Improving urban freshwater ecosystem health:

Drivers and barriers to public participation.

A thesis submitted in partial fulfilment of the requirements for

the Degree of Master of Science in Geography at

the University of Canterbury.

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2019

Abstract

Growing public scrutiny of freshwater quality issues throughout the country highlights their importance to the people of New Zealand. This unprecedented concern has been matched with the establishment of community-based initiatives, such as river networks and stream care groups. This research explores whether these can be part of the solution towards improving urban freshwater ecosystem health, a term that encapsulates both ecological integrity and societal values. It draws on international literature, semi-structured interviews and a study area of the Ōpāwaho/Heathcote River catchment in order to identify ways in which public participation can be part of improving urban freshwater ecosystem health.

A methodological approach grounded in social science foundations was employed. A comparative model was created that identified the key components of public participation. This comparative model was then utilised as a sorting mechanism to analyse seven published case studies of public participation in environmental based initiatives. Semi-structured interviews were then conducted in Christchurch to gain insights from interviewees on the state of local urban waterways, responsibility for their management, and how community-based initiatives can be integrated into urban freshwater management and decision-making regimes. Interviewees were sought from a range of backgrounds-including freshwater science and management professionals, local iwi, and members of community-based initiatives. This allowed a holistic and multi-dimensional perspective of the issue (s) to be framed.

Valuable insights were derived for the study area, the Ōpāwaho/Heathcote River catchment, an urban catchment in Christchurch that consistently displays poor freshwater health. Several themes were identified pertinent to the drivers and barriers of public participation in improving urban freshwater ecosystem health. The primary themes discussed were the development of a relationship with the freshwater ecosystems as the driver, and operational obstacles as the barrier to public participation. Findings derived through this research can be applied in the context of a citywide community water partnership that is currently under development. A partnership approach presents an opportunity to co-produce meaningful outcomes that could be used to address urban freshwater issues. Community-based initiatives play a pivotal role in improving urban freshwater ecosystem health. However, these groups are only one part of the solution. There is a need to develop further environmental literacy among the wider public, paired with sincere support from regulatory authorities, if there is to be a genuine interest in improving urban freshwater ecosystem health.

Acknowledgements

I express my gratitude to my supervisory team. Eric Pawson, for his unfailing support from initial research ideas in 2016, through to the completion of this thesis, and his invaluable feedback and expertise. Ed Challies, for his comments and encouraging me to think more widely. Heather Purdie, for her guidance through the university system and helpful comments. Shelley McMurtrie whose feedback and understanding of Christchurch freshwater history enriched my understanding of the area and gave meaning to this thesis.

I am extremely grateful to all the interview participants who volunteered their time to take part in this research. Their insights were invaluable.

To my family and friends. Thank you for your unconditional assistance and encouragement.

Thank you to the team at EOS Ecology for your ongoing support throughout the completion of this research. Thank you also to Georgia Petrie for her help with the layout of this document.

This thesis is the product of conversations, support and motivation from everyone listed above and I cannot thank you all enough.

Scholarships and Funding

I acknowledge the support from the UC Masters Scholarship, The Royal Commonwealth Society Canterbury Scholarship and the Charles Cook, Warwick House Memorial Scholarship. The financial support from these scholarships has enriched my thesis experience and enabled me to attend the NZFSS Conference in Nelson in December 2018. I thank the Waterways Centre for Freshwater Management for their support with the conference.

The care of rivers is not a question of rivers, but of the human heart.

Shōzō Tanaka

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Chapter 1. Introduction

Is Good Science Good Enough? This was the title of a plenary presentation by esteemed Professor Russell Death at the annual New Zealand Freshwater Sciences Society (NZFSS) conference in December 2018. The conference theme was "*Ka mua, ka muri: Looking back, moving forward"* to mark 50 years since the Society began. Death reflected on the theme, suggesting that there has never been a more important time for freshwater science in New Zealand. The presentation highlighted the freshwater issues that New Zealand faces, including having the most polluted river in the western world, the highest percentage of endangered fish in the world and no monitoring of endangered freshwater invertebrates (Death, 2018). Concerns were also expressed about freshwater ownership and water bottling, climate disruption and waterborne diseases.

Death made several points: (i) that there is sufficient scientific research into why we have these issues, (ii) a growing number of government-level reports that document the declining state of New Zealand's water quality (iii) government support for clean water and freshwater biodiversity and (iv) an unprecedented public concern for the health of New Zealand's waterways. Thought-provoking remarks were made near the end of the presentation. Death argued that scientists have sufficient knowledge to understand declining waterway health, but there appears to be little action taken to rectify this. He speculated that the traditional model of science that has been used for decades might not lead to improvements in freshwater ecosystem health. Contrastingly, he implied that efforts in collaborative governance were also ineffective. He stated that there is a need to determine where the role of science lies in successful freshwater management. The presentation concluded with a series of slides reflecting on the role of the Society. Death was quoted in the media by Mitchell (2018). "I hope we don't end up being a Society where we just record the decline in water quality, the loss of our native species and how bad that things have got". Perspectives from other plenary talks were also reflected in media articles, with iwi speakers outlining the importance of looking beyond academic approaches and including indigenous knowledge, or mātauranga Māori (Bohny, 2018). These talks and subsequent media reflection signify the importance of freshwater ecosystems from different perspectives.

This experience of attending the NZFSS conference serves as a platform to introduce this research. A well-refined body of scientific knowledge exists alongside increasing public concern, yet there seems to be little improvement in freshwater ecosystem health. There is a need to explore how freshwater management could produce more effective outcomes that lead to improvements in

ecosystem health. Using an interdisciplinary perspective paired with social science methodology, this thesis seeks to contribute to the research gap presented through this anecdote. The primary line of enquiry is to gain insights to the overarching question:

Can community-based initiatives facilitate progress on improving urban freshwater ecosystem health?

This research will seek insights into how community-based initiatives can be used to inform freshwater science and management using Christchurch, New Zealand as a focus area. The remainder of this chapter documents New Zealand's freshwater problem, and defines freshwater ecosystem health and its associated parts. It then outlines the objectives of this research and provides an overview of the study area, before presenting the structure of this thesis.

1.1 New Zealand's freshwater problem

New Zealand has over 425,000 kilometres of streams and rivers. A unique waterscape and biodiversity characterise New Zealand freshwater ecosystems as a result of geomorphic and biogeographic processes (Harding, Jellyman, Pearson, & Davie, 2016; Ministry for the Environment [MfE] & Statistics New Zealand [Stats NZ], 2017). This makes New Zealand waterways and the patterns observed within them markedly different from those located elsewhere (Vannote, Minshall, Cummins, Sedell, & Cushing, 1980; Winterbourn, Rounick, & Cowie, 1981). These patterns have resulted in a unique diversity of species that are endemic to New Zealand (McDowall, 1990; Winterbourn et al., 1981). It is commonly assumed that New Zealand has plentiful and pristine freshwater resources. However, currently both rural and urban systems are generally characterised by the following patterns: high levels of contaminants (including nutrients, heavy metals and sediment), high *Escherichia coli* counts, low visual clarity and macroinvertebrate community scores (MfE & Stats NZ, 2017). In addition, it is reported that close to 75% of native fish and 33% of invertebrates are under threat or at risk of extinction (MfE & Stats NZ, 2017).

These characteristics match the findings of other government reports that have described the decline in freshwater quality in New Zealand (Gluckman, 2017; Organisation for Economic Co-operation and Development [OECD], 2017). The primary drivers of these patterns can be attributed to land use relationships and how these have changed over time. Rural and urban systems are impacted by increases in agricultural intensification and urbanisation respectively (Gluckman, 2017; MfE &

Stats NZ, 2015, 2017). Rural systems have received considerable attention in recent times with less focus on urban systems (Harding, Moores, Trowsdale & Simon, 2016). Freshwater ecosystems are interconnected dendritic networks, where contaminants from anthropogenic land uses accumulate (Harding et al., 2016). This emphasises the importance of the relationship between freshwater and terrestrial land uses. This is particularly important in urban systems that are characterised by a complex array of contaminants and issues (Figure 1.1). Anthropogenic alterations associated with urban expansion and development can have adverse impacts on these systems.

Urban waterways can be defined as those with a high percentage of residential, commercial or industrial land use within the catchment (Gadd, 2016; Paul & Meyer, 2001). The collective impacts of urbanisation or urban development have been well studied internationally, giving rise to the term the *Urban Stream Syndrome* (USS). The USS describes the ecological degradation of streams draining urban catchments (Walsh et al., 2005). Streams suffering from the syndrome have the following symptoms (Walsh et al., 2005):

- Increased concentrations of contaminants and nutrients
- A flashier hydrograph
- Altered channel morphology and stability
- Dominance of tolerant species and a lower biotic richness

Many New Zealand urban streams conform to the patterns described by the USS (Christchurch City Council [CCC], 2018a; Harding et al., 2016; MfE & Stats NZ, 2017). Figure 1.1 presents the complex and interconnected nature of urban environments and urban streams, which contributes to the USS. It is important to note that the magnitude and scale of these issues may differ between streams and catchments. This is largely dependent on land uses directly adjacent to the stream and within the wider catchment (Walsh et al., 2005). Figure l.1 shows that catchment characteristics and activities can result in impacts to aquatic biota. Contaminants can enter the system directly (indicated by dashed arrows) or via the riparian zone (indicated by solid arrows). This creates difficulties for effective management or restoration of these degraded systems, as simply addressing one issue may not lead to improvements across the entire system. Therefore, a multi-faceted management approach is required. While there is a range of factors that can contribute to the USS (Walsh et al., 2005), stormwater is a significant contributing factor in New Zealand, including in Christchurch (CCC, 2016a, 2018; Harding et al., 2016). Local issues and their impacts are further

discussed in Chapter 3. These perturbations to urban freshwaters have detrimental impacts on the composition and function of ecological communities that inhabit these systems (Blakely, Harding, McIntosh, & Winterbourn, 2006; Brown et al., 2009; Dudgeon et al., 2006; Meyer, Paul, & Taulbee, 2005; Paul & Meyer, 2001). Degraded freshwater ecosystems can result in the values associated with urban water bodies becoming compromised.

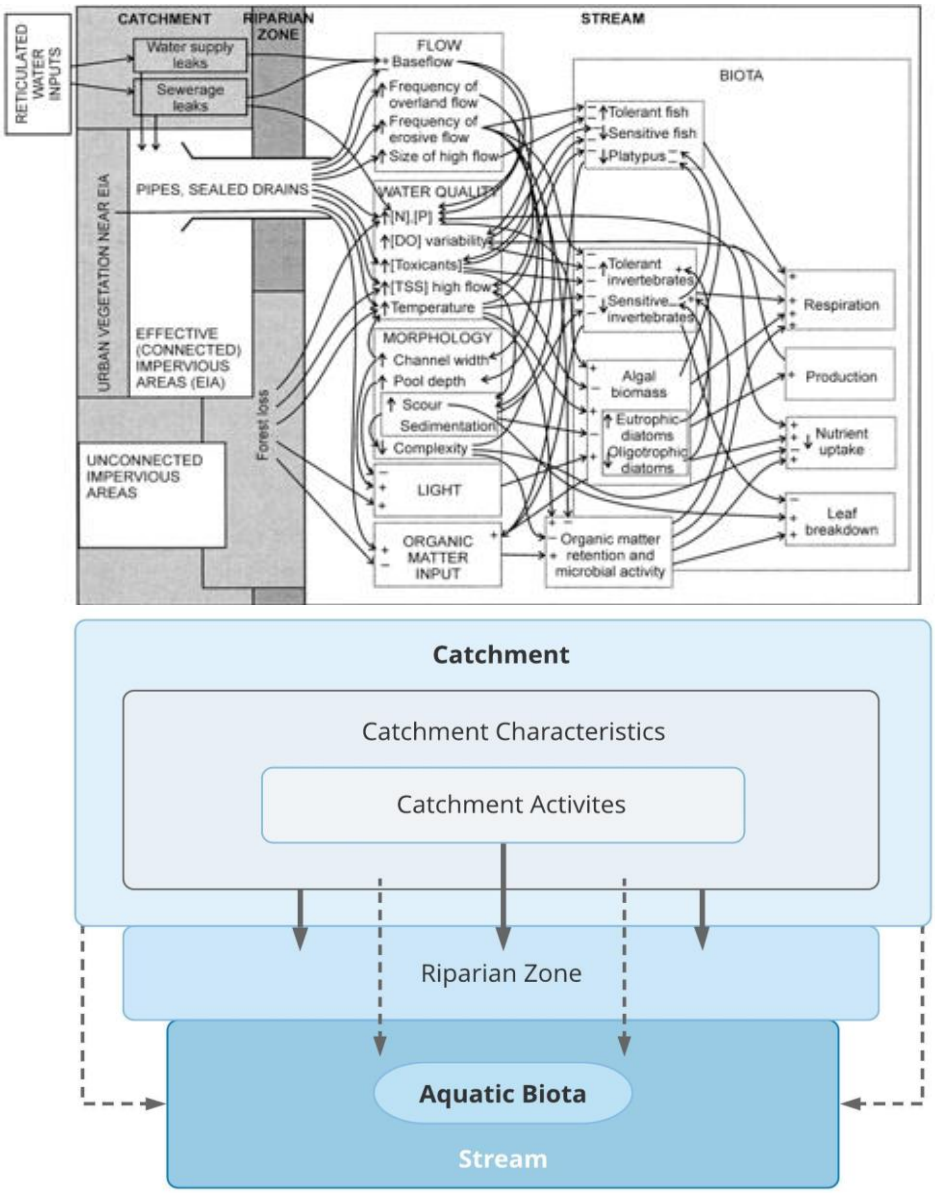


Figure 1.1. Top: The complex and interacting nature of urban stream impacts resulting in the Urban Stream Syndrome. **Bottom:** A simplified version of the concept showing that catchment activities and characteristics affect aquatic biota. (Adapted from Walsh et al., 2005).

While urban areas occupy a small proportion of Earth's surface, human populations are primarily concentrated within, or close to, urban areas leading to severe impacts on urban waterways

worldwide (Brown et al., 2009; Folke, Jansson, Larsson, & Costanza, 1997; Meyer et al., 2005; Paul & Meyer, 2001). This relationship is reflected in New Zealand, where urban rivers make up a small percentage of New Zealand's overall river length, but over 85% of New Zealanders live in urban areas (Harding et al., 2016). Urban freshwater ecosystems are the focus of this research as they have an interesting dynamic of natural and social interactions, due to the proximity and density of human populations in urban areas. The inherent complexities of these systems and the failure to make progress in improving their health, warrants the exploration of alternative approaches.

1.2 Ecosystems and ecosystem health

'*Ecosystems*' form the foundations of this research. According to Tansley (1935) ecosystems "form one category of the multitudinous physical systems of the universe, which range from the universe as a whole, down to the atom." (p. 300). Two things of relevance for this research can be derived from Tansley's definition of ecosystem.

1) An ecosystem can be a larger system that is made up of individual units.
2) Human populations and their interactions can be included in an ecosystem.

Urban freshwater ecosystems form the "ecosystem" of interest. This ecosystem is made up of two key units: an ecological unit and a social unit. Figure 1.2 depicts the inherent connection between social and natural units within a freshwater ecosystem. One way to examine ecosystems is to assess the health of that system, or the "ecosystem health".

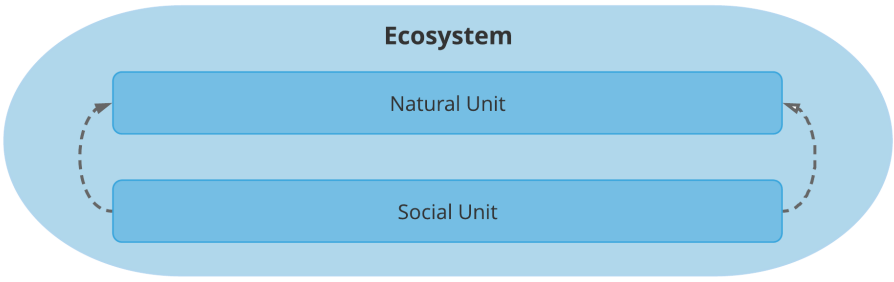


Figure 1.2. A visualisation of the ecosystem concept. The transparent blue colouring represents the larger ecosystem in which the natural and social units are embedded. The characteristics of these units are discussed in Section 1.2.1 and Section 1.2.2 respectively.

Ecosystem health provides an appropriate framework to direct this research. Freshwater ecosystem health integrates ecological values and social values as shown in Figure 1.3 (Boulton, 1999; Meyer, 1997; Young, Wagenhoff, Holmes, Newton, & Clapcott, 2018). The concept also reflects the nature of the issue (e.g. the interactions between anthropogenic (social) and natural units). Considering both social and natural elements makes robustly assessing freshwater ecosystem health challenging. However, the decline in urban freshwater ecosystem health means the exploration of novel methods is warranted to gain insights into making improvements.

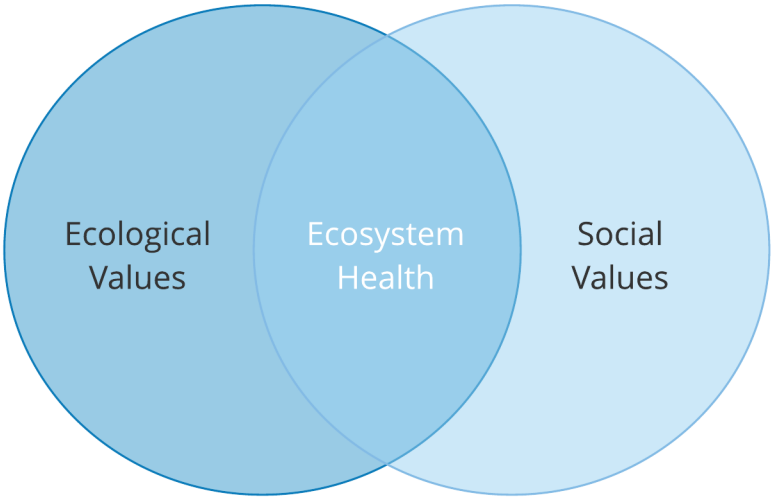


Figure 1.3. A schematic representation of freshwater ecosystem health. (Adapted from Boulton, 1999 and Young et al., 2018).

Freshwater ecosystem health has been contentiously debated with many definitions existing (Boulton, 1999; Karr, 1999; Meyer, 1997; Norris & Thoms, 1999; Rapport, Costanza, & McMichael, 1998; Schaeffer, Herricks, & Kerster, 1988). As defined by Meyer (1997) a healthy ecosystem is comprised of two key aspects (i) ecological integrity (ecological values) and (ii) societal needs (social values) (Figure 1.3):

- Ecological integrity captures more than just descriptive or binary measures of freshwater environments (i.e. temperature, pH, etc.) (Young et al., 2018). It measures the organisation of organisms, their interactions, the activity and productivity of a system and the system's resilience to perturbations (Rapport et al., 1998; Schaeffer et al., 1988). In essence, it integrates both the structure and function of a freshwater system.

- Human populations derive ecosystem services and goods from a functioning ecosystem enabling them to generate a series of values for these systems. These can be described as social values.

Ecosystem health has a direct synergy with this topic. An understanding of ecosystem health is critical to addressing issues that can adversely impact these systems, such as the USS. Each aspect of ecosystem health is further detailed in 1.2.1 and 1.2.2 respectively.

1.2.1 The natural unit

Freshwater ecosystems are characterised by a range of hydrological, biogeochemical and ecological features that are created by a range of interacting processes (Allan & Castillo, 2007; Vannote et al., 1980). Fluvial ecosystems are connected laterally, longitudinally and vertically and to a wider area known as a catchment (Allan & Castillo, 2007). Several forms of life inhabit a freshwater ecosystem ranging from aquatic microorganisms to larger freshwater fish. These include species of vertebrates and invertebrates, as well as terrestrial linkages with plants, birds and mammals. These forms of aquatic life make up complex food webs that are characterised by several different types of interactions (Allan & Castillo, 2007). Different species undertake different functions within a freshwater system. Biotic, and abiotic, processes and interactions determine the structure and composition of biota in freshwater ecosystems. Biotic properties are the living things within an environment, while abiotic describes the chemical and physical characteristics, or non-living aspects, of an environment (Campbell, 2011). These characteristics, processes and interactions collectively determine the structure of these systems (Allan & Castillo, 2007). These communities can occur in different places and under different conditions resulting in a variety services. An example may be a highly disturbed braided river system that supports different freshwater invertebrate communities, compared to a more stable spring-fed system (Gray, Scarsbrook, & Harding, 2006). Aquatic community assemblages give rise to certain ecosystem functions (Allan & Castillo, 2007; Costanza et al., 1997). Biodiversity is recognised as a major determinant of ecosystem functioning (Tilman, Isbell, & Cowles, 2014). Ecosystem functions describe the biological, habitat and ecosystem properties of an environment (Costanza et al., 1997; Frainer, 2013; Frainer, McKie, & Malmqvist, 2014). It is made up of processes (such as the cycling of energy and nutrients in a system) and properties (such as resilience, resistance or persistence) (Feio, Alves, Boavida, Medeiros, & Graça, 2010; Loreau et al., 2001; Tilman, 1997). It is important to acknowledge that this linear description of freshwater ecosystems is rudimentary and overlooks the

complex ecological interactions within these systems. However, the ecological functions of a system are pivotal in providing the services that are derived from these ecosystems and play a crucial role in determining ecosystem health (Figure 1.3) (Costanza et al., 1997; Feio et al., 2010; Meyer, 1997; Palmer & Febria, 2012).

1.2.2 The social unit

As shown by recent surveys, there is a growing awareness and concern in New Zealand for the state of the natural environment and freshwater ecosystems (CCC, 2018b; Colmar Brunton, 2017, Fish & Game, 2019). Findings from the longitudinal *Public Perceptions of New Zealand's Environment* study highlight that New Zealanders consistently perceive freshwater quality as the most important environmental issue in the country (Hughey, Kerr, & Cullen, 2013, 2016).

Human populations derive benefits from freshwater ecosystems and their ecological integrity. Urban freshwater systems have a diverse range of stakeholders, or users, that value the benefits and services these systems provide. These stakeholders range from community groups, individual members of the public or residents, businesses, industries, schools and iwi. Young et al. (2018) surveyed over 400 people who were asked to describe a healthy freshwater ecosystem. Key findings were that a freshwater ecosystem is able to provide for human values while also maintain certain ecological properties. Similar findings have been found internationally (Pinto, Maheshwari, Shrestha, & Morris, 2012).

Freshwater resources have been managed in various ways through time (Memon & Kirk, 2012; Tipa & Welch, 2006). Indigenous Māori have a close and interconnected association with the natural environment through their ancestry (whakapapa) and cultural beliefs (Harmsworth, Awatere, & Robb, 2016; MfE & Stats NZ, 2017; Ngata, 2018; Roberts, Norman, Minhinnick, Wihongi, & Kirkwood, 1995). Māori acknowledge a spiritual connection through ancestral lineage that personifies natural systems, in particular freshwater, forming an obligation to care for the environment (Harmsworth et al., 2016; Patterson, 1994; Roberts et al., 1995). Te ao Māori (the Māori world view) and mātauranga Māori (traditional and holistic knowledge systems) refer to a wide range of cultural concepts, values and beliefs that are translated into contemporary customary practices. These include mahinga kai (customary resource gathering), kaitiakitanga (guardianship) and ki uta ki tai (a holistic management concept that translates as 'from mountains to sea' and reflects the interconnected nature of environments) (Harmsworth et al., 2016; Patterson, 1994;

Roberts et al., 1995). These cultural practices are connected through inter-generational knowledge and application (Anderson, 2008; Harmsworth et al., 2016; Patterson, 1994), and can be used to inform modern Māori perspectives on environmental issues and their management (MfE & Stats NZ, 2017) (Chapter 3). Degraded water quality and ecosystem health is of significant concern to Māori (Te Rūnanga o Ngāi Tahu, 2015). This is due to the damage to the mauri (life force or energy) of these systems and the aforementioned values and practices it impairs (Harmsworth et al., 2016; Roberts et al., 1995).

