.0	92.5	92.5	92.5
Swale and basin and wetland	65.0	95.0	95.0	95.0	36.3	76.0	76.0	76.0	44.0	85.0	85.0	85.0
Swale and first flush Basin	37.0	90.0	90.0	90.0	19.3	52.0	52.0	52.0	24.0	65.0	65.0	65.0

[4] The Christchurch Contaminated Load Model is the model presented to the consent hearing and used in this SMP

Appendix G Consent targets: schedules 7 to 10

Waterways, Coastal and Groundwater Receiving Environment Attribute Target Levels in Schedules 7 to 10 from Condition 23, Consent CRC231955.

Schedule 7: Receiving Environment Objectives and Attribute Target Levels for Waterways

The EMP outlines the methodology for the monitoring of Attributes and how these will be compared against Attribute Target Levels.

TBC-A = To Be Confirmed once a full year of monitoring allows hardness modified values to be calculated, in accordance with Condition 52.

TBC-B = To Be Confirmed following engagement with Papatipu Rūnanga, through an update to the EMP, in accordance with Condition 54.

Objective	Attribute	Attribute Target Level	Basis for Target
Adverse effects on ecological values do not occur due to stormwater inputs	QMCI	Lower limit QMCI scores: Spring-fed – plains – urban waterways: 3.5 Spring-fed – plains waterways: 5 Banks Peninsula waterways: 5	QMCI is an indicator of aquatic ecological health, with higher numbers indicative of better quality habitats, due to a higher abundance of more sensitive species. QMCI scores are taken from the guidelines in Table 1a of the LWRP (Canterbury Regional Council, 2018). This metric is designed for wade able sites and should therefore be used with caution for non-wade able sites. These targets can be achieved through reducing contaminant loads and waterway restoration.

Adverse effects on water clarity and aquatic biota do not occur due to sediment inputs	Fine sediment (<2 mm diameter) percent cover of stream bed TSS concentrations in surface water	Upper limit fine sediment percent cover of stream bed: Spring-fed – plains – urban waterways: 30% Spring-fed – plains waterways: 20% Banks Peninsula waterways: 20% Upper limit concentration of TSS in surface water: 25 mg/L No statistically significant increase in TSS concentrations in surface water	Sediment (particularly from construction) can decrease the clarity of the water, and can negatively affect the photosynthesis of plants and therefore primary productivity within streams, interfere with feeding through the smothering of food supply, and can clog suitable habitat for species. The sediment cover Target Levels are taken from the standards for the original Styx and South-West Stormwater Management Plan consents, and are based on Table 1a of the LWRP (Canterbury Regional Council, 2018). These targets should be used with caution at sites that likely naturally have soft-bottom channels. These targets can be achieved through reducing contaminant loads (particularly using erosion and sediment control) and instream sediment removal.
Adverse effects on aquatic biota do not occur due to copper, lead and zinc inputs in surface water	Zinc, copper and lead concentrations in surface water	Upper limit concentration of dissolved zinc: Ōtākaro-Avon River catchment: 0.0297 mg/L Ōpāwaho/ Heathcote River catchment: 0.04526 mg/L Cashmere Stream: 0.00724 mg/L Huritīni-Halswell River catchment: 0.01919 mg/L Pūharakekenui-Styx River catchment: 0.01214 mg/L Ōtūkaikino River catchment: 0.00868 mg/L Linwood Canal: 0.146 mg/L Banks Peninsula catchments: TBC-A	These metals can be toxic to aquatic organisms, negatively affecting such things as fecundity, maturation, respiration, physical structure and behavior. The Council has developed these hardness modified trigger values in accordance with the methodology in the 'Australian and New Zealand Environment and Conservation Council, and Agriculture and Resource Management Council of Australia and New Zealand' (ANZG, 2018) guidelines, and the species protection level relevant to each waterway in the LWRP (Canterbury Regional Council, 2017). This calculation document can be provided on request. These targets can be achieved primarily through reducing contaminant loads.