New socio-cultural approaches to freshwater management in New Zealand are gaining traction with the Whanganui River now considered to have legal personhood under New Zealand law (Hutchison, 2014; New Zealand Parliament, 2017). The reconceptualisation of a natural system to a legal person challenges standard conventions of law, illustrating the influence of cultural and social knowledge in changing values of environmental systems (Harmsworth et al., 2016; Hutchison, 2014). Another example is the Waikato River Authority, a group that has been given custodianship over the Waikato River (Waikato River Authority, n.d.). In 2008 a Vision and Strategy document was produced for the Waikato River, with the Waikato River Authority established in 2010 to implement and administer the Vision and Strategy (Waikato River Authority, n.d.). There are several formal agreements and pieces of legislation (between the crown and iwi) to mark the formal nature of the group. The Authority addresses key issues that degrade the quality of the river and is responsible for implementing the river clean up actions undertaken through the Waikato River Clean-up Trust (Waikato River Authority, n.d.). These examples illustrate the social and cultural interest in environmental, or freshwater problems, and the recent changes in the way natural systems are portrayed. They also reiterate a level of guardianship and concern for waterway health that in part reflects the Māori views described above.

Highlighting the level of public interest is the number of stream or river care groups that exist in New Zealand. These groups have formed due to communities' concerns for the health of their local waterways and a desire to be involved in generating solutions to improve them. They also act as a vehicle to connect their wider communities to their local waterways. These will be referred to as community-based initiatives to encapsulate the differing characteristics of these groups. Currently, the development of a community water partnership for Christchurch is in progress. Outcomes from this process may provide additional support for the community-based initiatives and allow them to co-produce solutions to urban freshwater ecosystem health problems. Co-production is the bringing together of different knowledge types and skillsets in a public participation type forum. Public

participation (including co-production) and community-based initiatives are the focus of this research and are further discussed in Chapter 2 and Chapter 3.

This research has been developed as a reflection of what is happening on the ground, where local people are becoming involved in urban freshwater management in attempt to improve the health of their local freshwater ecosystems. This has been a key motivator in exploring the social dimension of ecosystem health.

1.3 Research objectives

The degradation of New Zealand's urban freshwater ecosystems warrants the exploration of alternative and contemporary approaches to addressing such issues. Within the larger research gap (there being a highly refined body of science but little improvement seen in ecosystem health) several smaller research gaps can be identified:

- The use of various forms of disciplinary knowledge, including social science, in an integrated manner to derive solutions to urban freshwater problems.
- A global and local lack of adoption of such approaches being used to address urban freshwater health problems.
- Investigating the role community-based initiatives may have in contributing to this larger research gap.

This research aims to gain an appreciation of whether community-based initiatives can facilitate progress on improving urban freshwater ecosystem health. The focus will be the Ōpāwaho/Heathcote River catchment in Christchurch, New Zealand, as a case study area (Figure 1.4). In order to address the overarching research question, the following research objectives will be addressed:

1) Identify the drivers and barriers to public participation in environmental problem solving

2) Determine how these drivers and barriers are expressed in the context of improving urban freshwater ecosystem health in the Ōpāwaho/Heathcote case study area

3) Understand how public participation and co-production can be used together to inform urban freshwater management and decision-making

A social science approach employing a case study analysis, reinforced with contextualised semi-structured interviews, was used to elicit insights to the objectives above. Exploring ecosystem health from a social science perspective allows for the examination of alternative methods of urban freshwater management that translate global learnings to a local context. The purpose of this research is to progress current urban freshwater management regimes by drawing from knowledge that intersects both scientific and social fields. Such information will provide a greater understanding of how public participation can inform meaningful urban freshwater management decision-making.

1.4 Overview of the Ōpāwaho/Heathcote River catchment

The Ōpāwaho/Heathcote River catchment is located to the south of Christchurch city and flows along the edge of the Port Hills (Figure 1.4). The spring-fed Ōpāwaho/Heathcote River is 25 kilometers in length and discharges into the Ihutai/Avon-Heathcote Estuary (CCC, 2016a; Deely & Fergusson, 1994; McFadgen & Goff, 2005). While urban waterways make up a small amount of total river length in New Zealand, Christchurch has over 150 kilometers of rivers and tributaries that lie within the city boundary (Harding et al., 2016). Through time, the waterscape of the catchment has undergone profound change (Taylor & McMurtrie, 2003). Land use within the catchment is largely residential, with some smaller areas of industrial activity in the upper and lower reaches. The catchment has as a reasonable proportion of hilly areas that are a mix of rural, urban and reserve land use (Figure 1.4) (Cameron, 1970; Deely & Fergusson, 1994; Purchase & Fergusson, 1986). Traditionally, the Ōpāwaho/Heathcote River boasted diverse and plentiful aquatic life that was highly valued by Ngāi Tūāhuriri (mana whenua of the Ōpāwaho/Heathcote River catchment) as a source of mahinga kai (Anderson, 2008; CCC, 2016a; Tau, 2000). Following European settlement, the river and catchment have undergone wide-spread modification to facilitate urbanisation (CCC & Environment Canterbury [ECan], 1998; CCC, 2016a; Pawson, 2000; Taylor & McMurtrie, 2003; Watts, 2011; Wilson, 1989). According to Christchurch City Council (CCC) annual monitoring, the Ōpāwaho/Heathcote River has the poorest water quality when compared to other urban waterways in Christchurch (CCC, 2018a). A comprehensive description of the catchment is detailed in Chapter 3.

The Ōpāwaho/Heathcote River catchment has two primary freshwater focussed community-based initiatives: (i) the Ōpāwaho Heathcote River Network (OHRN) and (ii) the Cashmere Stream Care Group (CSCG). These groups have an interest of conserving and improving ecological health

(Cashmere Stream Care Group; 2018a; Ōpāwaho Heathcote River Network, 2016) and are the focus of this research. The formation and persistence of community-based initiatives warrants exploration of their role in improving urban freshwater ecosystem health. These groups are further detailed in Chapter 3. The characteristics described above make the Ōpāwaho/Heathcote catchment an ideal catchment in which to base this study.

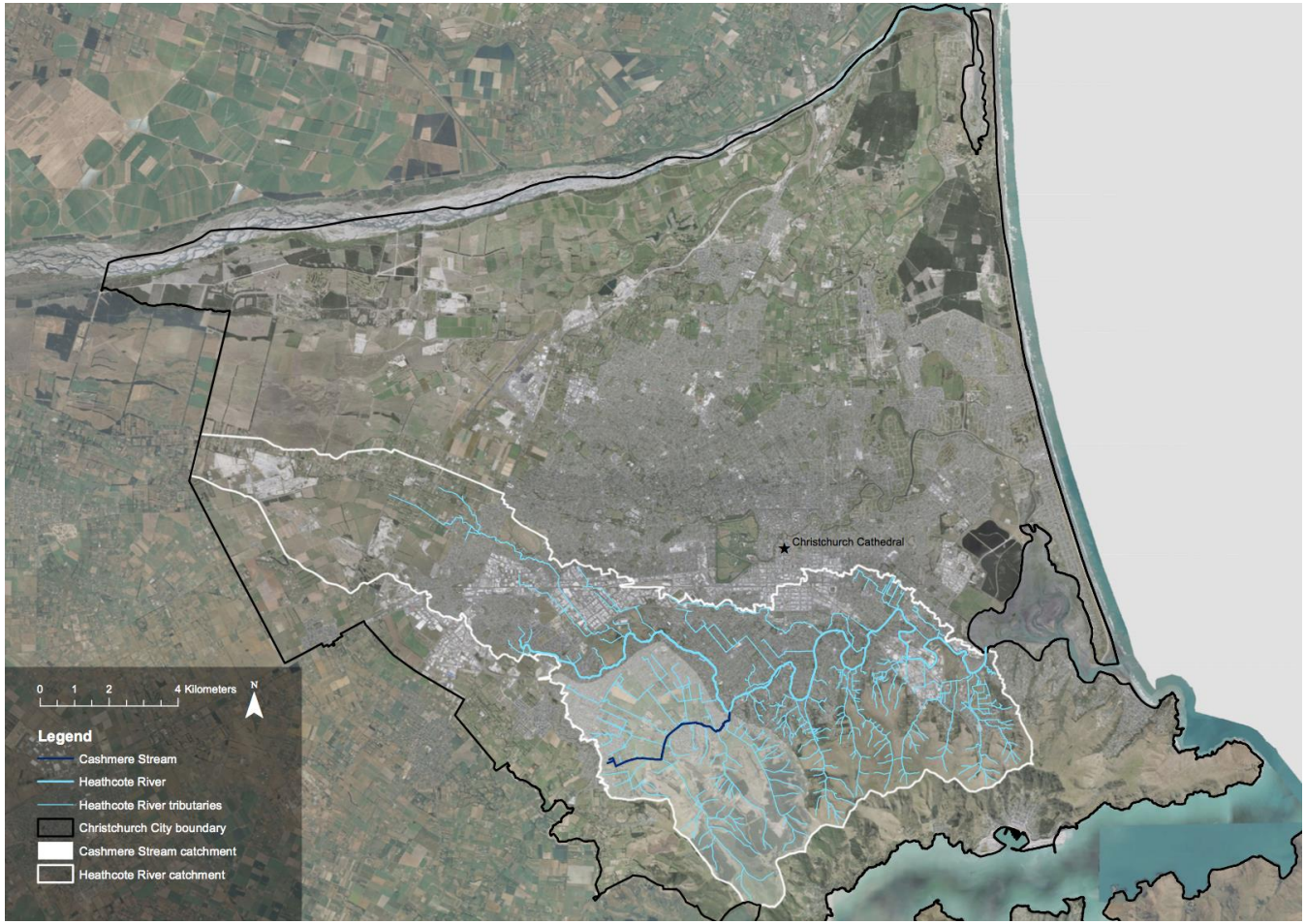


Figure 1.4. The Ōpāwaho/Heathcote River catchment. The catchment boundary is shown by the white outline with Christchurch city centre to the north-east (Christchurch Cathedral). The Cashmere Stream is shown in dark blue with the Cashmere Stream catchment area shaded. (Data sources: Christchurch City Waterways Layer, 2015, Christchurch City Council; Land Drainage Catchment Layer, 2018, Christchurch City Council; Christchurch Aerial Imagery 2015, Land Information New Zealand, Territorial Boundaries Layer, 2017, Statistics New Zealand. Retrieved from EOS Ecology database, Christchurch, New Zealand).

1.5 Thesis structure

This chapter has introduced the issue of concern, research objectives, and the study area. Chapter 2 explores the theoretical and conceptual background to the topic, presenting an examination of socio-ecological systems, public participation, and co-production.

The third chapter provides an in-depth explanation of current management regimes and details of the study area, the Ōpāwaho/Heathcote River catchment. Chapter 4 illustrates the methods used to conduct this research and outlines the development of a comparative model to examine specific local and international case studies of public participation in environmental problem solving. Chapter 5 presents the findings of the published case study analysis, while Chapter 6 presents the key themes collected via semi-structured interviews.

Chapter 7 discusses the insights derived through the research process in the context of the three research objectives (Section 1.3). This chapter also contextualises the findings to the Ōpāwaho/Heathcote River catchment to understand how community-based initiatives can be used to improve freshwater ecosystem health. The final chapter concludes the thesis and outlines a series of recommendations.

Chapter 2. Theories and mechanisms of public participation

This chapter uses relevant literature to explore socio-ecological systems and the connection between humans and freshwater systems. Following this, insights are derived on environmental degradation and the role of public participation. Wicked problems are defined and contrasted with respect to public participation. Different modes of public participation are then investigated, with a more comprehensive examination of co-production as a concept that could be used to address freshwater ecosystem health problems.

2.1 Socio-ecological systems

Scientific investigations of freshwater systems have traditionally focussed on aquatic species, their habitats and the interactions between them. Ecosystems, as described in Chapter 1, are a product of the organisms, the wider environment, and their interactions (both organic and inorganic), and not just the organisms of immediate interest (Tansley, 1935). To place this in context of this research, a freshwater ecosystem can extend to include human populations and their interactions with aquatic attributes of the system. As Tansley (1935) states "ecology must be applied to conditions brought about by human activity" (p. 304). Tansley also suggests that researchers mentally need to break down ecosystems into "isolates" for the purposes of investigation. Isolates can include a region, a waterscape, a specific stream, an ecological community, or a specific species, and their interactions (Tansley, 1935). However, the "systems we isolate mentally are not only included as parts of larger ones, they also overlap, interlock and interact with one another. The isolation is partly artificial, but is the only possible way in which we can proceed." (p. 300). This view supports the reductionist approach to freshwater management that has been common in New Zealand**.** As science and management of these systems has progressed, freshwater problems face new complexities.

Building on Tansley's concept of ecosystem, the *New Environmental Paradigm* challenged the use of nature exclusively for human use by considering human beings as a part of ecosystem thinking (Dunlap & Van Liere, 1978). This paradigm shift is in response to widespread change, attitudes and beliefs in an attempt to change human behaviour to avoid ecological catastrophe (Dunlap & Van Liere, 1978). The shift towards concepts such as the *New Environmental Paradigm* are evident in environment-society literature with some authors highlighting such approaches as conceptual shifts in ecology and ecosystem theory (Berkes, 2004; Grimm, Grove, Pickett, & Redman, 2000). Berkes (2004) suggests three key conceptual shifts in ecology:

1) *A shift from reductionism towards natural environments considered as systems*

2) *A shift to people and communities being included within these systems*

3) *A shift from expert based to participatory resource management*

This research seeks to build upon these conceptual threads by investigating the social unit and its interactions as part of ecosystems and ecosystem health (Figure 1.2 & Figure 1.3). Looking beyond the aquatic ecosystem, and considering humans as an integral component of these systems, may produce meaningful insights to inform contemporary freshwater management.

Leach, Mearns, and Scoones (1999) state that environmental degradation reflects a lack of synchrony between communities and their natural environment. The dynamic interactions between humans and nature can be considered as part of a multi-layered socio-ecological system (Berkes, 2004; Fraser, Dougill, Mabee, Reed, & McAlpine, 2006; Kinzig, 2001; Leach et al., 1999). Humans need to be considered as part of this system as opposed to separate from it, in order to create meaningful environmental change in a human dominated world (Berkes, 2004; Dunlap & Van Liere, 1978; Kates et al., 2001). A socio-ecological systems approach to investigating environmental issues (e.g. ecosystem health) demands various type of knowledge and understanding in order to develop a complete knowledge foundation (Berkes, Colding, & Folke, 2000). In such an approach, the use of multi-disciplinary science that integrates sub-sets of traditional science, including social science, allows the system to be viewed as a whole (Grimm et al., 2000; Kinzig, 2001).

2.1.1 Ecosystem services and ecosystem health

An inherent connection exists between human populations and urban freshwater ecosystems (Allan & Castillo, 2007). Ecosystem services refer to the indirect or direct benefits derived by human populations from the various ecosystem functions (Aylward et al., 2005; Bolund & Hunhammar, 1999; Costanza et al., 1997; Daily, 1997). There is a diverse range of freshwater ecosystem services (Table 2.1).

Table 2.1. Freshwater ecosystem services (Adapted from Aylward et al., 2005)

Service category	Services
Provisioning	Water (quantity and quality) for consumptive use (for drinking, domestic use, and agriculture and industrial use) Water for non-consumptive use (for generating power and transport/ navigation) Aquatic organisms for food and medicines
Regulatory	Maintenance of water quality (natural filtration and water treatment) Buffering of flood flows, erosion control through water/land interactions and flood control infrastructure
Cultural	Recreation (boating, hiking, and fishing) Tourism (river viewing) Iwi values and practices (mahinga kai, kaitiakitanga, ki uta ki tai) Existence values (personal satisfaction from free-flowing rivers)
Supporting	Role in nutrient cycling (role in maintenance of floodplain fertility), primary production Predator/prey relationships and ecosystem resilience

Services can differ between freshwater ecosystems (Aylward et al., 2005; Costanza et al., 1997). The provision of freshwater ecosystem services can shape what values individuals and communities attach to freshwater ecosystems (e.g. amenity or recreational values). Freshwater ecosystems are valued by human populations across the four well-being areas: social, cultural, economic and environmental (MfE, & Stats NZ 2017; Young et al., 2018). These values can vary based on local context and perspective and are not often clearly defined (MfE, & Stats NZ 2017). However, when ecosystem services are impacted, these values can become compromised.

Associations with freshwater systems described above are dependent on the aforementioned ecological communities and their functions. Secondly, such associations can be compromised through ecologically adverse impacts such as those associated with the USS (Figure 1.1). The focus herein is exploring how freshwater ecosystem health improvements can be made. This requires an understanding of ecological characteristics and interactions (ecological values) paired with the services and values derived by human populations (social values) in order to gain insights into making change.

As outlined in Chapter 1, ecosystem health forms the framework of this research as the concept considers both social and ecological parameters (Figure 1.3). The term *health* as it is used in a

medical context has a meaning which is easily understood by most people (Elosegi, Gessner, & Young, 2017; Fairweather, 1999; Karr, 1999) Young et al., 2018). Freshwater ecosystem health builds on this foundation by describing the state of freshwater ecosystems (Young et al., 2018). Despite this, ecosystem health in a broader sense has been highly contested and debated for many years with ambiguity around the definition of the concept (Boulton, 1999; Elosegi et al., 2017; Karr, 1999; Norris & Thoms, 1999; Rapport, 1995; Rapport et al., 1998;Young et al., 2018). This contention is predominantly attributed to the integration of societal indicators, which is seen as increasing complexity for the concept's practical use (Boulton, 1999; Karr, 1999; Rapport, 1995; Rapport et al., 1998). Despite this, freshwater ecosystem health has been used internationally as a framework to assess freshwater ecosystems via a series of indicators (Young et al. 2018). It is also used to describe the impacts of environmental degradation. The use of the concept in this thesis is to emphasise the importance of assessing ecological integrity (Section 1.2), as opposed to using structural or descriptive water quality measures (Palmer & Febria, 2012). It is also used to incorporate societal values when examining freshwater ecosystems.

2.2 Environmental degradation and public participation

Civilization has developed and adapted countless methods to harness the natural capital provided through well-functioning and service-producing ecosystems, often resulting in adverse impacts to the health of these systems. Environmental degradation is any change or disturbance by humans to an environmental system that is perceived to be deleterious or undesirable (Johnson et al., 1997). Environmental degradation occurs across a range of different ecosystems, including freshwater ecosystems (Abramovitz, 1996; Dudgeon et al., 2006; Johnson et al., 1997). The global decline of freshwater ecosystems has been documented (Abramovitz, 1996; Dudgeon et al., 2006). It is thought that decline in freshwater biodiversity is far greater than terrestrial systems (Sala et al., 2000). Dudgeon et al. (2006) discerns five primary categories for the decline of freshwater biodiversity. These are over exploitation, flow modification, water pollution, habitat degradation and species invasion (Dudgeon et al., 2006). The USS concept also describes the biological degradation of freshwater ecosystems in urban areas (Walsh et al., 2005) and is further detailed in Chapter 3. It is clear that anthropogenic actions degrade freshwater ecosystems as demonstrated by Dudgeon et al. (2006). Changes are required in order to conserve and protect the benefits derived form freshwater ecosystems (Abramovitz, 1996).

Through time, different cultures and religions have used different techniques to utilise the natural capital provided by such systems (Strang, 2015). As population growth increased, natural systems were altered to support humans, such as the drainage of land for development and to reduce flooding (Chapter 3). Earth is now deemed to be in a geological epoch named the *Anthropocene.* This epoch is characterised by the continuous alteration of natural processes and systems ultimately eroding natural capital (such as ecosystem services) at a planetary scale (Lorimer, 2012; Lorimer & Driessen, 2014). Public concern about anthropogenic impacts on natural ecosystems grew following environmental movements in the 1960s, with many expressing their desire to become involved in the management of these systems due to the inefficiencies of top-down approaches being able to mitigate such effects on environmental systems or address complex environmental or 'wicked' problems (Beierle & Cayford, 2002; Layzer, 2008; Murch, 1971; Tognacci, Weigel, Wideen, & Vernon, 1972). With concern pertaining to the impacts of anthropogenic problems, the exploration of public-based initiatives to address such issues and derive solutions to them is warranted. Public participation has been defined by Beierle and Cayford (2002) (p.6) as "mechanisms intentionally instituted to involve the lay public or their representatives in administrative decision-making." In recent times, consideration for environmental protection has come to the forefront of decision-making (Grimm et al., 2000; Stern, 2000), with Sexton, Marcus, Easter, and Burkhardt (1999) suggesting that a quiet revolution is taking place demanding better environmental decision-making that integrates governments, businesses and communities.

2.3 Wicked problems

This term describes problems for which there are no optimal or discrete solutions and have no stopping rule (i.e. they are inherently ongoing) (Duckett, Feliciano, Martin-Ortega, & Munoz-Rojas, 2016; Ludwig, 2001; Rittel & Webber, 1973). These problems are not simplistic in scope requiring navigation of multiple interacting and competing complexities (Vogel, Scott, Culwick, & Sutherland, 2016). Complex social-environmental issues can be classed as "wicked problems" (Duckett et al., 2016; Vogel et al., 2016). Wicked problems can plague aquatic ecosystems, especially urban systems, due to the complex array of issues that compile the USS (Walsh et al., 2005) (Figure 1.1).

Complexity arises from the plethora of intricate interactions between biological, physical and social systems (Kinzig, 2001; Lemos & Morehouse, 2005). Such problems are often driven by non-linear processes making it hard to attain centralised solutions due to opposing desires and ideals across

different sectors (Duckett et al., 2016). Finding solutions demands an appreciation of the dynamics and interactions of nature and society (Kinzig, 2001). In a freshwater context, Baron et al. (2002) state that river managers will require the best science to justify their decisions, and the public need to be informed of the values of functioning freshwater ecosystems, expressing the need for a multi-faceted approach to freshwater management. Solutions rely on a collaboration of scientists, policy makers, and the public implementing a new kind of multi-disciplinary approach (Lemos & Morehouse, 2005; Ludwig, 2001).

Academics from traditional scientific disciplines have explored ways to address environmental problems with answers largely remaining within singular disciplines (Grimm et al., 2000; Kinzig, 2001). Callon, Lascoumes, Barthe, and Burchell (2009) state that researchers become accustomed only to the problems they attempt to address, meaning that they are entrenched in one area that they do not look beyond. Furthermore, some argue that traditional scientific disciplinary knowledge is ill-equipped for addressing such complex problems (Vogel et al., 2016). Interestingly, the entrenchment of traditional scientific knowledge supports Tansley's (1935) theme of reducing systems to 'isolates'. However, these efforts fail to take a more holistic view of ecosystems ultimately constraining knowledge obtained to the 'isolate' of interest as opposed to the wider 'ecosystem'.

To address complex, or wicked, environmental problems, a well-equipped multi-disciplinary knowledge system is required (Ludwig, 2001; Polk, 2014; van der Hel, 2016; Vogel et al., 2016). To develop such a system, collaboration is needed to combine scientific and technical knowledge with other forms of knowledge such as local or traditional knowledge, as no single knowledge type is sufficient on its own (Armitage et al., 2009; Berkes, 2009; Berkes & Jolly, 2002; Davidson-Hunt & Michael O'Flaherty, 2007; Vogel et al., 2016). Such approaches are growing in recognition and increasing in use (Beierle, 1999), although some scientists are sceptical of knowledge that does not conform to traditional science (Berkes, 2009). Beierle (1999) states three reasons for the public to be involved in participatory environmental problem solving. The first reason is due to the shifting nature of environmental management priorities. An example of this is shifting from measuring point sources of pollution to considering diffuse sources of pollution. This is relevant for freshwater management in New Zealand where individual actions within a catchment may result in both point source or diffuse pollution (e.g. erosion from land use activities directly or indirectly entering stormwater network and ending up in streams). Secondly, they bring valid and innovative perspectives to decision-making. Finally, public participation can work towards finding more

publicly acceptable solutions to risk-laden decisions through integrating different knowledge types (Beierle, 1999). Furthermore, Dryzek (1997) states that community interests, which should come to the forefront during public participation, are more likely to include ecological concerns when deliberating solutions. This is possibly due to the local community being the primary stakeholder in local ecology (Hu et al., 2016). Public participation has proven to be successful across a range of examples of multi-stakeholder governance, including watershed management (Beierle, 1999). A range of community-based strategies have been investigated and implemented as an approach to addressing environmental degradation issues (Berkes, 2004; Kinzig, 2001; Leach et al., 1999). One example includes community-based natural resource management (CBNRM) (Kellert, Mehta, Ebbin, & Lichtenfeld, 2000). Characteristics of CBNRM include a commitment to involve the public in management of natural resources, devolution of power from central governments to local or indigenous people, a desire to link the objectives of socioeconomic development and environmental conservation or protection and a belief including traditional values and knowledge in managing resources (Kellert et al., 2000). Despite these characteristics and widespread use of participatory approaches, there is scepticism and debate over their merits. It has been suggested that some public participation leads to dilution of conservation schedules (Berkes, 2004), with some projects not performing as expected (Barrett, Brandon, Gibson, & Gjertsen, 2001; Kellert et al., 2000). Following the exploration of several examples, Kellert et al. (2000), reasoned that this is due to the dominance of socio-economic outcomes over biodiversity or environmental protection, stipulating that CBNRM rarely eventuated in reduced conflict, equal distribution of power and economic benefits, increased consideration of traditional environmental knowledge, protection of biodiversity or sustainable resource use. However, social and economic factors are becoming a measure of success and the use of more people-inclusive conservation initiatives is thought to be a reflection of the failure of exclusionary approaches (i.e. where public or community members are not involved) (Berkes, 2004).

2.4 The spectrum of participation

Public participation can take a range of forms and imply varied levels of participation, which can be described by many different terms (Beierle, 1999; Callon, 1999) as illustrated in Table 2.2. It is important to note that in the literature cited in the table, there is little consensus on the meaning of each term. This creates an underlying complexity when attempting to align an initiative against one of these terms. However, Clarke (2003) has attempted to define and differentiate some of the terms.

Table 2.2. Varying terms describing public participation in environmental initiatives

Term	Form of participation	Reference
Citizen Science	Science	Bonney et al. (2009), Conrad & Hilchey (2011), Silvertown (2009)
Participatory science	Science	Clarke (2003)
Community-based conservation	Science	Berkes (2004, 2007)
Participatory environmental monitoring	Science	Kinchy, Jalbert, & Lyons (2014)
Voluntary biological monitoring	Science	Lawrence (2006)
Community-based monitoring	Science	Conrad & Hilchey (2011)
Community-based natural resource management	Intermediate (i.e. has aspects of science and governance)	Brosius, Tsing, & Zerner (1998), Kellert et al. (2000), Stedman, Lee, Brasier, Weigle, & Higdon (2009)
Co-management	Governance	Armitage, Berkes, Dale, Kocho-Schellenberg, & Patton (2011), Armitage et al. (2009)
Integrated catchment management	Governance	(Warner, 2006)
Co-governance	Governance	Birnbaum (2016), Head & Ryan (2004)
Participatory governance	Governance	Fischer (2006), Fung & Wright (2003), Newig & Fritsch (2009)
Empowered Participatory Governance	Governance	Fung & Wright (2003)

The large number of terms illustrated in Table 2.2 indicates that there is a range of forms that public participation can take. These vary in the level of participation as well as the focus of participation, which can operate on a spectrum from science to governance. Each provides an opportunity to integrate different knowledge types. The science practices are likely to help build informed social opinions on the natural world through engaging with it (Figure 4.1), while the governance terms create foundations for an open platform in which different types of knowledge can be used to address environmental issues. These practices are not exclusionary or discrete, meaning that an initiative can integrate subsets of different practices. For example, community-based initiatives in the Ōpāwaho/Heathcote River catchment mix different practices together in their operation (i.e. they are a citizen science group as well as well as contributing to the management of freshwater resources in a governance sense).

Participatory governance is an intersection of governance, social science and political theory that emphasises democratic engagement, in particular through deliberative practices that seek to deepen citizen participation and engagement in governmental processes (Fischer, 2006; Fung & Wright,

2003; Newig & Fritsch, 2009). It is thought that Empowered Participatory Governance (EPG) is a more flexible and democratic way to address problems than other traditional forms of governance (Fischer, 2006). This term aligns with this research as it can be used across different fields of knowledge, includes a participatory component, and has direct linkages to governance initiatives or the endpoint of where knowledge can be used (i.e. decision making). EPG has also been employed with respect to the Canterbury Water Management Strategy (Jenkins, 2018). Fung and Wright (2003) have also identified a series of characteristics for EPG initiatives which have been used in this research (Chapter 4).

2.5 Co-production

A method that can be employed to integrate both governance and science characteristics is co-production. Co-production describes the active involvement of different resources or end users in an initiative or production process, as opposed to merely disseminating information to the public (Callon, 1999). Co-production provides an all-encompassing concept that can be used to broadly incorporate the different terms in Table 2.2, as well as the different bodies of knowledge required to address wicked problems. Callon (1999) describes the term as one of three types of public participation models (Table 2.3).

Table 2.3. Callon's (1999) three models of public participation

Model type	Description
Model 1 (public education)	Teaching the public about what scientists know
Model 2 (public debate)	Facilitating the public's questioning of scientists
Model 3 (co-production)	Redistributing of expertise through the collective investigation of problems

Co-production is also sometimes referred to as co-creation. Voorberg, Bekkers, and Tummers (2015) carried out a systematic review of 122 co-creation and co-production records (n= 95 co-production and n =27 co-creation). They determined that the two terms are used interchangeably and describes participation that is more specific and direct (Voorberg et al., 2015). They also stipulate that the terms are closely related to public participation and collaborative governance (Table 2.2). This thesis will refer to co-production to cover these concepts. The concept of co-production has emerged as a theme across several disciplines with the concept recently being recognised in a co-production special edition in *Nature* (Hickey, Richards, & Sheehy, 2018).

Co-production refers to direct engagement or interaction (i.e. face-to-face) of scientists and public in a pluralistic manner (Armitage et al., 2009; Callon, 1999). It is the bringing together of scientists, experts and concerned public to redistribute expertise and knowledge to collaboratively examine issues (Armitage et al., 2009; Callon, 1999; Landström et al., 2011; Polk, 2014; Vogel et al., 2016; Voorberg et al., 2015). Co-production is therefore a key mechanism of public participation of relevance for this research. Co-production embodies a paradigm shift that diverges from the standard practices of using only expert knowledge in environmental decision-making to a more holistic appreciation of different forms of knowledge (such as indigenous knowledge) (Berkes, 2004, 2009). The concept considers dynamic knowledge where different groups co-produce, validate and adapt knowledge for different issues and form an integrated understanding of a specific issue or problem (Figure 2.1) (Armitage et al., 2009; Berkes, 2009). The term fosters better relationships between parties involved (i.e. public, governments and experts). The concept also relies on developing trans-disciplinary solutions to environmental problems (Armitage et al., 2009; Polk, 2014, 2015).

The underlying premise of the co-production concept is to make science actionable, thus requiring a different approach to navigate sensitive or complex issues and produce understanding in a local context (Landström et al., 2011; Pohl et al., 2010). The use of the concept can result in beneficial outcomes. Firstly, co-production is thought to develop adaptive capacity through facilitating social learning (Armitage et al., 2011). Social learning is the result of collective reflection and deliberation when groups (or individuals) share ideas and experiences leading to the generation of solutions that can be used to resolve complex problems (Armitage et al., 2011; Diduck, Bankes, Clark, & Armitage, 2005). Adaptive capacity can be described as the adaptability of an individual or group to respond to disturbance or uncertain socio-ecological conditions such as wicked problems (Armitage et al., 2011). Social learning through co-production allows different types of knowledge's to be integrated, and meaningful solutions to be generated whilst improving the adaptive capacity of those involved in such a process. This can be referred to as multi-loop social learning where a single loop fixes smaller issues (like errors in a process) through to triple loop learning which may result in changes to governance or protocols (Diduck et al., 2005; Medema, Wals, & Adamowski, 2014). Moreover, co-production drives social learning in an ecological context when addressing complex problems (Dryzek, 1997). Therefore, co-production can be used to create more inclusive policy, which can involve crossing organisational and jurisdictional boundaries that often prevent such solutions being derived (Voorberg et al., 2015). These facets of social science theory are

important when considering public participation in addressing complex urban freshwater ecosystem health issues both immediately and in future scenarios. As environmental issues are complex and dynamic, a shift is required to develop problem-focused, systematic, and reflexive knowledge processes to address such issues (Raymond et al., 2010). Co-production has also been described as a way to address “wicked” problems as described in Section 2.3 (Vogel et al., 2016).

With a public dissatisfaction of policies and legislation, it becomes important for researchers and environmental management agencies to produce solutions that are beneficial and relevant to society. Co-production describes a contemporary mechanism of conducting locally meaningful and pragmatic science that can deliver benefits both to those directly involved as well as to involved as well as to society as a whole. These aspects of co-production can be linked to the problems faced in Christchurch and New Zealand regarding the management of urban freshwaters such as those that opened this thesis. This includes the concern about urban freshwater health, the dissatisfaction with the current management regimes, the increasing public awareness and concern for the degradation of freshwater environments, and the establishment of stream care groups wanting to improve freshwater health in urban areas. Figure 2.1 demonstrates a conceptual approach to co-production as an approach to making improvements in urban freshwater ecosystem health. This visualisation depicts how decision-making or governance structure can be informed by co-production. Furthermore, it highlights the underlying relationship between the health of an ecosystem and knowledge co-production. Practically, co-production acts as a mechanism to integrate community-based initiatives, expert knowledge and regulatory authorities (as well as other groups involved) encapsulated governance structure (such as collaborative governance). The versatility of co-production could play a key role in generating solutions for urban freshwater ecosystem health.

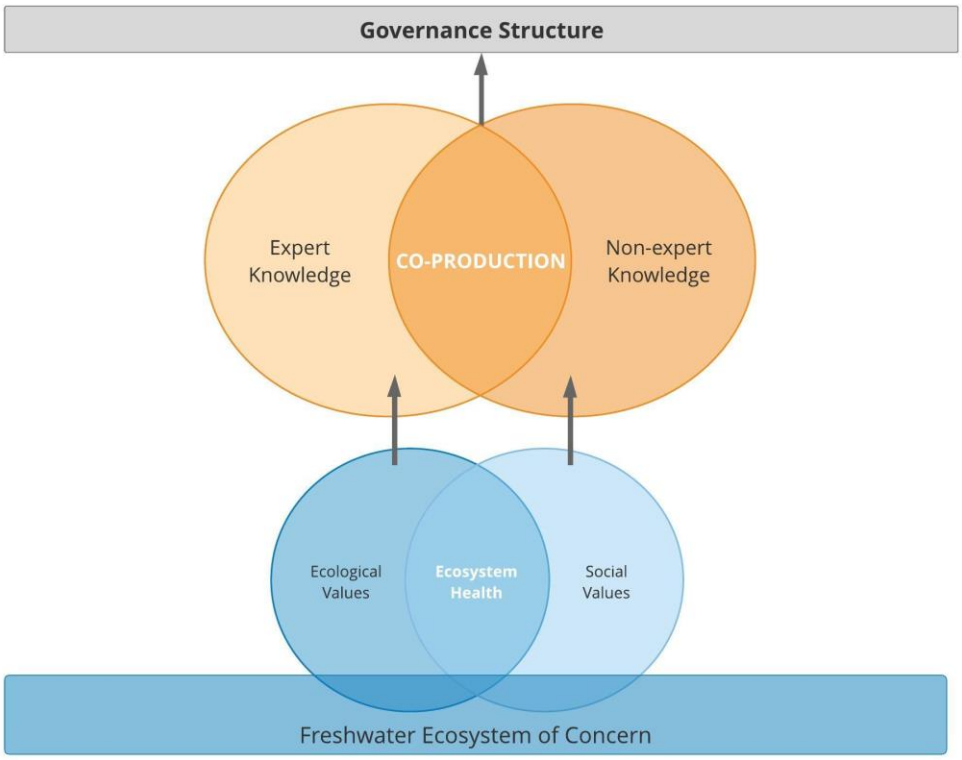


Figure 2.1. Conceptualisation of co-production and its relationship with ecosystem health, and an overarching governance structure.

2.5.1 Co-production in practice

The use of co-production is beginning to resonate through different science disciplines and other arenas such as public administration, science and technology, sustainability science and medical science (Hickey, Richards, & Sheehy, 2018; Miller & Wyborn, 2018; Pohl et al., 2010; Vogel et al., 2016; Voorberg et al., 2015). Exploring the public participation and environmental problem solving literature has yielded a variety of uses of co-production in environmental science initiatives (Table 2.4).

Table 2.4. Co-production uses in different environmental contexts and countries

Specific example	Location	Reference
Flood prevention	Pickering, United Kingdom	Landström et al. (2011), Lane et al. (2011)
Resource management and planning	Ontario, Canada	Davidson-Hunt & Michael O'Flaherty (2007)
Environmental contaminants	Canadian Artic, Canada	Berkes, Mathias, Kislalioglu, & Fast

		(2001)
Climate change	Canada United States	Berkes & Jolly (2002), Lemos & Morehouse (2005)
Biodiversity conservation	Canada and New Zealand	Berkes, Berkes, & Fast (2007), Berkes & Davidson-Hunt (2006), Moller, O'Blyver, et al. (2009)
Sustainable city development	Germany and Netherlands	Frantzeskaki & Kabisch (2016)
Environmental monitoring	Canada	Berkes et al. (2007)
Land and water governance	Not specified	Medema et al. (2014)
Coastal management	South Africa	Vogel et al. (2016)
Drinking water access	Africa	Adams & Boateng (2018)

An exemplary scenario of co-production is from Pickering in the United Kingdom (Table 2.4). Pickering faced flooding issues for many years with multiple events occurring between 1999 and 2007 (Landström et al., 2011; Lane et al., 2011; Whatmore & Landström, 2011). With several proposals for flood alleviation rejected due to unfavourable cost benefit ratios there was a need to find innovative solutions to address the flooding issues (Lane et al., 2011). A group of academics assembled a flood research group that included scientists, flood modellers, and lay public impacted by the flooding (Lane et al., 2011; Whatmore & Landström, 2011). This group co-produced solutions to the flooding issues with one solution subsequently implemented by the Environmental Agency (Department for Environment, Food & Rural Affairs [DEFRA], 2015). This example is further detailed as a case study in Chapter 5.

Co-production has also been used as mechanism to integrate both local and traditional indigenous knowledge (such as mātauranga Māori) into environmental decision-making (Armitage et al., 2009; Berkes, 2009; Davidson-Hunt & Michael O'Flaherty, 2007; Moller, Charleton, Knight, & Lyver, 2009; Moller, Kitson, & Downs, 2009; Moller, O'Blyver, et al., 2009). An example has been the use of co-production in the conservation the titi/sooty shearwaters (a seabird) in New Zealand. Mātauranga Māori differs from western science and is described as a process rather than content characterised by observation, storytelling and hands-on experience (Moller, Kitson, et al., 2009). Moller, Charleton, et al., (2009), Moller, Kitson, et al. (2009) and Moller, O'Blyver, et al. (2009) investigated the joining of mātauranga Māori and western science to improve the conservation of titi/sooty shearwater (a treasured mahinga kai (cultural harvest) species to Māori). Following a 14-year research project that included Māori kaitiaki and researchers, a series of guidelines were produced (Moller, O'Blyver, et al., 2009). Through this partnership, Māori contributed to developing science by suggesting research directions and hypotheses which made solutions

meaningful for the community. Other benefits from the project included scientists altering their perspectives on the inclusion of different knowledge types in generating solutions, and becoming less reliant on, and arrogant about, science being the only approach. Māori participants also appeared to alter their opinions on science. The integration and co-production of different types of knowledge were used to inform future conservation efforts for the titi/sooty shearwater, but can also be applied to wider contexts where different knowledge types are involved (Moller, O'Blyver, et al., 2009). Armitage et al. (2011) examined three case studies of co-production for various environmental issues in the Canadian Arctic alongside indigenous Inuit groups. The solutions derived from these cases of co-production are triggering both positive ecological and social outcomes (Armitage et al., 2011). The success of such examples in integrating indigenous knowledge and maximising both sets of knowledge to create solutions has ramifications in a New Zealand freshwater context as indigenous Māori are integral stakeholders of freshwater ecosystems (Section 1.2.2).

Co-production has several challenges that are summarised in Table 2.5. Some of these challenges were documented by Moller (Moller, O'Blyver, et al., 2009) and also Kellert et al. (2000) in Section 2.3. Challenges for co-production may be interlinked to drivers and barriers to public participation.

Table 2.5. Challenges associated with co-production approaches

Challenge	Description	Reference
1) Role of power	Participants involved may have different systems of understanding and practices (i.e. a regulatory authority decision maker compared to a community group member) giving rise to complex power relationships These power relationships between different participants need to recognised and accepted in an initiative	Armitage et al. (2011), Pohl et al. (2010)
2) Normative context of shared understanding	Desire to use co-production to achieve mutually agreed outcomes can be challenging. Especially with differing power relationships as different parties may desire alternating outcomes	Armitage et al. (2011), Pohl et al. (2010)
3) Capturing multiple framings of an issue	When working with different parties (i.e. experts and lay public), difficulties can arise in selecting the specific research issue and how to prioritise these	Polk (2015)
4) Identifying and integrating knowledge diversity	Determining how to integrate multiple knowledge types and systems of thought from different sources can be complex. It is important to assess how different types of knowledge may be integrated. This may	Armitage et al. (2011), Polk (2015)

	require a range of techniques such as generating a common pool of knowledge and shared understanding. Reflexivity of participants is critical to this (i.e. placing themselves in the context or viewpoint of another participant)	
5) Contributing to societal change and sustainability	Understanding how results of co-production processes can be used to influence societal change and sustainability where power and priorities dominate decision-making agendas	Pohl et al. (2010), Polk (2015)

The examples in Table 2.4 exemplify how different knowledge types can be brought together to co-produce solutions and knowledge to address complex or wicked problems in different contexts (i.e. flooding and species conservation). Parallels can be drawn from these examples to freshwater management in New Zealand, and in particular the Ōpāwaho/Heathcote River catchment, where the concerned public want to assist in improving freshwater health (Chapter 3 and Chapter 7). Therefore, the co-production approach is of interest as it may provide a platform to review the current practices involved in urban freshwater management in New Zealand. These insights and examples have promoted the idea of exploring how co-production can be used as an overarching theme to explore how community-based initiatives can facilitate the improvement of urban freshwater ecosystem health through potentially creating both positive social and ecological changes in response to wicked problems, despite the challenges listed in Table 2.5.

2.6 Conclusion

This chapter has illustrated the key relationships between natural systems or environments and human populations (society). It also reveals the relationships between expert, public and indigenous knowledge types. There is sufficient reason to view humans as part of a central ‘ecosystem’. Evidence demonstrates that the public should to be included when addressing complex or ‘wicked’ problems relating to environmental degradation. Several types of public participation exist, and evidence stipulates co-production is a valuable mechanism in addressing ecosystem health in freshwater systems. This supports the overarching thesis argument of exploring the role of social factors in informing urban freshwater management.

Chapter 3. Freshwater management in the study area: Ōpāwaho/Heathcote River catchment

This chapter presents the freshwater management regimes in New Zealand and outlines the relevant strategic and planning documents for this research. Following this, the chapter provides an in-depth description of Christchurch's freshwater history, the Ōpāwaho/Heathcote River catchment and the freshwater related issues today. Evidence of public concern and background to the existing community-based initiatives is presented alongside a more detailed description of the city's *Proposed Community Water Partnership*. The chapter concludes with the research positionality and the importance of reflexivity.

3.1 Freshwater management in New Zealand

The Resource Management Act (1991) (RMA) is the guiding legislation for managing the natural environment in New Zealand (MfE, 2015; Resource Management Act [RMA], 1991). The RMA aims to promote the sustainable management of the natural and physical resources. The RMA follows a hierarchal approach (Figure 3.1) with a range of authorities required to carry out different responsibilities. The RMA is currently being reformed (MfE, 2018). This may have implications for future freshwater management in New Zealand.

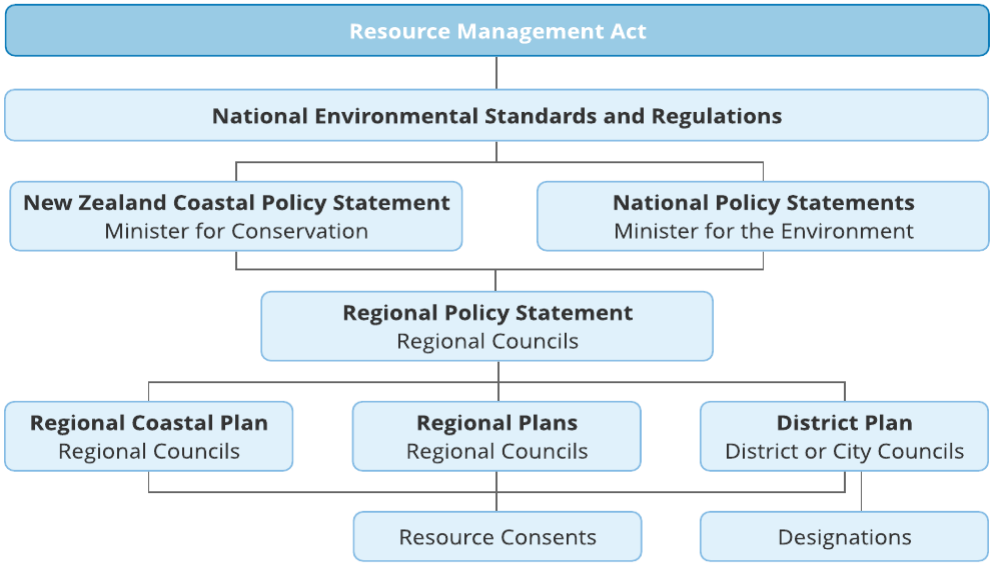


Figure 3.1. The hierarchal nature of the resource management process in New Zealand. (Adapted from Ministry for the Environment, 2015).