		Upper limit concentration of dissolved copper: Ōtākaro-Avon River catchment: 0.00356 mg/L Ōpāwaho/ Heathcote River catchment: 0.00543 mg/L Cashmere Stream: 0.00302 mg/L Huritīni-Halswell River catchment: 0.00336 mg/L Pūharakekenui-Styx River catchment: 0.00212 mg/L Ōtūkaikino River catchment: 0.00152 mg/L Linwood Canal: 0.0175 mg/L Banks Peninsula catchments: TBC-A	

Objective	Attribute	Attribute Target Level	Basis for Target
		Upper limit concentration of dissolved lead: Ōtākaro-Avon River catchment: 0.01554 mg/L Ōpāwaho-Heathcote River catchment: 0.02916 mg/L Cashmere Stream: 0.00521 mg/L Huritīni-Halswell River catchment: 0.01257 mg/L Pūharakekenui-Styx River catchment: 0.00634 mg/L Ōtūkaikino River catchment: 0.00384 mg/L Linwood Canal: 0.167 mg/L Banks Peninsula catchments: TBC-A No statistically significant increase in copper, lead and zinc concentrations	
Excessive growth of macrophytes and filamentous algae does not occur due to nutrient inputs	Total macrophyte and filamentous algae (>20 mm length) cover of stream bed	Upper limit total macrophyte cover of the stream bed: Spring-fed – plains – urban waterways: 60% Spring-fed – plains waterways: 50% Banks Peninsula waterways: 30%	Macrophyte and algae cover are indicators of the quality of aquatic habitat. Targets are taken from Table 1a of the LWRP (Canterbury Regional Council, 2018). Improvement towards these targets can be achieved by reduction in nutrient concentrations and riparian planting to shade the waterways.

		Upper limit filamentous algae cover of the stream bed: Spring-fed – plains – urban waterways: 30% Spring-fed – plains waterways: 30% Banks Peninsula waterways: 20%	
Adverse effects on aquatic biota do not occur due to zinc, copper, lead and PAHs in instream sediment	Zinc, copper, lead and PAHs concentrations in instream sediment	Upper limit concentration of total recoverable metals for all classifications: Copper = 65 mg/kg dry weight Lead = 50 mg/kg dry weight Zinc = 200 mg/kg dry weight Total PAHs = 10 mg/kg dry weight No statistically significant increase in copper, lead, zinc and Total PAHs	Metals can bind to sediment and remain in waterways, potentially negatively affecting biota. These trigger values are based on the ANZG guidelines (ANZG, 2018). These targets can be achieved through reducing contaminant loads and instream sediment removal.
Adverse effects on Mana Whenua values do not occur due to stormwater inputs	Waterway Cultural Health Index and State of Takiwā scores	Lower limit averaged Waterway Cultural Health Index and State of Takiwā scores for all classifications: Spring-fed – plains – urban waterways: TBC-B Spring-fed – plains waterways: TBC-B Banks Peninsula waterways: TBC-B	The Waterway Cultural Health Index assesses cultural values and indicators of environmental health, such as mahinga kai (food gathering). These indices are on a scale of 1 - 5, with higher scores indicative of greater cultural values. No guidelines are available currently for the different types of waterways, so these targets will be developed specifically for this consent, with higher targets for waterways with higher values. These targets can be achieved through reducing contaminant loads and habitat restoration.

Objective	Attribute	Attribute Target Level	Basis for Target
Adverse effects on Mana Whenua values do not occur due to stormwater inputs	Waterway Cultural Health Index and State of Takiwā scores	Lower limit averaged Waterway Cultural Health Index and State of Takiwā scores for all classifications: Spring-fed – plains – urban waterways: TBC-B Spring-fed – plains waterways: TBC-B Banks Peninsula waterways: TBC-B	The Waterway Cultural Health Index assesses cultural values and indicators of environmental health, such as mahinga kai (food gathering). These indices are on a scale of 1 - 5, with higher scores indicative of greater cultural values. No guidelines are available currently for the different types of waterways, so these targets will be developed specifically for this consent, with higher targets for waterways with higher values. These targets can be achieved through reducing contaminant loads and habitat restoration.

Schedule 9: Receiving Environment Objectives and Attribute Target Levels for Groundwater and Springs

The EMP outlines the methodology for the monitoring of Attributes and how these will be compared against Attribute Target Levels

Objective	Attribute	Attribute Target Level	Basis for Target
Protect drinking water quality	Copper, lead, zinc and Escherichia coli concentrations in drinking water	Concentration to not exceed: Dissolved Copper: 0.5 mg/L Dissolved Lead: 0.0025 mg/L Dissolved Zinc:0.375 mg/L No statistically significant increase in the concentration of Escherichia coli at drinking water supply wells	The most important use of Christchurch groundwater is the supply of the urban reticulated drinking water supply. Contaminants in stormwater that infiltrate into the ground could impact on the quality of water supply wells and/or springs. The compliance criteria for a potable and wholesome water supply are specified in the Drinking Water Standards for New Zealand 2005 (Revised 2008). Metals and E. coli were chosen for these targets, as these are contaminants present in stormwater. The target values for copper and lead are a quarter of the Maximum Acceptable Value (MAV) or Guideline Value (GV) taken from the Drinking Water Standards for New Zealand 2005 (revised 2008). This is to ensure investigations occur before the water quality limits in the LWRP are exceeded, which are that concentrations are not to exceed 50% of the MAV. An equivalent criteria has also been applied to the zinc target, which is not included in the LWRP water quality limits, but has a guideline in the drinking water standards.
Avoid widespread adverse effects on shallow groundwater quality	Electrical conductivity in groundwater	No statistically significant increase in electrical conductivity	Contaminants in stormwater that infiltrate into the ground could impact on groundwater quality. Long term groundwater quality at monitoring wells is undertaken by Canterbury Regional Council. Those monitoring points that occur within the urban area could be impacted by Council stormwater management activities. Electrical conductivity is to be used as an indicator for identifying any general changes in groundwater quality related to recharge.

Schedule 10: Receiving Environment Attribute Target Levels for Water Quantity

MODELLED CATCHMENTS				
Objective for the management of stormwater quantity: To mitigate the risk of inundation, damage to downstream property or infrastructure or human safety through management of stormwater run-off volumes and peak flows. The extent of mitigation shall be assessed against the achievement of attribute target levels for each receiving environment.				
Attribute Target Level: Modelled flood levels for the relevant AEP for the assessment year critical duration event shall not increase more than the Maximum Increase listed below when compared to the same modelled AEP for the baseline year impervious scenario critical duration, as determined using CCC flood models. The baseline year scenario and assessment year scenario shall be identical except for changes to the impervious area, mitigation measures and the inclusion of any new network(s) that has arisen between the dates of the two scenarios and within the city limits. All non-variant scenario parameters shall be as at the assessment year scenario. The critical duration shall be assessed at the monitoring location of the attribute target level. Non-variant scenario parameters include, but are not limited to, channel cross-sections, roughness and floodplain shape. Prior to undertaking the assessment the appropriateness of the non-variant scenario parameters shall be assessed and updated if necessary.				
WATER LEVEL REDUCTIONS OR TOLERANCES FOR INCREASES				
Receiving Environment	**Monitoring Location**	**Baseline Year**	**AEP**	**Maximum Increase (mm)**
Ōtākaro-Avon River	Gloucester Street Bridge	2014	2%	50
Pūharakekenui-Styx	Harbour Road Bridge	2012	2%	100
Ōpāwaho-Heathcote	Ferniehurst Street	1991	2%	30
Huritini-Halswell River	Minsons Drain confluence*	2016	2%	0
NON-MODELLED CATCHMENTS				
Receiving Environment	Attribute Target Level	Basis for Target		Notes
	Discharges from all new greenfield development into the Christchurch City Council network are mitigated using the "Partial Detention" strategy outlined in the Pūharakekenui-Styx SMP until such time as a monitoring location can be set during review of the SMP.	As measured through the CCC discharge authorisation compliance process for Resource and Building Consents until such time as a baseline Year can be set during review of the SMP.		CCC has just begun monitoring the Ōtukaikino at Dickeys Road Bridge. Council does not currently model flooding in the Ōtukaikino River. Flooding occurs primarily due to backwater effects in the Waimakariri River. Therefore, a best practice approach to mitigation of development will be implemented until such time as a Maximum Increase can be set during review of the SMP.