3.1.1 Central government

Under the RMA, central government is responsible for preparing national environmental standards and national policy statements (MfE, 2015). The most recent National Policy Statement (NPS) for Freshwater Management that was released in 2014, and then amended in 2017, contains provisions for ecosystem health (National Policy Statement for Freshwater Management [NPS-FM], 2014). The document is the second NPS following the RMA in 1991 and sets limits and targets for regional councils to meet on a variety of parameters by the end of 2025. The NPS sets "bottom lines" for two compulsory values, (i) ecosystem health and (ii) human health and recreation (NPS-FM, 2014). This means that eventually all rivers must meet or better or meet the prescribed bottom line for ecosystem health (Young et al., 2018). The provided definition of ecosystem health includes community and human values. The NPS is delivered in line with the National Objectives Framework, the first released since the RMA in 1991 (NPS-FM, 2014). Part of this includes set limits for some of the contaminants outlined as contributing to the USS (Walsh et al., 2005). The NPS acknowledges community and Māori values and interests (social, cultural, environmental and economic) (Harmsworth et al., 2016; NPS-FM, 2014). It is also suggested the document will act as foundation for the discussion about the desired state of freshwater (Harmsworth et al., 2016; NPS-FM, 2014). However, this has met criticism from some and does not meet the definition of ecosystem health as described in Chapter 1 (Joy, 2015, 2018). For example, these measures do not take into account components such as ecological function and integrity (Palmer & Febria, 2012), and use binary or discrete constants to derive a value for ecosystem health.

3.1.2 Regional and local councils

The RMA devolves much of its authority to regional and local councils (MfE, 2015; Woods & Howard-Williams, 2004). These authorities are responsible for managing the natural resources and the effects on the environment from a variety of land uses through a variety of mechanisms as shown in Figure 3.1. This is primarily managed through the processing of resource consents and enforcing compliance of consent conditions (MfE, 2015). In addition to the processing of resource consents, regional councils are responsible for monitoring water quality, while Territorial Authorities (city and district councils) are tasked with maintaining the stormwater and wastewater systems (MfE, 2015; RMA, 1991). For the context of this research, Christchurch City Council (CCC) as the Territorial Authority and Environment Canterbury (ECan) as the Regional Council are the regulatory authorities that carry out the listed roles in Christchurch.

Irrespective of the purpose of the RMA to 'remedy, mitigate or avoid adverse effects of development', freshwater ecosystems in New Zealand are in an ongoing state of decline (Gluckman, 2017). This decline is unlikely to be solely attributed to activities that took place prior to the implementation of the RMA in 1991, meaning impacts from activities from today are having impacts on freshwater systems. This questions the effectiveness of such management techniques and legislation to address these problems and prompts a critical analysis into other solutions. Despite an increasing understanding of the impacts of urbanisation on freshwater systems, legislation, strategies and targets, urban freshwater health is still a concern. Considering this, there is reason to warrant the exploration of alternative methods of urban freshwater management in an attempt to manage the multi-faceted impacts to urban freshwater systems.

3.1.3 Recognition of Māori values

Provisions for Māori values and customary practices are incorporated in contemporary management regimes (Harmsworth et al., 2016; Memon & Kirk, 2012; NPS-FM, 2014; RMA, 1991). Te Rūnanga o Ngāi Tahu, the predominant iwi of the South Island, representing five primary hapu, has a freshwater policy and several working groups for freshwater management (Te Rūnanga o Ngāi Tahu, 2015). This policy includes the desired outcomes of freshwater management in Ngāi Tahu rohe (territory/boundaries) and the means of how Ngāi Tahu seek to work with resource management agencies to achieve these outcomes (Te Rūnanga o Ngāi Tahu, 2015). The importance of freshwater to Ngāi Tahu has been exemplified through the media covering the recent change in Government and their approach to governing freshwater with Māori (Young, 2018).

3.1.4 Strategic and planning documents in Christchurch

In a local Christchurch context, there are a range of documents of relevance to the management of urban waterways (Table 3.1). Some of these documents are required under the RMA structure. The Canterbury Water Management Strategy (CWMS) is one document that is relevant to this research (ECan, 2009). Under the CWMS the Canterbury region is split up into various zones, including one for the Christchurch city area. Each zone has a leadership group, known as the Zone Committee (ZC), that assist with decision making around water resources for that zone. The ZC contains members of the public among other stakeholders, including ECan councillors. ZCs are a way members of the public can express their thoughts on freshwater management in Canterbury. The existence of these documents exemplifies that there is strategic and institutional support for

addressing urban freshwater issues, ecosystem health and including communities in freshwater management scenarios in Christchurch.

Table 3.1. Planning and strategic provisions relevant to freshwater management in Christchurch (Adapted from C. Appleton, pers. comm., 2017)

Priorities and outcomes	**Specific provisions**
Christchurch City Council priorities	Safe and sustainable water supply and improved waterways Enabling active citizenship and connected communities
Christchurch City Council Community Outcomes – Healthy Environment	High quality drinking water Unique landscapes and indigenous biodiversity are valued Sustainable use of resources
Documents, plans, strategies	**Document names or specific provisions**
Christchurch City Council Strategic documents	Waterways and Wetlands Natural Asset Management Strategy (1999) Christchurch City Council Surface Water Strategy 2009 -2039 Christchurch City Council Water Supply Strategy 2009 Christchurch City Council Waste Water Strategy 2013 Waterways and Wetlands Drainage Guide - Part A and Part B (2003) Stormwater management plans for key rivers (Halswell, Avon, Styx, and Heathcote Catchments) Christchurch City Council Infrastructure Strategy 2015 -2024 (Part 5) Draft Christchurch City Council Integrated Water Strategy
Environment Canterbury Land and Water Regional Plan	Water quality standards that need to be met by 2025 (both urban and rural)
Canterbury Water Management Strategy	Target 1 - Ecosystem health and biodiversity Target 3 - Kaitiakitanga Target 4 - Drinking water Target 5 – Recreational and amenity opportunities
Resilient Greater Christchurch Plan	Goal 2 - Support community organisations and leaders Goal 3 – Sustain the vitality of our natural environment
Greater Christchurch Urban Development Strategy	Goal that focuses on enhancing natural environments
Mahaanui Iwi Management Plan 2013	Provides for the importance of water to Māori cultural well-being and tangata whenua (Objective 1)
Other	**Details**

Department of Conservation, Ministry for the Environment and Ministry of Education	Various education and sustainability programmes and goals including Collaborative Community Education Model (CCEM) and Environmental Education for Sustainability (EEFS)

3.2 The hydro-social history of water in Christchurch

There are four main rivers that sit within Ōtautahi/Christchurch's city boundaries, two of which rise and discharge entirely within the city limits. The Otākaro/Avon River flows through the city centre, whilst the Ōpāwaho/Heathcote River is towards the south of the city (Watts, 2011) (Figure 1.4). Both rivers share similar characteristics, being spring fed systems that are integrated with several tributaries to form the interconnected network known as the Waimakariri River delta. However, their geomorphological and geographical characteristics differ with the Ōpāwaho/Heathcote River fed by hill tributaries resulting varying water quality and habitat issues, such as increased sedimentation (CCC, 2003a, 2003b).

Christchurch has a rich hydro-social history with freshwater systems (Pawson, 2000; Watts, 2011; Wilson, 1989). The pre-human landscape was characterised by widespread swamp and wetlands (Figure 3.2) (Wilson, 1989). Prior to the arrival of European settlers, indigenous Māori sustainably used these natural environments, as the waterscape provided for a range of customary practices including mahinga kai (Pawson 2000; Watts, 2011). European settlers arrived to a plentiful supply of artesian water and several waterways that could be used for civic amenities including transport and drainage (Watts, 2011; Wilson, 1989). In 1875 the Christchurch Drainage Board (the Drainage Board) was established primarily in response to waterborne diseases, high groundwater levels and flooding (Wilson, 1989). The Drainage Board was tasked with land drainage procedures and the management of wastewater. The Drainage Board continued to operate for over 100 years, in which time natural waterways were converted to open drains and were deepened to remove water as efficiently as possible (Watts, 2011; Wilson, 1989).

At that time, little consideration was given to ecological, hydrological or amenity values, with the primary concern being flooding and human health. A key example in the Ōpāwaho/Heathcote River catchment is the Woolston Cut which was commissioned by the Drainage Board in 1986 and resulted in a cut that allowed the river flow to bypass the natural meander of the Ōpāwaho/Heathcote River in an attempt to reduce flooding of low lying properties (Wilson, 1989; Watts, 2011). However, this also led to an increased incursion of tidal flow (and thus salinity) to previously freshwater environments, resulting in the death of riverside planting and subsequent

increased bank erosion (Watts, 2011). In time the Woolston Cut was viewed as an environmental disaster. There was an increase in public concern for the management of waterways and a move to consider more natural approaches to flood management (Watts, 2011).

During the 1900s, industries within the Ōpāwaho/Heathcote catchment totalled one quarter of New Zealand's manufacturing industry (Taylor & McMurtrie, 2003). Such industries included tanneries, wool scours, metal works and a battery manufacture, among others, that discharged their waste products directly into the river in the lower Woolston reaches. The construction of sewer systems by the Drainage Board in the late 1970s resulted in industry discharges diminishing as they were directed into these systems. This shifted focus onto stormwater inputs, similar to those today (Section 3.3) (Taylor & McMurtrie, 2003). Some industries are still present today including those in Hayton's Drain in the upper part of the catchment but are better regulated through the RMA (Moores, Gadd, Wech & Flanagan, 2009).

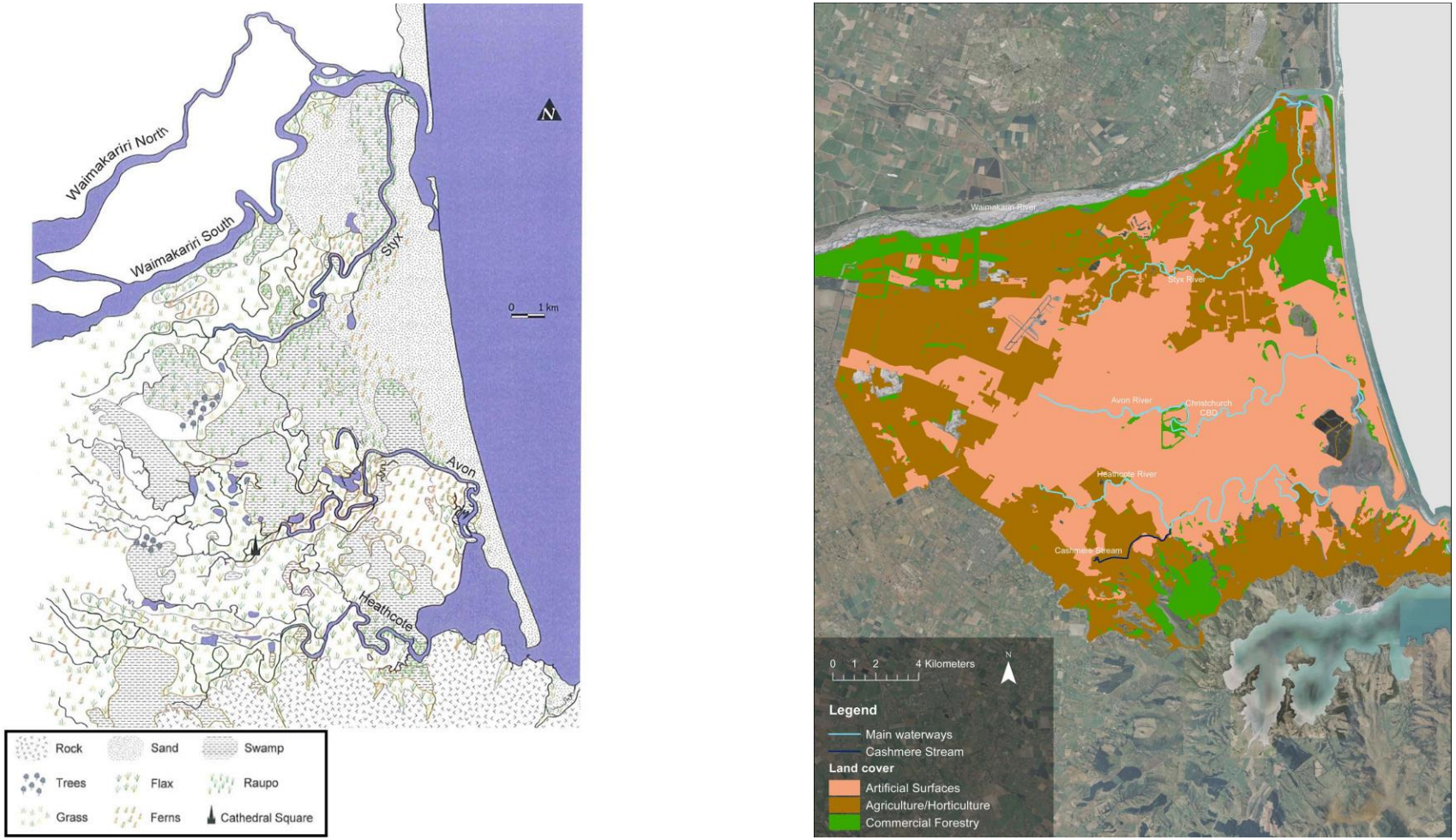


Figure 3.2. Left: The natural waterscape of Christchurch in 1856 depicting primarily swamp-land. Image compiled from the original black maps (Source: CCC, 2003b). **Right:** The different types of land uses in modern Christchurch, including artificial surfaces shown in orange. (Data sources: Christchurch City Waterways Layer, 2015, Christchurch City Council; Land Cover Data Base version 4.1, 2015, LRIS; Christchurch Aerial Imagery 2015, Land Information New Zealand. Retrieved from EOS Ecology database, Christchurch, New Zealand).

In 1989, the Drainage Board was amalgamated with CCC under local government reform (Couling et al., 2005; Watts, 2011; Wilson, 1989). Following the decommissioning of the Drainage Board, a paradigm shift in freshwater management occurred (Couling et al., 2005). This resulted in the creation of the *Waterways, Wetlands and Drainage Guide* in 2003, which superseded the *Christchurch Drainage Board Design Manual* (CDBDM) of 1986 (Couling et al., 2005). Where the prescriptive CDBDM had failed, this document established a philosophy that encouraged managers and designers to work with natural features and processes in the landscape (Couling et al., 2005). This document enabled Christchurch to become a leader in waterway restoration and practise more integrated living with nature through embodying a multi-faceted approach to freshwater management (Couling et al., 2005). The guide set out six core values for managing freshwaters in Christchurch in contrast to just drainage (Table 3.2). These values have been reiterated in more recent management approaches. One example is the Land Drainage Recovery Programme (LDRP) which was set up in 2012 following the 2010/2011 earthquake events to rectify heightened flooding and drainage issues as a result of geomorphological and infrastructure damages (CCC, n.d.). However, it is important to note that the mandate of the LDRP is predominantly focused on resorting drainage capacity and function (CCC, n.d.).

Table 3.2. Core values of the Waterways, Wetlands and Drainage guide (Adapted from CCC, 2003a)

Values	**Description**
Ecology	The self-sustaining processes and inter-relationships among plants, animals and insects
Landscape	Includes the special character of sites and places, their aesthetic qualities and their meaning to society
Recreation	Includes active and passive recreation, and the structures that support these activities
Heritage	Includes sites and activities of historical significance (e.g. structures and remains) and natural significance (e.g. remnants and landforms)
Culture	The community's perception of a resource and its values, indicated by community involvement in management, celebration of past events, and planning for the future
Drainage	Includes inter-relationships between groundwater and surface water, natural flow regimes, and management of storm events

The rich history between people and freshwater ecosystems in Christchurch signifies the importance of considering local communities in future management approaches. Furthermore, paradigm shifts in Christchurch freshwater management towards the consideration of multiple

values support the exploration of multi-faceted approaches to urban freshwater management, such as using community-based initiatives.

3.3 Issues in Christchurch urban waterways

The impacts of urbanisation on ecological integrity are intricate and include physical, biogeochemical and biological aspects (Figure 1.1) (CCC, 2003b; Harding et al., 2016; Paul & Meyer, 2001; Violin et al., 2011; Walsh et al., 2005). These impairments stretch beyond the subset of water quality parameters and work collectively to create the USS (Walsh et al., 2005). Other factors include alterations to flow regime (e.g. flashier floods and lower base flows) (Paul & Meyer, 2001), channelisation resulting in a reduction in habitat heterogeneity (CCC, 2003b; Malmqvist & Rundle, 2002), changes to riparian zone and catchment (Walsh, Waller, Gehling, & Nally, 2007), habitat fragmentation and in-stream modifications (such as the installation of a culvert) that create barriers for migrating biota (CCC, 2003b). More recently, the effects of artificial lighting have also been considered to impact aquatic fauna (Pawson & Bader, 2014; Perkin, Hölker, Tockner, & Richardson, 2014). Urbanisation also leads to the introduction of contaminants that have adverse impacts on water quality and aquatic biodiversity. These include increased sediment loading, chemical contaminants (CCC, 2003b), and potentially micro plastics (Wagner et al., 2014). Such factors work in tandem leading to the suppression of biological diversity in these systems, leaving only the most tolerant taxa (CCC, 2003b; Walsh et al., 2005). A reduction of biodiversity can impair the function of ecosystems and ultimately compromise the services and values they provide (Section 2.1.1) (Meyer et al., 2005).

Given that there are many factors that contribute to the USS, addressing only one factor (such as improving water quality, or removing sediment) will not necessarily improve the overall state or ecological integrity of a system if other limiting factors remain. This is implicitly shown in Figure 1.1. Therefore addressing ecological health issues, such as the USS, requires a multi-faceted approach.

This research primarily focuses on water quality factors because in Christchurch most attention has been given to stormwater (C. Appleton, pers. comm., 2017; CCC, 2016a). As outlined in Section 3.2, industry was prominent in the Ōpāwaho/Heathcote River catchment resulting in adverse ecological impacts due to degraded water quality (Cameron, 1970; Taylor & McMurtrie, 2003).

With the introduction of the RMA in 1991 many of these industry impacts were better managed, meaning efforts shifted to consider stormwater inputs (Taylor & McMurtrie, 2003).

The following are key issues of concern for Christchurch (CCC, 2003b, 2016a, 2018).

- Sedimentation. Increased sedimentation can have multiple effects on the ecology of the receiving environment including smothering food resources at the bed of the stream and clogging the gills of fish and invertebrates. Figure 3.3 shows sediment in the Ōpāwaho /Heathcote River. The low gradient of Christchurch waterways and the geological characteristics (e.g. highly unstable loess sediments) of the Port Hills soils make sedimentation of the Ōpāwaho/Heathcote River a key issue.
- Heavy metals and hydrocarbons. Zinc, copper and lead are commonly found in freshwater environments from various sources (as described below). These metals cause chronic and toxic effects to both fish and invertebrates (Beasley & Kneale, 2002). Metals can also attach to the sediments that enter waterways. Chronic and toxic effects to aquatic life can also occur from polynuclear aromatic hydrocarbons (PAHs) (Beasley & Kneale, 2002).
- Increased nutrients and bacteria (e.g. Escherichia coli). Elevated nutrient levels in these systems can lead to an increase of nuisance weed growth with subsequent diurnal reductions in dissolved oxygen, and related disturbance from regular removal for flood management (Greer, 2014; McDowell et al., 2009).

These contaminants originate from several sources including public, commercial and private properties. Sediment can be derived from a variety of sources including land clearance and development, eroding stream banks, riparian vegetation removal, and erosion of deforested catchments (especially hill catchments like areas of the Port Hills), and can enter waterways through the stormwater network if a network is present (CCC, 2003b). Heavy metal contaminants often originate from vehicle components (Beasley & Kneale, 2002), air conditioning cooling waters (O'Sullivan, Wicke, & Cochrane, 2012) and roof cladding (Adrian, Butler, Imao, Marwick, & Pienisch, 2015; Bielmyer, Arnold, Tomasso, Isely, & Klaine, 2012) where they can accumulate on road surfaces or car parks (Adrian et al., 2015; Wicke, Cochrane, & O'sullivan, 2012). Chemical pollutants can come from industry practices (combustion) or oil spills (i.e. ill-functioning vehicle engines) as well as old roading materials (Beasley & Kneale, 2002; CCC, 2003b). These also accumulate on surfaces and are then washed into waterways via the stormwater network. Nutrients

and bacteria can contaminate waterways from the faecal matter of domestic and non-domestic animals such as waterfowl as well as septic systems (Groffman, Law, Belt, Band, & Fisher, 2004; Moriarty et al., 2011). Fertilisers are also thought to contribute to nutrient loading (Law, Band, & Grove, 2004).

Increases in impervious surfaces in urban catchments results in a hyper-connectivity between catchment land use and aquatic systems (Figure 3.2) (Violin et al., 2011; Walsh et al., 2005). This means that direct run off can enter the stormwater network untreated. This network of pipes then discharges directly into rivers, untreated. Stormwater treatment systems have been used in an attempt to mitigate the adverse effects caused from stormwater contaminants entering waterways (CCC, 2016a; Harding et al., 2016). However, this only often occurs in modern developments as opposed to older developments (CCC, 2016a; C. Appleton, pers. comm., 2017; Harding et al., 2016). This places an onus on individual, group and industry actions when addressing the impacts of stormwater contaminants; hence the focus of stormwater in Christchurch (C. Appleton, pers. comm., 2017).

Figure 3.3. The Ōpāwaho/Heathcote River during a more stable and low flow period (left), compared to sediment-laden state following a high rainfall event (right). (Source: Will Keay, January 2019 and August 2018).

3.4 Public interest and concern in Christchurch

Christchurch was impacted by a destructive earthquake sequence in 2010-2011. These events resulted in significant changes to freshwater systems, including river valley elevation and changes to the estuary into which both of Christchurch's key rivers (Ōtākaro/Avon and Ōpāwaho/Heathcote)

drain (Zeldis, Skilton, South, & Schiel, 2011). Liquefaction, subsidence, flooding and damage to private properties were widespread in the city following this event. The *"Share An Idea"* campaign was run by the Christchurch City Council following the earthquakes to gain an understanding of what people wanted in a rebuilt city (CCC, 2011). Themes from the campaign included rebuilding the city with more green space and better environmental outcomes/management including for freshwater systems (CCC, 2011).

Specific surveys have also been undertaken in Christchurch to gauge public concern around environmental issues. In 2007 a survey was conducted to gain the perceptions on Christchurch's waterways (C. Appleton, pers. comm., 2017). Fifty-six percent of respondents thought rivers and streams in the city were not healthy with many attributing 'visual' factors to the main cause of these patterns. In addition, 51 of 289 (18%) participants outlined that all residents are responsible for improving the quality of water in waterways (C. Appleton, pers. comm., 2017). The results of a 2017 CCC waterways survey showed that when compared to other social issues (housing, health, education and transport) waterways were ranked second behind health (CCC, 2018b). In addition, around 60% of people rated Christchurch waterway condition as 'poor' or 'terrible' (CCC, 2018b). A large number of survey respondents believed that they could influence change in environmental systems and that community environmental care groups have the biggest impact on change (CCC, 2018b). These findings were reinforced by another CCC survey that was conducted in August 2018, where residents were asked to reflect on life in Christchurch with regard to the natural environments of the city (CCC, 2018c). Seventy-six and 57% of respondents thought surface waters and riverbanks were the poorest condition environments in Christchurch, respectively (CCC, 2018c).

Although these documented examples indicate that there is an interest in a better ethic of care for urban environments within Christchurch, they may contain a degree of error because of the survey method employed. Completion of the survey is subject to the knowledge level of the respondent and their understanding of freshwater (or environmental) problems. Overall they reveal the broader public concern for the natural environment and urban freshwater systems.

3.5 Ōpāwaho/Heathcote River community-based initiatives

Christchurch has a range of groups interested in freshwater (C. Appleton, pers. comm., 2017). Two key community-based initiatives in the Ōpāwaho/Heathcote River catchment are the Cashmere Stream Care Group (CSCG) and the Ōpāwaho/Heathcote River Network (OHRN) (CCC, 2016a;

Ōpāwaho/Heathcote River Network, 2016; Cashmere Stream Care Group, 2018a; McMurtrie & James, 2013). The CSCG is primarily concerned about the health of the Cashmere Stream (a tributary of the Ōpāwaho/Heathcote River). The OHRN acts as an "umbrella" organisation connecting all the individual groups to enable an integrated approach to community-based activities in the catchment (Figure 3.4). In this way, the OHRN gives a centralised voice for other groups.