Christchurch City Council

Appendix H Guidelines for Bird Strike Management

Bird Strike Management In Stormwater Basin/Water Body Design

Purpose of Design Guidelines

Bird strike is defined in the Christchurch District Plan as when a bird or flock of birds collide with an aircraft and is a key threat to the safe operation of Christchurch International Airport. It is of concern throughout the Ōtākaro-Avon catchment, which lies east of the main Christchurch Airport runway. Bird strike is a significant safety risk which requires diligent management and collaboration between Christchurch International Airport Ltd (CIAL/ the airport), local government and surrounding landowners.

References in the following paragraph are to sections of the Christchurch District Plan.

Strategies for reducing the risk of strikes at the airport focus on managing wildlife populations on and surrounding the airport. There are provisions in the District Plan addressing issues arising out of incompatible land uses relating to the avoidance of bird strike risk introduced in Chapter 6, Section 6.7 Aircraft Protection, supported by Policy 6.7.2.1.2. Section 6.7.4.3 Activity status tables – Bird strike Management Areas outlines activities and specific standards aimed at managing the establishment of new land uses such as water bodies and stormwater basins that might provide new and additional habitat that is attractive to birds, such that it may increase the movement of birds across flight paths. Appendix 6.11.7.5 outlines controls related to water bodies and stormwater basins within the 3km radius, however considerations for bird strike must also be taken into account up to 13km from the airport runway thresholds, in collaboration with CIAL.

Parameters

Bird strike risk can be avoided or minimised appropriately using best practice guidance provided below, in the District Plan, in collaboration with CIAL[5]

Bird use of stormwater management basins are similar to those of natural water bodies. Parameters to minimise bird strike are similar for both basins and water bodies, and include minimising facility surface area as much as practicable, and design considerations such as:

- maximisation of drainage to avoid standing water,
- increased bank gradients to deter bird nesting,
- avoidance of permanent island features which can provide perching sites for birds,
- appropriate landscape design considering perimeter plant species selection and densities (diagrammed in Figure 17 below).

Ongoing bird strike risk management also extends beyond design and implementation to water body or basin operations, maintenance and/or monitoring.

[5] Rules in the District Plan specifically control the creation of new stormwater basins or water bodies within identified Birdstrike Management Areas (i.e., Rule 6.7.4.3.1 Activity P3). Other plan provisions also deal with bird strike and are generally referenced in Section 11.6.2 of this management plan.

The risk of bird strike will vary from site to site and may be influenced by factors such as proximity to the airport, the flight patterns of specific bird species, surrounding land uses and natural factors such as season, species ecology, and landscape features.

Some general guidelines for design of stormwater basins / water bodies to minimise the risk of bird strike are shown in Figure 17. Specific implementation of these guidelines will vary on a site-by-site basis and should be undertaken in consultation with CIAL and on receipt of ornithologist advice.

Additional guidelines are:

1. Minimising open water and vegetative cover that provides food, shelter or roosting for birds are the primary habitat features of focus for bird risk management near the airport.