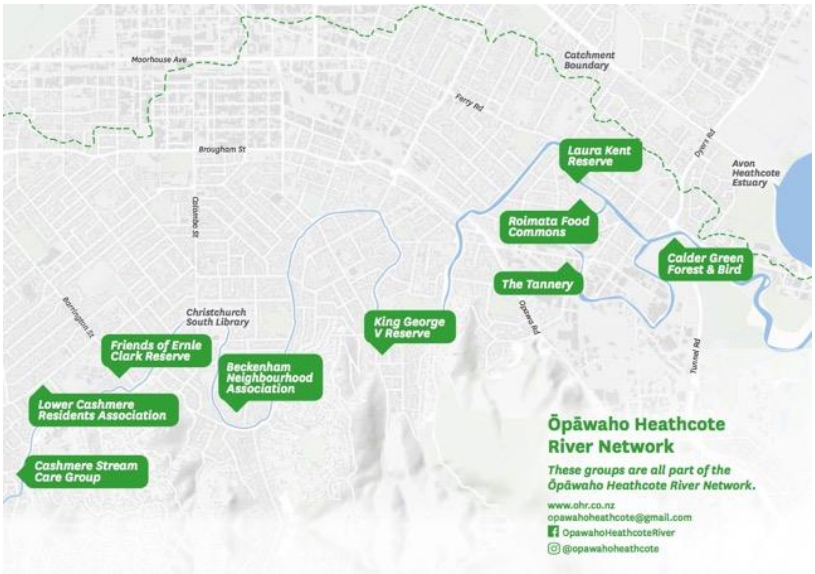


Figure 3.4. The spatial arrangement of the groups that make up the Ōpāwaho Heathcote River Network, including the Cashmere Stream Care Group. (Source: A. Hasselman pers. comm., 2019).

Figure 3.5 shows how the OHRN place themselves in the context of urban freshwater management and decision-making framework. This is known by the network as the '*Oreo model'* where the network are the 'cream filling' between the community groups (the groups listed in Figure 3.4 including CSCG) and governance/regulatory authorities (CCC, ECan and the Zone Committees).

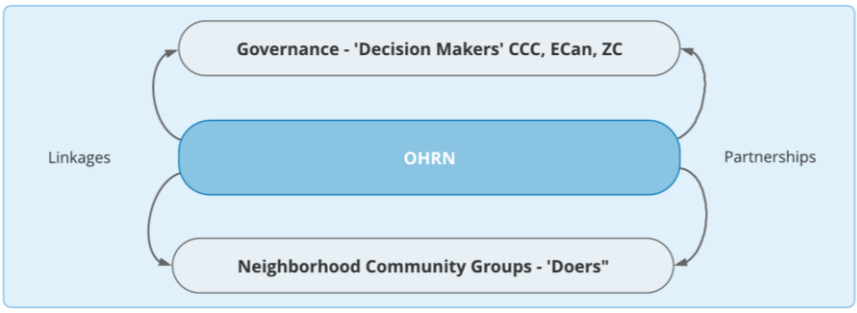


Figure 3.5. The Ōpāwaho Heathcote River Network 'Oreo model' to collaborative governance. The network is connected to neighbourhood community groups (Figure 3.4) and governance groups (CCC, ECan and Zone Committees) by partnerships and linkages. (Adapted from A. Hasselman pers. comm., 2019).

The committee of the CSCG has around 8-10 members who are primarily local residents and are often retired (or do not have full time employment). The OHRN has a committee with the same number of people that includes representatives from some of the different groups shown in Figure 3.4. Some committee members have worked as either scientists or for regulatory authorities but have since retired, thus bringing relevant experience to the group. Committee members undertake most of the work and lead activities, or projects, that the groups run (Chapter 7). These groups have visions that are grounded in ecological health (Table 3.3) and are undertaking initiatives that attempt to create change in and around the river and its catchment, including societal interactions with the river.

Table 3.3. Ōpāwaho/Heathcote River catchment community-based initiatives and their visions/goals (Source: Cashmere Stream Care Group, 2018a; Ōpāwaho Heathcote River Network, 2016)

Group	Purpose/Vision	Catchment
Cashmere Stream Care Group	To protect and enhance the health of the Cashmere Stream and its catchment	Ōpāwaho/Heathcote
Ōpāwaho Heathcote River Network	*Vision:* An ecologically healthy river that people take pride in, enjoy, and care for *Purpose:* To facilitate a collaborative network which advocates for the regeneration of the whole of Ōpāwaho/Heathcote River	Ōpāwaho/Heathcote

In addition to the groups outlined above there are other initiatives or programmes that have been implemented to engage and educate people with the river. This includes Whaka Inaka (EOS Ecology, 2015, 2016a, 2016b, 2016c) a programme designed to improve inanga/whitebait spawning along the Ōpāwaho/Heathcote River through engaging and educating community, and school children about their local river and the inanga/whitebait life cycle. Whaka Inaka is used as a case study in this research (Chapter 5). Local business owner Alasdair Cassells has put forward $400, 000 towards cleaning up the river near the Woolston Tannery (Napier, 2014). The “Mother of All Clean Ups” also takes place annually in the catchment to remove rubbish and litter with over 700 people attending in 2018 (Guildford, 2018). Council driven initiatives have also been undertaken since 2000 largely focused on education and awareness (C. Appleton, pers. comm., 2017).

3.5.1 The Proposed Community Water Partnership

Recently, a Community Water Partnership (CWP) has been developed in Christchurch. This captures the public concerns and aligns with many of the goals and objectives of the various strategies and plans outlined above. In 2016, a joint workshop with ECan, CCC, and University of Canterbury staff, was held with community to discuss the state of urban waterways and how solutions could be derived (C. Appleton, pers. comm., 2017). A key outcome was the need for both local and regional councils to engage with communities about urban freshwater resources. This requires a well-refined community education and engagement programme (C. Appleton, pers. comm., 2017). Following the workshop, a document titled the "Proposed Community Water Partnership Initiative Business Case" was produced with a series of outcomes (Table 3.4). In essence, the document aims to bring together and empower communities to value Christchurch's waterways (C. Appleton, pers. comm., 2017).

Table 3.4. Outcomes of the Community Water Partnership (CWP) (Source: C. Appleton, pers. comm., 2017)

Outcome	Detail
1	Through this programme "working together to improve waterways", communities and leaders are empowered to sustain the vitality of our natural environment (Resilience Greater Christchurch Plan), to value water resources
2	Honour the water strategy in the Te Hononga Agreement
3	A well informed community that supports strategic partners with making important decisions with respect to: • Long Term Plan funding for implementation of water services and infrastructure; • Key legislative changes to District Plan and Regional Plans to restrict use of materials that are sources of heavy metals that ends up in the stormwater
4	The programme is delivering on a wide range of Council strategic/plan outcomes (such as those listed in Table 3.1)
5	Effective working relationship between strategic partners to deal with issues around the city's water resources
6	Greater number of people involved in water education and project events over successive years
7	Surveys undertaken over successive years, show people involved with waterway events and the general public have a greater level of understanding about the positive difference they can make to improve our waterways and better manage water resources
8	Council's Strategic Priorities – Safe and sustainable water supply and improved waterways, and enabling active citizenship and connected communities being realised

9	Along with legislative changes, increasing number of people helping to stop contaminants at source so that they do not enter stormwater. This results in less demand for stormwater treatment infrastructure. Examples would be minimising the use of copper cladding on buildings and protecting it so it does not leach. Diverting roof water to private rain tanks or rain gardens
10	Reduction in the per capita abstraction of water for potable water use over time

The outcomes of the CWP, as shown in Table 3.4, include working and engaging with strategic partners (CCC, ECan, Ngāi Tahu, the Christchurch West Melton and Banks Peninsula Zone Committee's (ZC)) as well as schools and community stream care groups (C. Appleton, pers. comm., 2017). The document outlines funding and resources will be provided. The CWP did not receive funding through the CCC long-term planning process in 2018. However, there is still interest from the partners listed above in the CWP, with ideas of creating a charter and education programme being mooted. This has resulted in additional workshops, funding applications and discussions among those involved.

The CWP forms a critical component of this research and is discussed in Chapter 7. It provides a working framework to explore how community-based initiatives can be used to improve ecological health in urban freshwater ecosystems. It is important to reflect on the current initiatives happening on the ground in Christchurch of which the CWP is one. This may act as a potential mechanism to move forward in addressing urban freshwater issues using co-production as an operational theme for facilitating public participation.

3.6 Research positionality and reflexivity

Several factors have influenced this research project. It is important to identify the influence of the factors that lead to the development of a research project and where the researcher is placed in the context of the research (Waitt, 2016). Waitt (2016) notes that it is beneficial for the researcher to state their initial ideas on the topic. This ensures that the audience can gain an appreciation of the lens through which the researcher is exploring the topic. It also allows the reader to understand how, and why, the research has developed in a specified direction and the reasons behind the selected methodology.

The context of the research is my embodied knowledge generated from living and recreating in the Ōpāwaho/Heathcote River catchment. I also participated in community-based initiative meetings and events. These experiences mean I regularly engage with the river, am exposed to the issues first

hand and gain a perspective of the concerns of the community-based initiatives. This investigation interests me as scientists seek to find innovative solutions to freshwater-related problems. Through my studies, I completed courses in a variety of disciplines including ecology, resource management and a problem based learning task. In my fourth year, I completed an internship at the environmental consultancy, EOS Ecology. These experiences equipped me with a unique "tool belt" of differing knowledge forms. Having an appreciation of the Ōpāwaho/Heathcote River catchment and its issues, I saw an opportunity to apply this knowledge in an attempt to provide potential solutions to the issues in this catchment. The Human Ethics Application process required me to think about any conflicts of interest. As I work part time at EOS Ecology, I made it clear to each interview participant that I worked there prior to starting the interview.

This research was driven by my initial thoughts that there was little being done to protect or improve urban freshwater ecosystems in Christchurch. I had the impression that very few people were interested in the health of these systems and that this was perhaps due to having insufficient knowledge of the factors and interactions that made up this topic. Therefore, I felt I was suitably equipped to investigate this issue and help provide possible solutions for improving freshwater ecosystem health from in an inter-disciplinary manner.

Reflecting on the process of the research is a key principle when undertaking qualitative research. Reflection is important as it takes into consideration the position of the researcher and their assumptions at the beginning of the research process. Reflecting throughout the research process allowed for a thorough understanding of the findings derived and how they can be most effectively used to answer the overarching question of this thesis. Reflection allows the researcher to adapt their research to ensure they select the most appropriate course of action to address research aims. Popa, Guillermin, and Dedeurwaerdere (2015) argue that reflexive research methods are important in addressing complex environmental issues and makes reference to the use of co-production. Social science research cannot be forced into a linear and dichotomous structure as it aims to gain an appreciation of the interface between the natural, social and theoretical arenas. Therefore, some fluidity in the selected methods is required in order to adapt to the research methodology.

3.7 Conclusion

The RMA has provisions for freshwater management. Christchurch-specific strategic and planning evidence exists to support community-based initiatives in improving urban freshwater ecosystem health alongside a need to consider ecological values. Christchurch has a detailed history of freshwater issues that have changed over time, with a current focus on addressing issues 'at their source' and shifting towards a more holistic view of freshwater ecosystems with multiple values' with strategic backing. It is clear that there is a large public interest that reinforces the need for alternative approaches for addressing urban freshwater issues. This interest is more widely reflected in the establishment and operation of Ōpāwaho/Heathcote River catchment community-based initiatives. The proposed CWP provides for the inclusion of community-based initiatives and may have important implications for future freshwater management in Christchurch. The CWP appears to be the first attempt at implementing the aforementioned strategic goals (Table 3.1). These insights provide validation to further explore Ōpāwaho/Heathcote River catchment community-based initiatives and the potential role they may play in informing urban freshwater management in Christchurch.

Chapter 4. Methodology

This chapter explains the methodology used to generate insights to the listed research questions. It then describes the particular methods used including an analysis of published case study comparison and semi-structured interviews conducted with those in Christchurch. A comparative model was created to analyse each specific case study and the results presented. Finally, the chapter illustrates the use of semi-structured interviews to obtain local insights to support research findings from the case study examples. The processes used to analyse both sets of results are also discussed.

4.1 Case study methodology

A significant body of theory and practice supports public participation in environmental problem solving as demonstrated in Chapter 2. However, there are limited documented examples of where this has occurred in New Zealand, warranting the need to explore public participation processes using relevant examples.

A case study analysis was selected as an overarching methodology for deriving answers to the research questions. Case study research can be described as a concentrated study of a small number of discrete instances to gain a greater appreciation of a larger phenomenon (Gerring, 2007; Baxter 2016; Taylor, 2016). Case studies can also assist in identifying and understanding the contextual influences on a phenomenon. There are several examples of what sort of phenomenon can be researched, including events, places or processes, making it appropriate to investigate public participation in environmental management. Herbert (2010) suggests that the case study approach allows similarities and differences to be derived from different examples. The case study methodology was chosen based on the argument presented by Baxter (2016) that a deeper understanding of a phenomenon can be sought through the exploration of individual examples. These insights can then be used to address more complex problems. This methodology is well suited to this research as specific examples can be used to support existing theoretical concepts and aid in the development new explanatory concepts that may arise during this process. A series of individual examples were explored to further develop the existing knowledge of public participation in environmental problem solving.

Case study research can be informed by two key approaches, idiographic and nomothetic. Idiographic refers to a more intensive research of particular examples to gain a greater

understanding of the phenomena while nomothetic is a more extensive approach that aims to investigate a series of features across a range of scenarios (Baxter, 2016). This research primarily follows an idiographic trend as it aims to develop an in-depth understanding of participation in environmental problem solving. However, to derive solutions, case studies in conjunction with interviews were used to provide a suitable representation of the patterns expressed in a real world setting, therefore giving some nomothetic attributes. This multi-faceted research approach allows for a more comprehensive understanding of the existing theory and its application for addressing environmental issues. Such an approach allows for answers to be derived from observations from the social world, the natural world and from theory (Figure 4.1).

The transferable nature of a case study methodology (Baxter 2016; Taylor, 2016), allows for the findings of this process to be transferred into an urban freshwater ecosystem health context, despite being conceived within different environmental problem solving scenarios. To reciprocate, using a case study strategy may also allow for the wider results of this research to be applied to different environmental contexts (e.g. public participation around sea level rise impacts). Figure 4.1 depicts the transcending nature of the different areas in which environmental problem solving is located (i.e. social participation in managing natural systems). This figure builds upon the foundations of Figure 1.2 as it displays an ecosystem in which a social and natural unit exist. This figure exemplifies how the process of learning from case studies can take place. Inductive processes are often used in qualitative research to gain an understanding of empirical observations and place them in a theoretical context (Baxter, 2016). However, deduction plays an important role in this inquiry thus giving the case study methodology a cyclic type approach. This allows the integration of theory and practice to be viewed with a holistic lens. This is a critical factor as when placed in an urban freshwater ecosystem health context there is a need to learn from both worlds (theory, social), where social behaviour is inherently based on perceptions of the natural world (Figure 4.1).

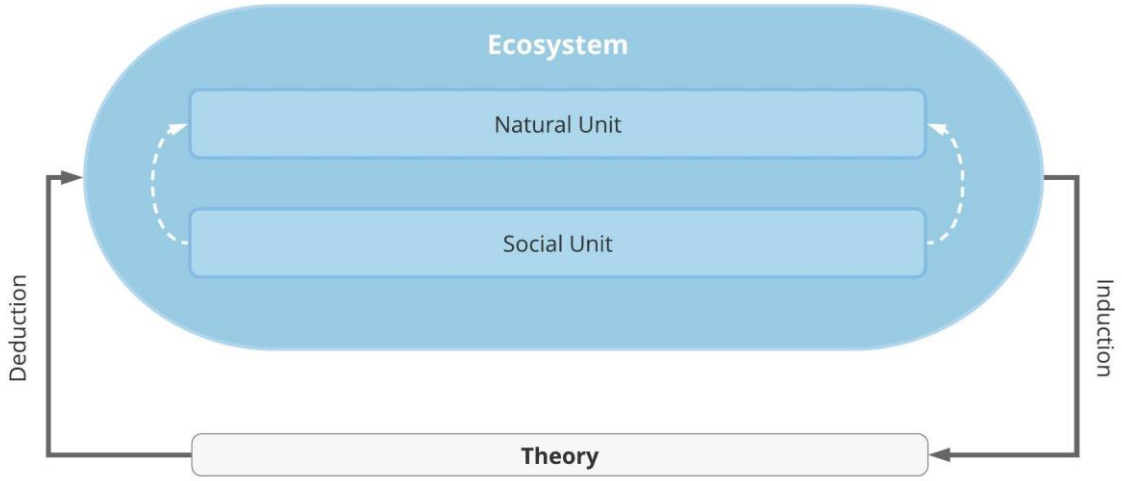


Figure 4.1. The nature of the case study methodology. It interconnects theory, the social world and natural processes. Findings from this process can be used to inform decision-making in an environmental problem solving context. (Adapted from Baxter, 2016).

This methodology is a powerful way to understand and solve practical problems while cementing knowledge on an existing phenomenon. Through undertaking a case study process there is an opportunity to test, expand and generate new insights into theoretical concepts. Case studies also produce credible and trustworthy explanations of knowledge that can be transferred and applied in different contexts (Baxter, 2016; Gerring, 2007). This allows a more effective completion of the final section translating the research findings into the Ōpāwaho/Heathcote River catchment.

4.2 Seven comparative case study examples

Specific case studies of freshwater environmental problem solving were selected for a comparative analysis. Seven examples were selected from different countries to ensure an appreciation of the drivers and barriers to public participation are understood across different contexts. All studies explored had a freshwater focus. Individual examples varied in length and took place at different scales. The characteristics of these examples are detailed in Chapter 5.

Case studies were sourced from published literature or where sufficient information existed from other sources (i.e. summary reports produced following a project). However, varying search methods were used as Conrad and Hilchey (2011) state that some examples or projects may not have been documented in published peer-reviewed sources. This included searching through relevant authors who had produced publications on the theoretical concepts outlined earlier or had

illustrated their work with examples of interest. This also allowed access to material that was not published in academic sources. This was undertaken by searching the University of Canterbury library multi-search database and other relevant journal databases such as *Web of Science*. A variety of terminologies were used to search and obtain relevant literature. Search terminology included keywords such as; 'public participation', 'co-production', 'community engagement', 'citizen science' and 'participatory science'. Furthermore, a simple web search for similar terms, using *Google*, was conducted to obtain examples not available in published literature databases. Members of the supervisory team also suggested examples. Seven examples were selected for analysis to cover a spectrum of different forms of public participation with a consideration that local Ōpāwaho /Heathcote River catchment groups carry out a range of activities.

4.2.1 Construction of the comparative model

There was an absence of suitable methods available to systematically compare and contrast case studies of public participation in environmental problem solving. A comparative model was therefore created that spans the intersecting arenas that make up the wider topic of public participation within a freshwater and ecosystem health context. The model consists of several different components to allow the individual attributes of each case study to be identified and compared (Figure 4.2). The comparative model is temporally focused to aid users in visualising a public participation initiative through all stages as they happen in time (i.e. from start to finish). Viewing an initiative from this aspect gives insights into where drivers and barriers may arise in such a process.

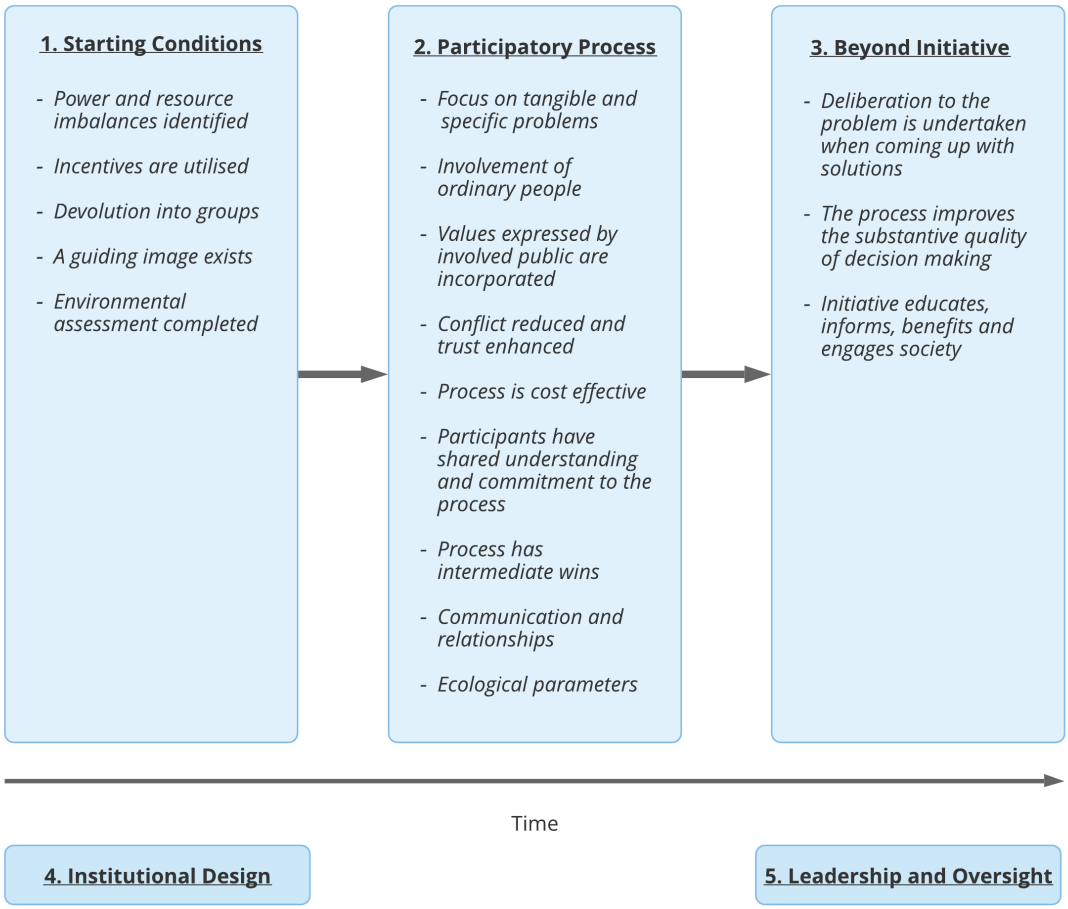


Figure 4.2. The comparative model created to assess public participation in community-based environmental initiatives. There are five core components (labelled 1 to 5 and shaded in blue) with a series of specific attributes for each (shown in italics). Components 1 to 3 operate across time, while 4 and 5 are important for the entire process. (Source: Author).

The comparative model (Figure 4.2) was created using knowledge from a range of literatures including governance (Fung & Wright, 2003), freshwater ecology/ecological restoration (Palmer et al., 2005; Suding et al., 2015), and public participation (Ansell & Gash, 2008; Beierle, 1999). Only certain parts of the ecological restoration literature have been placed in the model where relevant. This has been summarised by *Ecological parameters* in Figure 4.2. Other terms from the ecology-based papers have been translated more broadly to fit the environmental problem solving theme where appropriate. If an initiative has an ecological restoration or other ecology-based components, these may be used, with details found in Palmer et al. (2005), Suding et al. (2015). Each component and attribute is described in Chapter 5.

The different components presented in various papers were brought together in an integrated manner to portray a public participation activity (Figure 4.2). Although this comparative model has been constructed using primarily freshwater focused literature, its use is unlikely to be limited to freshwater ecosystems. However, further research and testing would be required to determine this. The comparative model has been a crucial step to undertaking a specific example analysis. The use of the model allowed information to be readily dissected, which facilitated analysis. In addition, the comparative model is also valuable for ensuring that pragmatic comparisons and themes could be extracted for discussion in the final chapters of this thesis. These comparisons and themes are crucial for providing initial insights to the drivers and barriers to public participation while subsequently providing solutions to the overarching research question.

The comparative model acts as a "multi-tool" for constructing this thesis. It has been created through exploring the theoretical and conceptual background to the topic (Chapter 2). Secondly, the comparative model has been used as a systematic sorting mechanism to process seven case studies of public participation (Chapter 5). In addition, through undertaking an analysis of case studies, there is an opportunity to validate and refine the model (Section 5.7).

4.2.2 Analysis of case study findings

Each example was processed and analysed using the framework of the comparative model (Figure 4.2). This allowed for efficient and consistent method of comparison for each example. Findings were extracted and annotated on a separate document using the five components of the comparative model. Analysis primarily focused on examining the similarities and differences from each example and scrutinising them against comparative model attributes. Each component of the comparative model was entered into a spreadsheet and notes were made under each component heading. This spreadsheet was used to store the results of all examples. This integrated process allowed for key themes to emerge that could be used to provide answer the research question while also identifying areas where the comparative model needed improvement. These findings are presented in Chapter 5.

4.3 Semi-structured interviews

An interview method was employed alongside the specific example case study analysis. Interviews were conducted with people involved in Christchurch urban freshwater science or management

professions, and community groups. Interviews were used to obtain empirical and contextual insights into community-based initiatives in the Ōpāwaho/Heathcote River catchment. Interviews are used in geographic research for four key reasons (Dunn, 2016). These are to: bridge a gap effectively where other methods are unable to do so; examine intricate behaviours or motivations; gather a range of opinions, meaning or experiences on a particular issue; and to empower and respect those providing the data (interview participants).

During the interview process, several different perspectives needed to be obtained. These ranged from community group members, to staff at regulatory authorities, as well as researchers from external organisations and local iwi. Based on their different backgrounds, each group had potentially different motivations and behaviours towards the management of urban freshwater ecosystems. These were likely to operate on different scales and within structures due to their positions (e.g. a paid freshwater ecologist, compared to a non-paid community stream care group leader) which may alter their perspectives. The use of interviews allowed for the diversity of ideas and knowledge imparted from participants to be captured. Answers to interview questions were then compared and contrasted to give a holistic perspective on the differing opinions surrounding improving urban freshwater ecosystem health. In addition, interview methods support the induction and deduction type approaches as shown in Figure 4.1.

Various types of interview methods can be used to obtain insights into an issue. Structured interviews utilise a rigid set of interview questions, similar to a questionnaire, while unstructured interviews are more conversational with licence to both parties to contribute. Unstructured interviews but can be directed with a series of topics (Dunn, 2016). A hybrid approach is semi-structured interviews. This approach has a planned order but allows flexibility in the interview process (Dunn, 2016). This method was chosen because it allows for the expression of different perspectives and opinions to be captured providing enriched qualitative insights to the research topic (Dunn, 2016; Longhurst, 2016; McDowell, 2010). This is a critical aspect for this topic as participants are made up from different sectors of the freshwater science and management field. A semi-structured approach provides each informant equal opportunity to express their viewpoint irrespective of their level of knowledge, position in their organisation, and background. However, it is important to consider this is an idealised description and in practice differences in the process may arise. Face-to-face interviewing was used to ensure rapport was built between the interviewer and informant. A face-to-face interview ensures an intimate and comprehensive understanding of the responses provided by the informant (Dunn, 2016). Unexpected emerging themes, valuable to

the research, can also be explored using this interview approach. In practice, emerging themes surfaced and were explored accordingly where time allowed (Chapter 6).

The use of semi-structured interviews as a primary data collection method is suitable for use within the overarching case study methodology. The interviews provide another layer of understanding to the overarching topic, helping to gain a more intimate appreciation of the processes involved in public participation. This methodology has been designed for use in combination with a comparative model designed for assessing case studies of public participation (Section 4.2.1).

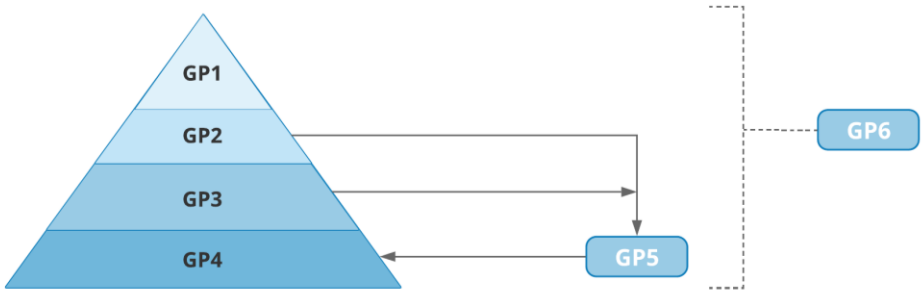
4.3.1 Carrying out semi-structured interviews

As face-to-face interaction is required for interview purposes, a University of Canterbury Human Ethics Application was submitted prior to undertaking the interviews. This application was completed following the case study example examination. This allowed a more comprehensive understanding of the research topic and helped to identify appropriate questions for interview participants, as these are subject to review as part of the Human Ethics Application. Completing the application helped to cement what methods that would be used for this inquiry as the application required specific aspects to be well discussed. In addition, completing the application prompted thinking and acting in an ethical manner.

Freshwater is a well-followed topic in New Zealand with a large number of people associated with the research, care, management and decision-making of freshwater ecosystems and their components. This means there is a wide range of potentially available participants. Interview participants are often selected from relevant themes and issues that arise from background knowledge or literature review processes (Dunn, 2016). This approach was used in this research when generating an interview participants list. Initially, a list of potential informants was generated based on the knowledge of the researcher and supervisory team. Following this, categories were generated on themes relevant to the research, such as the different positions held in government, regional and local authorities, community group members, and research or external organisations (Figure 4.3). The initial list was refined to around 25 people based on these categories. Key participants known to the research team were then contacted such as members from Ōpāwaho/Heathcote River catchment community-based initiatives and staff members at regulatory authorities who have played a role in working with these groups. The remaining participants were

contacted randomly from the initial list largely following the categories to ensure they were sufficiently represented in line with the aims of this research.

Potential interview participants were contacted via publicly available email addresses with a research information sheet and consent form attached (Appendix A & Appendix B). The email included a brief overview of the researcher and the project. Each participant was asked if they would be willing to take part in an interview. If the potential participant agreed to an interview, a request to meet at a mutual public location, interview time and the interview topics were sent in response. Most participants approach responded and agreed to take part in the research. When a participant did not respond, another was approached from the same category, although most participants were assembled on the first attempt. In total, 13 participants were interviewed over the period of 60 days. The final number of participants and how they relate to each other is shown by Figure 4.3.



Group	Category	Number of Participants
GP 1	Political/parliamentary	1
GP 2	Regulatory authority governance	2
GP 3	Regulatory authority staff	3
GP 4	Community	4
GP 5	Community and regulatory authority	1
GP 6	Research/external organisation	2

Figure 4.3. Visual representation of the categories of the final interview participants and their relationships. The diagram also shows the number of participants in each group.

Each participant was asked the same set of primary questions. Secondary questions or "follow ups" were asked where appropriate to derive further information on the response or to prompt a more in-depth response. "Follow ups" were also used to explore emerging themes that arose during the interview. These mainly consisted of asking why they held that particular opinion or how a particular decision was made. Questions were arranged under four main topics and were designed to build and maintain rapport with the participant. These categories are presented below:

1) *The condition of New Zealand's urban waterways*

2) *Responsibility and management of urban waterways*

3) *Drivers and barriers to public participation*

4) *Application on the ground*

Within the categories, interview questions were formulated where broader and easier-to-answer questions were asked first before moving to more reflective and abstract questions. These questions largely followed a hybrid type design culminating in aspects of both a funnel and pyramid interview structure as suggested by Dunn (2016). This structure allows for information about the participants and their position to be obtained thus providing a lens to see how their perspectives and opinions are shaped. Building rapport is key to understanding the participant's worldview on urban freshwater ecosystems and ensuring interview success. An interview schedule was used to ensure consistency was maintained between participants and to ensure questions were asked in the most appropriate manner. This schedule was also used as a tool to make notes and as a template to transcribe the interviews.

Each interview was recorded using two different recording devices (a mobile phone and Dictaphone) to ensure a copy of the interview was collected in case of technical or physical fault. Written back-up notes were also taken. Recording of interviews allowed for a more natural and attentive interchange between the researcher and participant (Dunn, 2016). Better engagement in the interview allowed for critical listening to take place which was then used to form additional secondary questions to ensure a comprehensive understanding of the participants' perspective. Interview recordings were then transcribed and were completed within ten days of the interview. Transcribing was undertaken through playing back the recording and typing the interchange into word processing software. Following the transcription of each sentence, the answer to the entire question was played back to ensure every detail was captured. This allowed for the interview to be heard three times. (i): at the interview (ii): when each sentence was transcribed and (iii): when listening to the question response playback. Transcribing the interview facilitates analysis and comparison of the interview data (Dunn, 2016). Transcribing immerses the researcher in a second (or third) engagement with the data collected allowing for more efficient analysis (Dunn, 2016).

As required by the Human Ethics Application, transcriptions were returned to the participants for them to add or amend any additional information. When returning transcriptions, follow up

questions were also asked as research themes had emerged and developed by the time later participants were interviewed. Several participants returned their transcripts with minor amendments. At the end of the interview and again when returning their transcript, one participant (from Group 3 in Figure 4.3) expressed their concern to remain anonymous. Another participant, from Group 2, outlined that perspectives and opinions expressed were their personal beliefs not those of their organisation. These qualifying comments indicate the sensitive nature and importance of freshwater issues in New Zealand because while most participants were happy to be identified, some were concerned about where their opinion could be expressed. All participants were kept anonymous to ensure a fair representation in this research.

4.3.2 Interview data analysis

During transcription, annotations of the transcript document were made to identify interesting points and emerging recurring themes. These annotations were often made on the third exposure (listening to the playback of the entire question) of the interview (see above). This process was helpful as a primary form of analysis over the course of the transcription period. Identification of key points and themes aided the reflection process discussed above and allowed the research to develop. The remainder of the analysis process was completed following multiple readings of the transcriptions to ensure an intimate understanding of the data.

Findings collected from the semi-structured interviews were analysed using a latent content analysis as described by Dunn (2016). This process embodies an exploration of interview texts for themes. Part of this process is determining the underlying and implicit meaning of what was said by the various participants. The thematic analysis process was split into the four interview categories above based on the themes that emerged throughout the research process. The analysis was undertaken by selecting interview questions within these categories that contributed to the aims of the thesis and provided insightful answers to the research questions. A fifth category was created to house emerging themes titled, *Partnerships*. Responses to the questions were initially placed on a table. This allowed the direct response from each participant to be captured. Responses were then summarised into groups as represented in Figure 4.3. This meant that answers could be compared and contrasted within and across groups. Tables were then further refined to show the key messages or used to produce a written summary that addressed the question of interest. These are presented in Chapter 6.

Information from the interview process was also used to clarify the drivers and barriers to public participation identified from the case study analysis. Analysis of the case studies, and interview findings, was required to derive meaning from the data collected through these methods. It aimed to; (i) elicit interesting themes and information from the case studies and semi-structured interview data to answer the research questions, while: (ii) simultaneously validating the comparative model used in the initial stages of this research. The respective results are discussed in Chapters 5 and Chapter 6 of this thesis. Chapter 7 focuses on the findings of this research in the context of the study area, the Ōpāwaho/Heathcote River catchment.

4.4 Attending community-based initiative meetings and events

During the course of this research, meetings and events held by the Ōpāwaho/Heathcote River Network and the CSCG were attended. The purpose of this was to observe the activities and events carried out by groups to gain an enriched understanding of how these groups operate and function. This was helpful in obtaining unique insights into the background and the processes involved in the running of a community-based initiative. In addition, it ensured a better understanding of the activities undertaken by the groups. Observations of these groups are discussed in Section 7.1. Attendance assisted in identifying potential interviewees (such as those in leadership roles) and gave insight into the issues of concern for the community-based initiatives. Overall, this helped to create comprehensive understanding of community-based initiatives in the study area.

4.5 Conclusion

This research uses an overarching case study methodology and various methods to derive answers to how community-based initiatives can be used to improve urban freshwater ecosystem health. The initial background exploration identified the need for a method to assess specific published examples of public participation. Following this, a comparative model was created and then subsequently used to process seven case studies of public participation in environmental problem solving, both nationally and internationally. Semi-structured interviews were conducted with relevant community group members and individuals in the Christchurch freshwater science/management field to gain a local contextual appreciation of the research findings for the study area. These interviews were then transcribed. Analysis was largely compromised of a mixed method that best suited the themes and areas that were identified during reflection and initial analysis. This provided the best approach for this research inquiry and is a unique approach to

addressing environmental issues. The remaining chapters of this thesis contain the findings derived using this methodology, a discussion of the findings and their implications.

Chapter 5. Comparative case studies of public participation

In this chapter the results of the seven case studies are analysed using the comparative model described in Chapter 4 (Figure 4.2). Each attribute of the model's components is described followed by a summary of insights from the seven case study examples. New attributes arising from this process are described at the end of each component summary. The purpose of this chapter is to show where drivers and barriers to public participation may arise in an initiative, while also demonstrating the characteristics of such public participation initiatives. The chapter concludes with the relevance of the insights derived to the purpose of the research. Also presented is a revised version of the comparative model depicting the newly derived attributes from this process.

5.1 Background to the seven case studies

Seven examples of public participation were chosen for examination (Table 5.1) to show the diverse nature and different forms of public participation, with examples spanning a range of different public participation initiatives. Examples chosen also represent the types of activities undertaken by community-based initiatives in the Ōpāwaho/Heathcote River catchment, where some groups combine several types of public participation.

Table 5.1. Specific case studies chosen for comparative analysis

Name (code)	Location and number of people involved	What is the issue of concern?	How were people involved? What activities were completed?	Key References
Loweswater Care Programme (LCP)	Loweswater, England. (Began with small group of local farmers and grew to ~35 participants)	Eutrophication of the Loweswater Lake and the factors that contribute to this	Involved in public meetings to express opinions and work towards solutions for issues	Tsouvalis & Waterton (2012)
Pickering (PCK)	Pickering, England (8 local community members and a small group of academics)	Flooding in the Pickering village	Meetings to co-produce solutions to the flooding problem	Landström et al. (2011), Lane et al. (2011), Whatmore & Landström (2011)
Whaka Inaka (WHI)	Christchurch, New Zealand (~650 students and over 400 community volunteer hours)	Installation and monitoring temporary spawning habitat of inanga/whitebait and educate wider community about inanga/whitebait	Community members assisted a science team in installation and monitoring of temporary spawning habitat. Involved in an education programme where local schools carried out monitoring of temporary spawning habitat and learnt about the inanga/whitebait lifecycle	EOS Ecology (2015, 2016a, 2016b, 2016c)
Riverfly Monitoring Initiative/ The Riverfly Partnership (RMI)	England wide (2400 active volunteers)	Monitoring of streams to detect severe alterations in water quality.	Public members (predominantly anglers) trained to monitor freshwater ecosystems	De Fiore & Fitch, (2016), Huddart, Thompson, Woodward, & Brooks (2016)
Xiaoqing River Restoration (XRR)	Jinan, China (not disclosed but not limited as all public were able to be involved)	Poor ecological health of the Xiaoqing River	Public report pollution events to online database	Hu, Liu, & Chen (2017)

Open Air Living Laboratories (OPL)	U.K. wide but concentrated in England (Over 950,000 people have participated).	Address loss of biodiversity, climate change and environmental degradation in urban areas through a research programme that integrates scientists and communities	Individuals and communities participate in monitoring of environments using the monitoring kit supplied by OPL	Davies et al. (2011)
FreshWater Watch (FWW)	Global (Over 8000 trained citizen scientists including staff from HSBC).	The global decline of freshwater health	Citizen scientists collect water quality data and contribute this to a central database	FreshWater Watch (2018), Loiselle (2016)

Examining seven case studies provides an opportunity explore varying initiatives to generate meaningful insights. Chapter 4 presented the comparative model that was used to sort and compare case studies of public participation. This has been reproduced below for use in this chapter (Figure 5.1). The aim is to explore a series of initiatives in a temporal manner using the designed comparative model (Figure 4.2 & Figure 5.1). Insights will be obtained to help gauge the drivers and barriers to public participation. In addition, the comparative model will be validated as an approach to better understanding public participation in freshwater management.

The comparative model has five core components with a range of attributes for each component (Figure 4.2 & Figure 5.1). Each attribute is presented with a brief description to clearly define its meaning. A comprehensive analysis of each attribute can be found in the original papers that were used to generate the comparative model (Ansell & Gash, 2008; Beierle, 1999; Fung & Wright, 2003; Palmer et al., 2005; Suding et al., 2015). Following this each of the core components will be summarised using examples from the case study examples to provide insights.

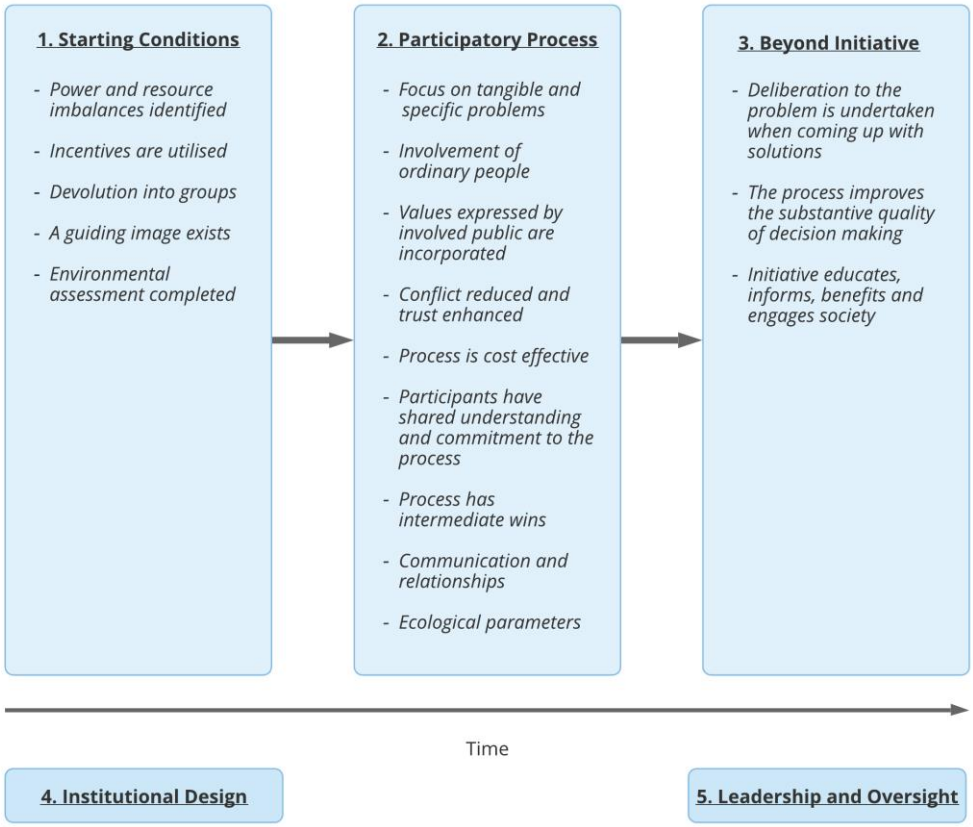


Figure 5.1. The comparative model from Figure 4.2 reproduced for use when reading this chapter. Components are presented by blue shading and attributes are in italics.

5.2 Starting conditions

The initial steps of a public participation initiative, where the problem and background information are introduced, are critical and can either facilitate or discourage cooperation (Ansell & Gash, 2008), as well as providing key information for understanding its characteristics. Once the problem has been depicted the reader should be able to understand the objective or overarching goal (s) of the initiative. The following are the key attributes for starting conditions.

- ***Power/conflicts/resource imbalances are identified:*** It is important any power or resource imbalances and conflicts are recognised prior to beginning an initiative. Without this the collaboration initiative may be jeopardised allowing stronger actors to take advantage (Ansell & Gash, 2008). It is also important to have a prior understanding of the prehistory of antagonism and cooperation when considering these conflicts.
- ***Incentives are utilised:*** As most participation or collaboration initiatives are voluntary it can be important to incentivise participation with some groups (Ansell & Gash, 2008).
- **Devolution into groups:** When working with localised issues in local environments, the devolution of power to local units is often critical to an effective outcome (Fung & Wright, 2003).
- ***A guiding image exists:*** This was stipulated by Palmer et al. (2005) to help guide ecological restoration projects. It is essential to have a core outcome or favoured/idealised endpoint that is shared by all participants.
- ***Environmental baseline assessment has been completed:*** An ecological assessment is required only when there is an ecological outcome involved. More generally, an ecological assessment can be an environmental assessment. Despite this, an environmental assessment can be used to help shape and define problem. The initiative should also be informed by both the past and future where practicable as suggested for ecological restoration (Suding et al., 2015).

5.2.1 Starting conditions summary

Starting conditions varied between examples. The larger and more monitoring-focused initiatives (FWW, OPL and RMI) overcame any conflict, power or resource imbalances. However, it would be rudimentary to state that these do not exist at finer scales. Due to the nature of the PCK and LCP

examples, there were inherent imbalances stemming from the integration of local people, stakeholder groups and environmental agencies. Despite this, specific concerns were not reported (Landström et al., 2011; Lane et al., 2011; Tsouvalis & Waterton, 2012; Whatmore & Landström, 2011), which could be due to the design of the initiatives (Section 5.5). Interestingly, the XRR appeared to have some conflict and imbalances among stakeholders. This is due to a lack of executive power and institutional barriers impacting on public involvement, which is sparsely detailed in Hu et al. (2016).

The offering of incentives was not documented in any of the examples except in PCK where the initial recruitment offered participants an opportunity to be part of a process that generated solutions for a local issue and be part of an experiment that co-produces knowledge (i.e. a monetary incentive was not offered) (Lane et al., 2011). In most examples those who participated were interested or concerned, providing a self-motivating incentive to participate (e.g. an angler is interested in riverfly populations and therefore may want to be involved). Hu et al. (2016) stated that an improvement to the XRR where few participated would be to offer incentives such as financial rewards. Breaking down into small groups (devolution) may be driven by size and scale of the initiatives. OPL, RMI and FWW have smaller scale hubs or projects in which groups are involved (Davies et al., 2011; FreshWater Watch [FWW], 2018; Huddart et al., 2016). In the OPL example the regional hubs focussed on more local issues than the broader scale initiative (Davies et al., 2011). In contrast PCK and LCP began as small groups of local people and did not devolve further (Lane et al., 2011; Tsouvalis & Waterton, 2012). It appears that larger and more externally driven initiatives are more likely to devolve.

Each case study had a clear endpoint or goal. In some instances these were defined by the community/public group (PCK and LCP) and in other cases defined by the organisations associated with them (WHI, FWW and OPL). The endpoint or goal differed from the larger projects to the more community driven ones. Such goals were formed from an understanding of the problem and the environmental or ecological assessment. An environmental or ecological assessment aids in developing an understanding the issue and the factors that may need addressing. This is critical to developing an initial approach. Although markedly different, each case study built on the understanding of the issue. OPL was created due to a lack of connection between people and the environment. PCK had a severe flooding issue that needed to be addressed, the XRR was in response to poor water quality, and the WHI in response to declining inanga/whitebait spawning habitat.