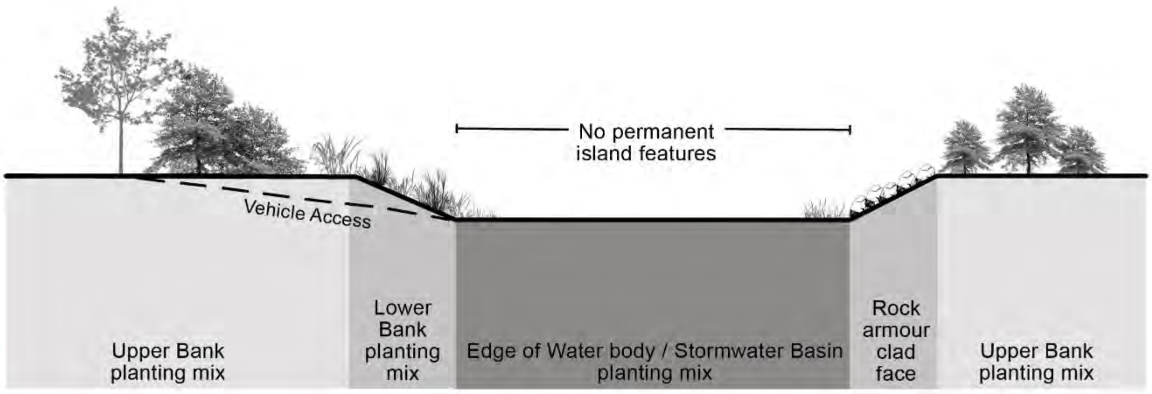

Figure 17: Typical Basin Section

2. Landscape planting plans must limit the attractiveness of basins to birds using suitable non-attracting plant species. Vegetation with berries, nuts, desirable forage, attractive flowers, edible tubers or roots, or large, abundant or high-nutrient seeds should be avoided as a potential wildlife attractant. In general, using low diversity planting strategies and avoiding high-nutrient organic soil amendment (which can attract invertebrates that attract certain birds) is important. Plant species should be limited to those listed in Table 15 (and Appendix 6.11.9 of the District Plan).

Table 15: Plant Species for Water Bodies /Stormwater Basins in the Ōtākaro-Avon Catchment

Edge of Water body / Stormwater basin	
Botanical name	**Common name**
Schoenoplectus validus / tabernaemontani	lake club rush / kapungawha
Eleocharis acuta	spike sedge
Carex germinata	makura
Schoenus pauciflorus	bog rush
Polystichum vestitum	prickly shield fern
Juncus pallidus	tussock rush / wiwi
Cyperus ustulatus	umbrella sedge
Lower Bank	

Botanical name	Common name
Anemanthele lessoniana	wind grass
Astelia fragrans	bush lily / kakaha
Coprosma propinqua	mikimiki
Dianella nigra	ink berry / turutu
Plagianthus divaricatus	swamp ribbonwood
Upper Bank	
Botanical name	**Common name**
Aristotelia serrata	makomako / wineberry
Carpodetus serratus	marbleleaf / putaputaweta
Coprosma rotundifolia	roundleaved coprosma
Dodonea viscosa (frost tender)	akeake
Eleocarpus hookerianus	pokaka
Griselinia littoralis	kapuka / broadleaf
Hebe salicifolia	koromiko
Hoheria angustifolia	narrow leaved lacebark
Kunzea ericoides	kanuka
Leptospermum scoparium	manuka
Lophomyrtus obcordata	rohutu / NZ myrtle
Myrsine australis	mapou
Myrsine divaricata	weeping mapou
Pittosporum eugenioides	lemonwood
Pittosporum tenuifolium	matipo
Plagianthus regius	lowland ribbonwood
Podocarpus totara	totara
Prumnopitys taxifolia	matai
Pseudowintera colorata	peppertree
Sophora microphylla	kowhai

3. High risk bird species of particular concern to aircraft bird strike are summarised in Table 16. Flexibility or adaptability is needed as birds may modify their behaviour in response to installation of new stormwater facilities in ways that were not anticipated during design, resulting in an aviation safety problem. Continued collaboration between stormwater facility designers and CIAL is recommended.

Table 16: Bird Species Causing Particular Risk of Bird Strike (Dr. Leigh Bull, 2021)

Bird Species	Habitat Characteristics
Southern black-backed gull *(Larus dominicanus)*	Found in most habitats. Colonies can occur on islands, steep headlands, sand, or shingle spits or on islands in shingle riverbeds.
Canada goose (*Branta canadensis*)	Graze on pasture, young crops, and aquatic plants. Prefer pastoral land adjacent to a lake or large pond.
Feral pigeon/ Rock pigeon (*Columba livia*)	Variety of habitats. Roost and nest in buildings, under bridges/wharves, and on ledges of cliffs and caves. Occupy open habitats, usually near water (e.g. river-beds, sea and lake shores, agricultural pasture, and urban parklands).
Spur-winged plover (*Vanellus miles*)	Move in response to availability of wetlands. Use temporary and recently constructed artificial wetlands, and leave a drying wetland or diminished food supply.

Stormwater basin designers should make early contact with CIAL for referral to an ornithologist familiar with aviation operations.

Ōtākaro-Avon
Stormwater
Management Plan

letstalk.ccc.govt.nz

Christchurch
City Council