There is a clear difference in the driving force of these initiatives based on the different types of participation (Figure 5.2). The matrix depicts the examples and how they can be related to each other. The horizontal axis shows how the initiative is ranked in terms of the driver of the process (i.e. community group members or externally by corporations/businesses), while the vertical axis describes the type of public participation (active or passive). Active participation occurs when those participating are involved in the process of creating/directing the initiative, while passive participation is when those who participate follow a pre-established programme (i.e. monitoring environments using existing resources). The distribution shows that more externally driven initiatives are usually characterised by passive participation, with the exception of the WHI that incorporated an education programme (Table 5.1). Active participation seems to be associated with community driven initiatives such as PCK or LCP. The matrix reveals a gap where there is no community driven passive participation. The Ōpāwaho/Heathcote River catchment community-based initiatives can also be ranked on this matrix (Section 7.2).

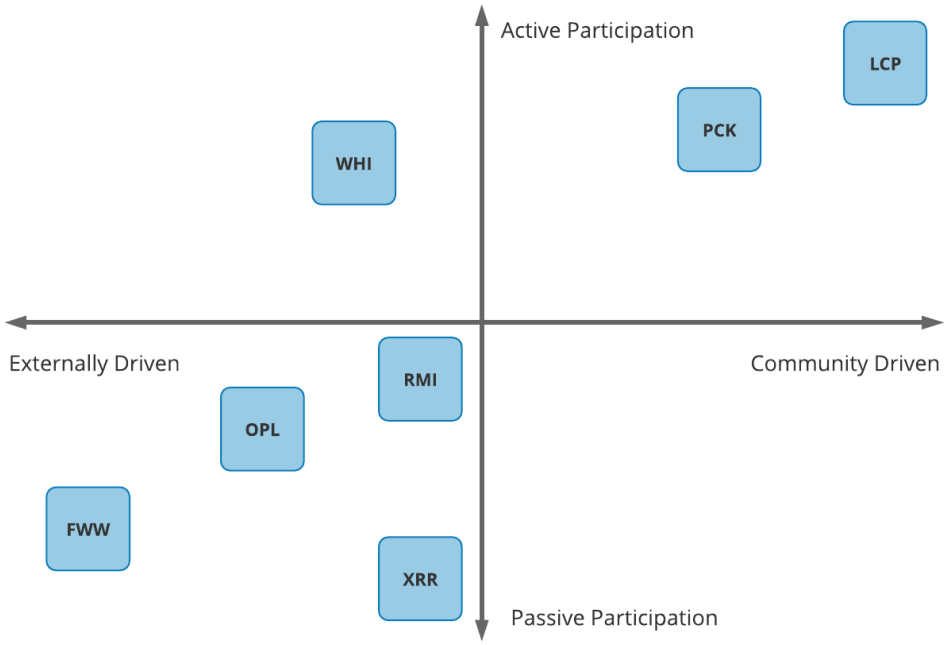


Figure 5.2. A conceptual matrix depicting the case study examples against the key driver of the initiative and the type of participation. Note: Positions were allocated based of interpretation of the initiative (i.e. no numerical or formal ranking procedure was undertaken).

5.2.2 Additional attributes derived from starting conditions

Examination of the starting conditions revealed an additional attribute to those listed above. Funding for the initiative can often be identified through the starting conditions. The case study examples suggest those bigger and more externally driven initiatives have more funding with FWW

receiving funding from HSBC over a five-year period (FWW, 2018; Loiselle, 2016), while OPL received £13 million from the UK Big Lottery Fund (Davies et al., 2011). In contrast, LCP began with funding for their project placing importance on other attributes in this component. However small grants were later awarded to the group (Tsouvalis & Waterton, 2012). WHI was supported by some government funding, supplemented with in-kind support from the organisations involved and support from local businesses. PCK, LCP, and OPL were all supported by universities which may have provided additional funding and resources. Considering Figure 5.2, it seems more community driven projects may have to achieve milestones in order to gain funding in comparison to the externally driven initiatives/programmes. This has important ramifications for the community-based initiatives the Ōpāwaho/Heathcote River catchment, as many are locally driven projects focusing on specific issues.

5.3 The participatory process

The participatory process can be hard to describe as it often progresses in a non-linear fashion and is largely dependent on feedback from the starting conditions component of an initiative (Ansell & Gash, 2008). The process focuses on addressing the problem incorporating ordinary people and their values. It largely describes the interactions between differing stakeholders and their influence on generating potential solutions to a problem or the collection of information to inform their opinion on the issue. The participation or collaboration process can be highly complex and variable, making the attributes below a simplification of the interactions that occur during this process (Ansell & Gash, 2008).

- ***Focus on tangible and specific problems:*** *When the public are involved there is likely to be a concrete concern, meaning that there is a drive to work on solutions to practical problems (Fung & Wright, 2003). This focus can help to derive meaningful solutions that can be used to make headway on broader scale issues.*
- ***Involvement of ordinary people/bottom-up participation:*** *If participants or members of the public are affected, they need to be involved to impart their knowledge, experiences and interest when formulating and deriving solutions (Fung & Wright, 2003). This attribute is thought to enrich the solutions derived (Section 2.5).*
- ***Values expressed by involved public are incorporated:*** *Differing values, opinions and assumptions of all stakeholders need to be discussed in a process that allows each option to*

be considered (Beierle, 1999). This mutual process can help derive solutions to problems that reflect the public perspective.

- ***Conflict reduced and trust enhanced:*** *Trust and conflict are critical aspects when addressing environmental problem solving (Ansell & Gash, 2008). Trust needs to be developed mutually between participants and also the relevant institutional system (Beierle, 1999). Often trust can be compromised by conflict of perspectives, values or interests (i.e. environmental vs. economic or corporate).*
- ***Process is cost effective:*** *Beierle (1999) stipulates that not every environmental decision requires or justifies an active public participation programme. Any such programme needs to produce results that justify the resources spent.*
- ***Participants have shared understanding and commitment to the process:*** *A shared understanding is at developed when those involved can imagine what they can achieve collectively. A shared understanding is synonymous with generating clear goals and shared vision between parties involved (Ansell & Gash, 2008). Commitment is a critical attribute to collaborative efforts from all participants and is often driven by original motivation to participate.*
- ***Process has intermediate wins:*** *Ansell and Gash (2008) discuss intermediate wins in a collaborative process as critical process outcomes. Small achievements in a process can help to drive momentum and success while generating feedback into the cycle of a collaborative process.*
- ***Communication and relationships:*** *Face-to-face communication is considered a necessary condition for collaboration as it aids in developing trust, commitment and mutual respect (Ansell & Gash, 2008). At a broader scale, relationships with government or regulatory institutions is beneficial for decentralised problem solving initiatives (Fung & Wright, 2003).*

5.3.1 Summary for participatory process

The participatory process is where steps are taken to work towards the aim of the project. This process varied for different initiatives, which is to be expected considering the differences in starting conditions and also the overall nature of initiatives as depicted in Figure 5.1. The attributes for this component are summarised below.

Each initiative focused on a specific problem(s) with Table 5.1 showing the different problems that each example was trying to address. A notable comparison can be made between XRR and LCP. The XRR initiative was started due to poor ecological health of the Xiaoqing River resulting in a loss of industry and adverse impacts to amenity values. The provincial government established an authoritative agency to improve the ecology of the river. However, Hu et al. (2016) state that it is a complex interaction of factors that are contributing to the decline of the ecology in the river requiring a multi-faceted approach. This highlights the importance of some of the starting conditions (understanding the problem and conducting a thorough ecological assessment) to ensure the problem is addressed accordingly. In contrast, the LCP wanted to determine the factors leading to overarching problem of algal blooms/lake eutrophication (Tsouvalis & Waterton, 2012). The group started as a collection of local farmers who were concerned about the intermittent algal blooms on the lake. Over time, the group investigated a raft of different issues and altered practices in an attempt to address them. Initially they received small grants to test soils, re-route waste water, create buffer zones and install septic tanks (Tsouvalis & Waterton, 2012). More recently, the group has initiated five small projects including the impacts of domestic detergents on water quality, the role of tourism and what will happen in the future, and sediment records and land use change, among other projects (Loweswater Care Project [LCP], 2011). This comparison highlights the importance of addressing specific issues and focusing on tangible problems. The LCP attempts to gain an understanding of the varying factors that contribute to the problem over time while XRR focuses on the broader issue of "improving ecology" seemingly without understanding or addressing the contributing factors.

Ordinary people or affected members of the public were involved in each study (Table 5.1). The larger examples such as FWW, OPL and RMI trained people or had resources available that those participating can access. LCP and PCK which involved people who were directly impacted by a local problem. The XRR and WHI involved people who lived alongside the river of focus. WHI had people directly involved through assisting with installation and monitoring, and indirectly involved by subscribing to the projects social media channels. Involvement in the XRR was limited, with citizens living within close proximity to the river being asked to upload pollution incidents onto an online database through a mobile app called *'WeChat'* (Hu et al., 2016). Interestingly, the public in New Zealand is encouraged to use a mobile app named *'Snap, Send, Solve'* to report similar issues or non-compliance. These reports get sent directly to the relevant local authority. Those initiatives that are more community driven and/or have high levels of active participation tended to have a shared understanding and strong commitment to the process. This is because their values are being

readily incorporated into the process through direct and active participation. This was apparent with both the LCP and the PCK examples. Larger initiatives can have opportunities to develop commitment and understanding. For example, OPL has regional hubs in which community input helps to develop their focus in local areas (Davies et al., 2011).

More externally driven and passive participation initiatives provided less opportunity to include participant values. This could be due to their structure and the monitoring-based nature of these initiatives (e.g. FWW, OPL and RMI). XRR participants simply uploaded observations to an online database. WHI did not directly seek the values from the participants in the programme (school children) but indigenous (mahinga kai) values were a key focus of the programme (EOS Ecology, 2015). Both the PCK and LCP examples aimed to generate meaningful solutions using local and public knowledge. Through various steps the public involved were provided a platform to express their knowledge, concerns and ideas on how to address the issues. This included analysing photographs, examining consultancy reports, openly discussing and debating technical parameters and questioning monitoring techniques (Lane et al., 2011; Tsouvalis & Waterton, 2012). This open collective platform helped to shape enriched initial solutions to the respective problems. Participant values can create conflict and change the level of trust in an initiative. Where there is more active participation (Figure 5.1) conflict and trust are better addressed. These can be linked to co-production challenges listed in Table 2.5. The way that the LCP and PCK initiatives were carried out meant that any issues could be addressed and trust developed during the process. This proved critical in developing an open forum. The larger, more passive and/or externally driven participation initiatives (OPL, XRR, FWW, WHI) did not appear to mention conflict and trust issues. This is perhaps because they are more focused on monitoring and there were few opportunities to include opinions and values that could generate conflict. While not considered in published material, it is possible that externally driven initiatives could foster and enable more community driven initiatives to evolve. For example, through taking part in a larger monitoring initiative, people involved could then establish a more local initiative based on their interests and be enabled to investigate such issues. This was experienced in WHI where school students presented what they learnt through the programme to the local council (Section 5.4). Interestingly, the growth of LCP became more external as larger players (such as environmental agencies and universities) became involved.

Intermediate wins can be difficult to identify as some initiatives may have a broader end goal while some may not. The LCP developed through a series of intermediate wins from small projects they undertook, such as getting small grants to test soils, re-route wastewater, and create buffer zones

(LCP; 2011; Tsouvalis & Waterton, 2012). The group developed and more stakeholders became involved and undertook new research projects (LCP, 2011). The public involved in PCK wanted to display their work to the public and created a public exhibition to do this (Whatmore & Landström, 2011). Although considered as a critical part of an initiative (Beierle, 1999), there was little mention of the cost-effectiveness of the case studies. It was mentioned that in the RMI case using citizen scientists and standardised protocols could have lowered financial costs (De Fiore & Fitch, 2016). This may be similar to OPL and FWW.

Effective communication between participants and other stakeholders in an initiative is critical. It appears that the XRR was impeded due to poor communication mechanisms at several levels. Hu et al. (2016) quoted from different people/groups supposedly involved in the process. Members of the public that were interviewed stated they were unaware that they could participate, did not know how to participate or found it useless. Meanwhile, the top-down approach managed by two levels of authority outlined that citizens were involved and that the experiment had problems largely due to "a lack of motivation among community members." (p.27) (Hu et al., 2016). This provides a good example of the importance of having good communication and relationships between communities and authorities. In comparison, other examples had several agencies and universities directly involved in the process (LCP, PCK & OPL), or used effective science communication such as interactive online features (FWW) and public-friendly report cards and media releases (WHI). Face-to-face communication was a part of all the initiatives except XRR. It occurred more in the more active and/or community driven examples where regular meetings took place to exchange opinions and new information (LCP and PCK) or learn information (WHI). No additional attributes were apparent for the participatory process.

5.4 Beyond the initiative and long-term outcomes

This component describes the outcomes of completing a public participation initiative. It includes the formation and deliberation of potential solutions and then the debating of these to generate a final solution that can be implemented. Other outcomes may also be achieved.

- ***Deliberation of the problem is undertaken when generating solutions:*** *Fung and Wright (2003) stipulate that deliberative decision-making (joint critical examination of possible solutions) is a distinctive value of participatory regimes. Those taking part will come together and listen to the various positions and generate group choices.*

- ***The process improves the substantive quality of decision-making:*** *The inclusion of different publics is a source of innovative alternatives and facts on situation (Beierle, 1999). It is thought that public input can help to generate solutions that can be applicable to a wider range of interests and in some cases more technically rigorous. Therefore the use of the public can help create more substantive solutions to environmental problems.*
- ***Initiative educates, informs, benefits and engages society:*** *Suding et al. (2015) suggests that an ecological restoration process (and outcome) needs to engage members of the public. Meanwhile, Beierle (1999) outlines that public education is important in an environmental regulation approach (i.e. such as the RMA) as it allows the public to identify violations, apply pressure and contribute to the monitoring of compliance. In an ideal world, an informed and educated public would be able generate alternatives and deliberate issues alongside government representatives and experts.*

5.4.1 Beyond the initiative summary

The initial attributes for this component can be integrated together. In general, the more externally driven initiatives (Figure 5.1) do not put an onus on decision-making (i.e. monitoring programmes). Despite this, in OPL there are still methods for public input through local/regional projects that can have implications for decision-making. LCP and PCK are examples where decision-making has been a key focus and local people are intimately involved in the process. Both case studies document examples of where deliberation and alternative decision-making has been used. In the PCK example, the public worked with modellers to create a bund design. Lane et al. (2011) observed that during initial meetings the public shifted from focusing on the bottom of the catchment to creating a natural bund storage system upstream. This idea formed the focus of the rest of the group and was eventually implemented. In addition, the PCK group wanted to display their work to the wider public so held a public exhibition one afternoon and attracted 200 people (Whatmore & Landström, 2011). The intimate nature of the LCP group resulted in projects being shaped through reoccurring deliberation and decisions being made in an alternative manner to the status quo (i.e. where the regulatory make the decisions). “The LCP was based in a pragmatic philosophy of critical debate and frequent rejection of the status quo … As the LCP developed as a group it continued to allow for, and indeed welcome critique and dissent as vital to ways of thinking differently about the problem of water quality in Loweswater.”(p.166) (Tsouvalis & Waterton, 2012). Monitoring-focused initiatives may be a driver in improving the substantive quality of decision-making. Contributing to data collection may help those involved develop a more in-depth

understanding of the system and therefore facilitate alternative solutions if opportunities are presented.

Educating and engaging society was demonstrated in different ways through the case study examples. OPL works with disadvantaged communities and children (Davies et al., 2011). The PCK example generated a solution that could address the flooding concerns and FWW trained a series of citizens including over 8000 from the HSBC organisation (Table 5.1). XRR appeared to have crude engagement mechanisms (a passive internet web app) and therefore had questionable benefits for those that participated. Improvements to the XRR are noted by Hu et al. (2016), including using incentives to better engage citizens. WHI was an effective education and engagement programme and discussed in detail below.

A noteworthy outcome is that OPL, RMI, WHI and FWW have all had academic papers published using data collected through the initiatives (Bone et al., 2012; Orchard, Hickford, & Schiel, 2018; Thompson et al., 2016; Zhang et al., 2017). While this is not a critical outcome of a project, it signifies that effective public participation is robust enough for scientific outputs.

5.4.2 Additional attributes identified

The case study analysis identified two new attributes for this component. Firstly, whether participants return to be involved in activities or the initiative. Having completed the initial stages it is important to ensure that participants will return if the initiative aims to be self-sustaining long-term. This was demonstrated across most examples above, except in the XRR where citizens interviewed stated that they never participated or only did so once (Hu et al., 2016). Returning participants can be a result of other attributes such as offering incentives, developing trust and intermediate wins. This can also be a result of the leadership and institutional design components. This is a critical attribute for working toward self-sustaining initiatives that engage public regularly, especially those that have long term objectives and goals (e.g. LCP).

Secondly, a desired outcome is the application or implementation of the results by regulatory authorities. A significant example is WHI, which is notable for the diversity of the project. The project’s primary focus was the addition and monitoring of temporary inanga/whitebait spawning habitat (Table 5.1). The wider community were invited to volunteer in setting up the experiment, assist the science team during the monitoring, and were kept informed by a Facebook page, media releases, onsite signage and public presentations (EOS Ecology, 2016b). The programme was

implemented with a series of partners including university, iwi and Conservation Volunteers as well as support from local businesses (EOS Ecology, 2015, 2016a, 2016b). The project was additionally complemented with a participatory science module targeted at schools in which students collected additional data on the pests that may predate on inanga/whitebait eggs (EOS Ecology, 2016c). A series of visually engaging report cards or summaries were produced detailing the findings of the programme or engagement (EOS Ecology, 2016a, 2016b, 2016c) (Figure 5.3). Moreover, having completed the education component a group of local children went to the Christchurch City Council to present what they had learnt about inanga/whitebait spawning and the need to change the maintenance regime of the riparian area in local rivers (CCC, 2016b). This lead to a test period of different management approaches being implemented. This highlights the benefits that can be provided by such an initiative that is well designed and diverse in its implementation. Similarly, data used by the RMI data collected by groups led to the prosecution of a polluter (Huddart et al., 2016). In addition, a bund designed using public inputs was implemented in the PCK example (DEFRA, 2015).

Figure 5.3. Excerpt pages from the engagement summary (left) and schools pest monitoring module (right). This exemplifies effective science communication that is appealing to the target audience (e.g. children). (Source: EOS Ecology, 2016b, 2016c).

These examples highlight the benefits of the public being included in the process from advocating for changes to getting changes implemented. They also emphasise the importance of the interactions with other attributes such as having intermediate wins, good relationships with local authorities and trust in the process among others. This attribute also can also influence participants returning to the process.

5.5 Institutional design

Ansell and Gash (2008) refer to institutional design as the protocols that lead to procedural legitimacy of a collaborative process. They suggested that the primary design question is *who should be involved?* Collaboration is thought to work best if the process is open and inclusive (Ansell & Gash, 2008). Participation must not be exclusive.

In more externally driven initiatives (Figure 5.2), participants are trained to become citizen scientists or participate in environmental monitoring. OPL regional hubs (university led) focussed on local issues which are derived through a process including meetings and workshops with local people and research into problems of concern for that area (Davies et al., 2011). The regional groups then contributed to completing the national surveys. It was unclear how the public were involved in XRR beyond reporting information to '*WeChat*' and the execution of an environmental education programme in some areas (Hu et al., 2016). This passive participation may have led to the dissatisfaction expressed by public in this example as shown by Hu et al. (2016). There was no account in published material of how individuals were recruited to join RMI (Huddart et al., 2016). However, information on their website outlines that training is required before data is collected and that this must be undertaken in con-junction with the local group (The Riverfly Partnership, n.d.). As WHI contained an education programme designed for school children, classes of students from local schools were chosen to attend monitoring days and collect additional information (EOS Ecology, 2016b, 2016c). The public could also become involved in this initiative through following the project's Facebook page, as well as assisting in the installation, monitoring and removal of the temporary habitat (EOS Ecology, 2016b).

In community driven initiatives, academics involved in the PCK example placed advertisements on local shop windows and notice boards. Participants were offered incentives as discussed above (Section 5.2). This encouraged those interested to participate. The initiative did not follow a set path and allowed participants to shape direction of the initiative. In comparison, the LCP began with a group of local farmers who were concerned with water quality of the lake (Table 5.1). This

continued to develop incorporating different stakeholders (ecologists, social scientists, businesses, environmental agencies and residents) that were not pre-selected ultimately creating a "truly open forum" (p. 115) (Tsouvalis & Waterton, 2012). From these examples, there are clear differences between the externally driven initiatives in comparison to the more community driven examples. There is also an indication of the difference in active and passive participation. It seems the more community driven examples have the concerned public brought in at the start in contrast to the externally driven initiatives, where participants are recruited once the initiative is established.

Parallels can also be drawn between this component and the communication attribute of the participatory process. It is important that connections can be made between the design of a participatory initiative and the wider regulatory set up in that area. For example, RMI used standardised bio-monitoring methods also used by the Environmental Agency (De Fiore & Fitch, 2016; Huddart et al., 2016). This programme essentially acted as an extension to the statutory monitoring regime, with groups collecting samples more regularly than the statutory agencies. It also allowed data collected to be compared to other datasets more readily. This may have had a key role in the prosecution that took place (Section 5.4.2). Connections and working alongside agencies or authorities can help achieve more effective outcomes. The institutional design, and connections with regulatory system, can also be linked to the leadership or oversight provided during an initiative.

5.6 Facilitative leadership and oversight

Fung and Wright (2003) state that local units (groups) do not operate autonomously and that there is a need for groups to connect to governmental or regulatory bodies which can help reinforce the quality of the collaborative process and outcomes. This can be achieved through having oversight from centralised institutions (Fung & Wright, 2003). Moreover, Ansell and Gash (2008) recognise leadership as a critical ingredient for guiding a collaborative process. Herein, both centralised oversight and leadership have been combined.

Different levels of leadership or oversight were observed in the case study examples. FWW detailed little specific information on the amount of leadership or oversight. In addition to the trained HSBC employees, FWW had over 40 scientists leading local research projects (FWW, 2018). There was also participation from over 30 organisations including NGO's, river and wildlife trusts, and government agencies. OPL used national surveys, delivered through regional programmes/hubs (Davies et al., 2011), with the nine regional programmes administered by local universities (using

students and volunteers). OPL was and continues to be supported by a network of the partners from the various theme centres (e.g. air, water, soil, etc.) based at universities to the wider support services from relevant organisations and agencies (e.g. Natural History Museum and the National Biodiversity Network) (Davies et al., 2011). Similarly, the RMI had a national coordinator who is funded by the Salmon and Trout Conservation Trust (Huddart et al., 2016). Each group had a local coordinator. Twenty-five regional hubs also offered support and were hosted by one of the river or wildlife trusts (Huddart et al., 2016). WHI was a multi-organisation collaboration involving a company, university, and iwi (Te Rūnanga o Ngāi Tahu). It was led by the science and engagement company who had in-depth science knowledge and science communication skills. This initiative was designed as a science programme with participatory science and school education programme components, so required professional oversight and leadership. In contrast, there was no evidence of any professional oversight provided to public participating in the XRR. There was a series of people involved in the initiative (Section 5.5) but the public were participating through mobile apps despite the programme wanting to have high levels of participation. There was a '*River Leader'* system in place but this was found to have a lack of legal basis and therefore was not very successful (Hu et al., 2016). The '*River Leader'* system delegates the responsibility of monitoring regional water quality to the street office (local government).

Both PCK, LCP, and WHI had the direct involvement of university academics, with PCK and WHI involving academics from the beginning. Five academics were involved in the PCK process and they documented the actions of the groups as they worked through. In addition there was a group facilitator, a meeting manager and a recorder (Lane et al., 2011). This oversight allowed the initiative to progress. However, it is important to note that this process was not directed by the academics and the participants involved were allowed to shape the direction of the approach. In contrast, the LCP started with the local group of farmers and other authorities (Natural England, Environmental Agency and Lakes District National Park Authority). The academics simply entered the project as observers of participatory initiatives and documented the findings. Again, the academics did not direct the initiative (Tsouvalis & Waterton, 2012). Having external oversight and leadership (i.e. assistance from academics or professionals) seems to have benefitted the more community driven initiatives (LCP and PCK) and may be a critical link in incorporating further support from other agencies and authorities and addressing the regulatory system in play. Moreover, those with academic support seem to have highly detailed accounts of the process undertaken (OPL, LCP, PCK).

5.7 Revisiting the comparative model

Figure 5.4 presents an updated version of the comparative model following the examination of the case studies, highlighting some newly identified components and attributes. This updated version has provides a schema and insights that can be used to evaluate public participation in the Ōpāwaho/Heathcote River catchment. This is explored in Chapter 6.

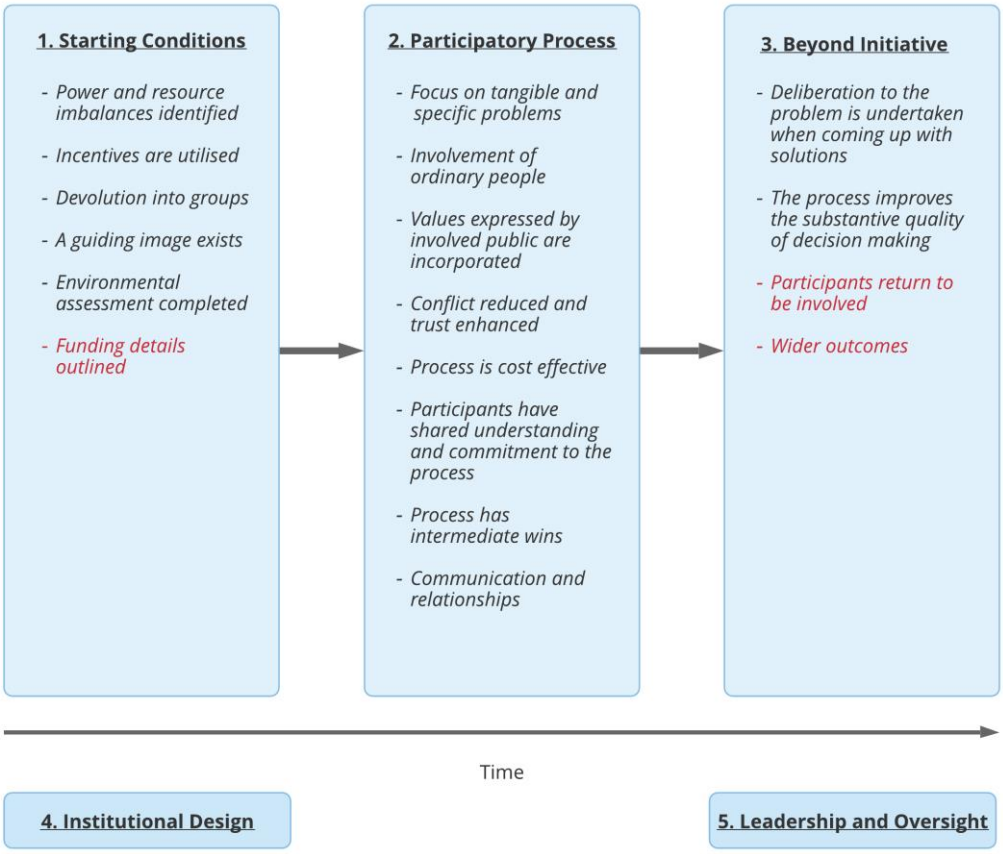


Figure 5.4. An updated version of the model following the case study analysis. New attributes are coloured in red text.

Despite the comparative model components being specified in a temporal manner, the scale and duration of initiatives are not captured. The scale of initiatives was clear when examining the different case study examples. FWW, OPL and RMI are large initiatives that span different regions and countries. Some of these are broken down into smaller units (OPL and RMI). The LCP and PCK are small community driven initiatives and devolving to smaller units may not be appropriate. The comparative model can be used to examine an initiative at either scale. The scale of an initiative can interact with the duration. For example, the OPL has been continued for many years while PCK generated an alternative to the existing flooding management with no further action taken. Some initiatives may have the ability to be cyclic and never end (i.e. there is no defined end

point), whereas others may have a structured end point. The comparative model works for either situation but in those that have a broader goal the process as described by the model could be considered to be a cyclic type model where an intermediate win can flow through each component whilst contributing to the overarching goal of the initiative. This has relevance for the community-based initiatives in the Ōpāwaho/Heathcote River catchment as many have broad goals pertaining to ecological improvements and therefore have no obvious endpoint. Therefore, it is likely that they may go through this process several times. This was seen in the RMI where following prosecution of the polluters, the initiative has continued since with monitoring still taking place.

Each component and attribute is not discrete and is likely to interact with other attributes to reach an outcome, as suggested by Ansell and Gash (2008). Therefore, because one attribute or component is strong does not mean that the initiative will be successful overall. All components and attributes need to be considered as a whole. The specific role of each attribute may be built upon in future research.

5.8 Conclusion

Each component of the comparative model has been discussed using insights from relevant examples of public participation and environmental problem solving. This exercise has helped to derive an indication of where the drivers and barriers may exist in a public participation initiative. This process has extracted new insights not discussed or presented in the initial rendition of the comparative model while simultaneously validating the use of the comparative model to examine example of public participation in environmental problems solving examples.

The case studies have reinforced the value of public participation in environmental problem solving. Case study examples have demonstrated that the public involved in such processes are interested, aware of (or learn about through participating) the complex nature of the problems and with the correct initiative design and support can contribute valuable perspectives into such situations. Having undertaken an examination of case studies using the components and respective attributes it is clear that an intimate understanding of the initiative is required in order to extract valuable insights. This process has demonstrated that the comparative model works for assessing any example of public participation from active participation to passive participation across a temporal scale. Consequently, the model can be taken forward and used as ‘checklist’ to inform existing initiatives or assist in the design of future initiatives. These insights can then be used to inform improvements for community-based initiatives in the Ōpāwaho/Heathcote River catchment.

This chapter has demonstrated how published cases can be used to elicit insights into public participation. However, there is a need to explore public participation more intimately in a local context as written accounts may not provide the level of detail to derive meaningful insights into how public participation may contribute to environmental problem solving. Chapter 6 presents the results of the semi-structured interview process that contextualises insights to public participation into the local context for the study area.

Chapter 6. Key themes of participation in the study area

This chapter presents key themes related to public participation in the study area, which are pertinent to the research objectives (Section 1.3). Semi-structured interviews generated rich insights into the participants' perspectives on freshwater science and management in Christchurch. Responses are presented under the four interview question categories listed in Section 4.3, with additional findings related to the proposed Community Water Partnership (CWP) (Section 3.5). This chapter builds on Chapter 5, to gain a contextual understanding of the drivers and barriers to public participation in the Ōpāwaho/Heathcote River catchment. Furthermore, findings presented in this chapter are significant because they diverge from author expectations at the outset of the research, and help to strengthen the argument for using public participation in environmental problem solving. Codes are used to ensure participants remain anonymous: P for a participant and GP for the group that the participant is from (Table 6.1).

Table 6.1. Participant groups, unique code and category presented in order of groups

Group	Participant (s)	Participant category
GP1	P11	Political/Parliamentary
GP2	P05, P12	Regulatory authority governance
GP3	P01, P04, P08	Regulatory authority staff
GP4	P02, P06, P07, P13	Community
GP5	P09	Community and regulatory authority
GP6	P03, P10	Research/external organisation

Note: This information is visualised in Figure 4.3.

6.1 The condition of New Zealand's urban waterways

The first category of interview questions explored participants' perspectives on the state of New Zealand's urban waterways, key issues of concern, and how change in ecosystems is understood. The initial questions were also important for building rapport with research participants.

Participants agreed that the state of urban freshwater ecosystems in New Zealand and Christchurch is poor. These perspectives align with published reports for both New Zealand and Christchurch (i.e. that the state of urban waterways is poor) (Chapter 1). Participants drew on a range of evidence when responding. One respondent from a regulatory authority (GP2) stated that "we haven't figured

out our stormwater [management] in any urban environment" (P05), while another GP2 participant commented on the complexities of urban catchments, where no single organisation is in charge of land use. They also outlined that the problem (i.e. stormwater contamination) can also originate from individual private properties. This suggests that solutions or strategies for improvement could generate conflict, especially if there is a difference in management responsibilities and opinions about the source of contamination. Conflict is an important factor on the comparative model (Figure 5.1), and is likely to require careful consideration when working with multiple parties (i.e. in a co-production approach). Conflicts may also arise due to the challenges of co-production (Table 2.5). Notably, respondents from regulatory authorities (GP2 and GP3) comprise a mix of decision-makers, and experts (Table 6.1), which may result in resource/power imbalances and disadvantages for the public participating in co-production type initiative.

Community participants (GP4) felt that there was a lack of awareness about stormwater management in the community, in particular the ways in which individual actions can produce contaminants that accumulate in freshwater ecosystems. A disconnect between individual action and the river was noted; "they see it as a natural landscape, but don't see that it is part of a system, and that we are impacting on that system" (P06). Similar responses were heard from other community-based participants, with P13 suggesting that there is a very human-centric approach to managing urban waterways, where lifestyle convenience is placed before the health of the environment. Overall, most respondents said that there had been an improvement in ecosystem health since the reduction of industry inputs (Chapter 3), but there was still progress to be made. Conversely, one participant from a research organisation (GP6) thought care of freshwater ecosystems had declined, citing a negative attitude the council towards riparian vegetation and sediment management. This is an interesting observation considering that sedimentation has a major impact in the Ōpāwaho/Heathcote River and its tributaries. It also further calls into question the ability of the RMA to manage or mitigate the impacts of development (Chapter 3) and is further discussed in Section 7.4.

An interesting opinion regarding the legacy of freshwater management was expressed by P09, who stated that "when I look back on history, they [early European settlers] came to Christchurch for a better world and a better place and a better environment, but they repeated the same issues they had in England. They used the waterways as a convenient way to get rid of their waste, particularly the Heathcote; the Avon was the jewel and the crown. The Heathcote was the poor second cousin, twice removed. It was a dumping ground. It was trashed." This exemplifies the changing hydro-

social connection between people and the local rivers through time (Chapter 3). Moreover, it highlights the perceived poor state of waterways and the need for positive environmental change.

Key issues of concern from the point of view of the interviewees are shown in Table 6.2. Participants were asked to describe an issue directly impacting the health of the waterway (e.g. contamination) or a management-related issue (e.g. such as meeting targets). Responses from participants representing governmental or regulatory authorities (GP1, GP2 and GP3) were generally focused on targets, responsibilities and priorities. This is not surprising as the participants in these groups are from authorities charged with regulation. These participants suggested that management guidelines and targets for freshwater health and water quality, set by central government, would not be met. One participant outlined the need for behaviour change to complement stormwater infrastructure and management regimes, which cannot be relied on to solve the problem alone. GP2 and GP3 participants saw management as complicated, with responsibilities split between different authorities. They also stipulated that there was insufficient resourcing to address these problems appropriately. For example, local government does not have the power to change certain things such as using copper cladding and roofing materials (both of which would require a change to the Building Act 2004). Split responsibilities for stormwater management can impair decision-making. Territorial authorities are responsible for managing the infrastructure (i.e. the piped stormwater network), whereas regional authorities manage the receiving environment (i.e. stream and rivers). Thus the management priorities of government and regulatory authorities could create tensions between parties when attempting to co-produce solutions. This could lead to challenges outlined in Section 2.5, including identifying shared goals and dealing with power relationships. This could result in the public participation initiative being compromised.

Table 6.2. Key issues of concern reported by interviewees with respect to urban freshwater ecosystem health

Group	Issues of concern
GP1	• Ensuring standards are appropriate for consents and rules • Setting up appropriate transitions for rule/regulation changes
GP2	• Split responsibilities between district, regional and central government • Fragmented management for key sectors such as stormwater • Changing behaviour and public awareness • Cost associated with management and increasing rates

GP3	• Resourcing and funding • Meeting targets set under legislation (e.g. local and regional plans and NPS-FM) • Inability to rely solely on stormwater infrastructure to improve waterway quality • Effectively addressing contaminants with existing resourcing, money and priorities • Sediment in streams
GP4	• Contaminants impacting the waterway (e.g. sediment) • Inability to do anything on the ground due to planning/legislation requirements still being developed (mainly for residential red zone area) • Lack of certainty as to what actions they can take • Funding for local groups to be able to do things • Finding out how groups can be of use in addressing the problem • Support for the evolution of a functioning group • Short term thinking and long term effects (such as lack of stringent legislation changes for infrastructure and re-development following the 2011 earthquakes)
GP5	• Behaviour change and marketing/incentivising behaviour change
GP6	• Hard to involve those who have power to act or change anything • Overcoming legacy barriers in management and shifting towards more ecological focused decision-making • When everyone is interested, who is responsible for taking the lead?

Key concerns for community members (GP4) included accessing sufficient funding for community-based initiatives and identifying pathways for involvement in decision-making and management processes. These insights indicate that while there is concern about contamination (Table 6.2), there are also other process-related factors that play a role for community members. One participant from a research organisation (GP6) raised the issue of overcoming legacy barriers (specifically the mandate to improve drainage in waterways) and shifting towards ecological focused decision-making. An example given of the ways in which CCC, and its predecessors (the Drainage Board), have discouraged public interaction with waterways by ensuring drainage is well managed over ecology and other values (Chapter 3). The other participant in GP6, however, questioned what form of leadership would emerge when everyone is responsible for urban waterway health. Interestingly, staff from local authorities (i.e. GP2 and GP3) stated that people do not listen to or trust the regulatory authorities. This supports the idea of a division between local authorities and the public they serve, and also raises the question of whether community-based groups in fact play a role in disseminating key messages to the wider public. These concerns are relevant to starting conditions, and the participatory process, components and attributes in Figure 5.1. This may have implications for relationships and communication with regulatory authorities or government. This was

demonstrated in the Xiaoqing River Restoration case study (Table 5.1), where weak communication, and relationships, between the public and various officials eventuated in poor public participation. This emphasises the need for good institutional design (Component 4 in Figure 5.1). An effective public participation initiative would identify and address these prior to generating solutions.

The majority of informants across all groups stipulated that improvements in ecosystem health would be determined by measurable difference in scientific parameters (presence/absence or change in abundance of key species, reduced contaminants, improvement in ecological diversity metrics). Some participants mentioned that they would know changes had occurred from observing differences in long-term trend data (P05), by comparison against standards (P11), and through the annual CCC water quality monitoring reports (P04). While most GP4 participants acknowledged that there was a range of scientific indices for measuring change, some put forward a range of more social indicators of change. These included: people interacting with the waterway, feeling proud and enthused to walk alongside the waterway, no intergenerational loss of recreational or cultural practices, activities happening next to the river and people engaging with the river as part of their daily lives. Many also suggested a social take on scientific parameters including, a reduction in sediment, being able to harvest food as traditional Māori have traditionally, being able to swim in the river, and seeing an aesthetic change (e.g. riparian planting). These social perspectives were supported by P09, who discussed the absence of a spiritual connection with waterways. This relates to the connection indigenous Māori have with freshwater ecosystems, and role of water in their well-being (Ngata, 2018; Tapsell & Dewes, 2018) (Chapter 1).

Interview responses on this topic suggest that scientific monitoring is the primary way people recognise and understand change. However, there are also social factors that denote change. These findings are critical to the overarching research question, as the research suggests there is a need to continue monitoring initiatives and reporting the results to people. Science communication is addressed later in this chapter (Section 6.3).

6.1.5 Summary

According to participants, the state of New Zealand's urban waterways is poor. Generally, authorities are concerned about targets, standards and priorities, while community members are concerned about funding and how they can be involved in generating solutions. Most participants believe that scientific knowledge, and metrics, will reflect change, while others (largely community

members) understand change in more social ways. These findings indicate the differences in thinking for urban freshwater management and provide the initial indication of the social factors at play in public participation initiatives.

6.2 Responsibility and management of urban waterways

The second group of interview questions explored responsibility for, and management of, New Zealand's urban freshwater ecosystems. Interviewees were asked about who is responsible for the health of freshwater ecosystems, the role of community-based initiatives, whether the public should be involved in the decision-making, and whether there is room in the current legislation for such approaches.

The majority of participants believed that everyone is responsible for the health of New Zealand's urban freshwater ecosystems. P02 stated that "when I say we all are, I mean central, regional and local government, iwi, communities and universities." This also includes schools and businesses with P09 noting "we all have the ability at work, to say to our company, that we want more environmentally sustainable business practices happening in our offices." P02 stated that education in schools is very beneficial, as a positive message can be dispersed through to the wider family. The overarching reason for everyone seen as being responsible was that individuals contributed to the problem, with the source of contamination was being activities on private property and daily practices such as using motor vehicles. The problem "comes from the way we live and the way we treat our environment" (P03). It was suggested that individuals and businesses "change what they do at source, because infrastructure alone cannot fix everything and getting healthy waterways will never be achieved by the things ECan and CCC do alone (P04). While accepting everyone is responsible, P10 placed an onus on individuals to understand freshwater ecosystems and have a sense of pride and place. Regulatory authorities are also seen as sharing responsibility for the health of urban freshwater ecosystems. While these responses primarily show that individual actions need to be altered, there is also a role for regulatory authorities to make changes. An example of this is discussed in Section 7.4.

Compelling responses came from community respondents in GP4. Everyone is responsible because "we are connected to the system and we are all a part of it. But within that…, there are different levels of governance or ability to effect change. Some people have legal ability or policy and planning, but ultimately it is New Zealand citizens, we have to see as important" (P06). P02 echoed this by saying that "those that are more aware of it have a responsibility to ensure others become

aware of it". One participant outlined that the local Māori had a strong environmental ethic. This ethic has influenced the "law and psyche of our people", but is being diminished by the unbalanced "take take take" modern environmental attitude (P13). This aligns with the values that Māori hold for freshwater ecosystems (Section 1.2.2) and how indigenous knowledge (e.g. mātauranga Māori) can be included alongside science to co-produce meaningful solutions (Section 2.5). Some participants considered that governments and councils were also responsible through setting standards and rules. However, P03 expressed concerns about the way local authorities had managed urban freshwaters over time, referring to the example of drainage works in Christchurch (Section 3.2). This approach focussed on improving drainage efficiencies at the expense of ecosystem functioning. A representative of one regulatory authority (GP3) outlined that while various levels of government are responsible for certain aspects of managing urban freshwaters, there was a lack of visibility or acceptance that individuals are also responsible. P11 gave an example where a local community group had a Memorandum of Understanding (MOU) with the local authority. This was to ensure no adverse impacts would result from any work in, or near, that system. The group recently referred to this MOU when planned works by the local authority to add transport infrastructure were likely to have detrimental impacts to the environment of concern. This implies that the local authority neglected the MOU until the group made their formal complaint, suggesting that there is an organisational disconnect between authorities and community partners in decision-making.

Overall, responses to this question suggest that everyone is responsible for the health of urban freshwater ecosystems, and this means that individual (and joint) actions and behaviour change are critical. This theme links to the wider idea of including people in within the ecosystem (Section 2.1). Comparisons can be made to the Loweswater Care Project case study (and to some extent Pickering) where those involved were directly impacted by lake eutrophication (or flooding) (Table 5.1). These people considered themselves responsible for the environmental decline they were experiencing, and had a vested interest in generating solutions (Chapter 5). This can be linked to the community-based initiatives in the Ōpāwaho/Heathcote River catchment. Responses to these questions by community participants demonstrates that members of community-based initiatives believe they are contributing to poor health of the river and are interested in generating solutions. This may motivate them to participate in community-based initiatives. The idea that everyone is responsible for the health of urban freshwater ecosystems also differs from expectations at the start of the research. Differences between participants groups were expected, as participants come from a range of backgrounds (e.g. experts, community members, officials). This signifies the importance of

these findings, as they support public participation to address urban freshwater ecosystem health issues. This is because everyone is seen to be responsible for, and contributing to, the health of urban freshwater ecosystems and therefore can be included in generating solutions to improve it.

In general, participants stated that the public already have a say in the decisions that are made with respect to urban freshwater ecosystem health through existing forums and processes (such as the Zone Committees (ZCs) and submissions processes). GP4 (community) participants suggested that public, or community-based initiatives, need to be included throughout the process of collaboration, stating that this would lead to better inclusion of public opinion and community values in the process. This means that they are not brought in at the end once the ideas have been finalised. This may result in more innovative solutions being generated as suggested in the literature presented in Chapter 2, and case study examples in Chapter 5 (e.g. the Loweswater Care Project and Pickering). P03 suggested, however, that current mechanisms that exist for public participation are broken. P05 stated that avenues for participating are unattractive and inaccessible, stating that people have a lot of "power to sway how much investment is made…, but participation in those type of decisions and submitting on long term plans is a way to put people to sleep." P08 stated that the community is becoming more interested in urban freshwater ecosystem health, leading to more investment from local authorities in public participation. However, it was implied that while the public can have a say, it is important to realise that not everyone wants the same outcome. An example was given on how the community concern about flooding clashed with improved water quality, and how this can challenge councils' collaboration processes. This complexity can be linked back to the challenges of co-production (Table 2.5), and in particular the challenges of reaching a shared understanding and working towards mutual goals.

Interviewees implied that sufficient opportunity for collaboration already exists in legislation. Some participants suggested that while community-based initiatives, or collaboration, are not always acknowledged, it is up to authorities to try such an approach. Another participant stated that while the legislation does not exclude collaboration, decisions are made elsewhere (e.g. CCC). These responses imply that legislation defines the decision-making process and therefore the opportunities for public participation. In contrast, community participants commented that any opportunities within normal planning processes are too constrained, and tightly managed, by local authorities. They said that group activities had been more successful when groups had done things first, and asked for permission later. P06 said that it has become an expectation for regulatory authorities to collaborate with interested public, "although we want to be taken on a journey and not brought in at

the end to react to things" (P06). They cited an example of the recent CCC Global Stormwater Consent application (further discussed in Chapter 7), where community-based initiatives have made submissions for the first time. This participant stated that the legislation may need to be changed to accommodate the growing awareness and consciousness on the part of community-based initiatives. This was reinforced by P05 who stated "we are thinking more strategically, like how do we enable these community groups on the ground to start talking and collaborating?"

Interview responses suggest that traditionally, regulatory authorities and legislation (i.e. the Resource Management Act) have generally excluded public participation. However, this may be changing. If considering co-production and the comparative model (Figure 5.1), having the correct institutional arrangement between parties is crucial for the effective generation of possible solutions. Component 5 on the comparative model (leadership) may also play a role in creating such solutions.

6.2.1 Summary

Insights derived from these questions show that everyone is seen as responsible for the health of urban freshwater ecosystems. Key reasons for this relate to the interconnected nature of freshwater ecosystems, and the impacts that individuals have on these systems. Mechanisms for public participation are generally considered ineffective and in need of updating to improve accessibility. While legislation does not exclude public participation, it appears not to encourage or empower the concerned public. However, some groups have undertaken activities irrespective of legislation. Interestingly, it appears that some participants are expressing aspects of conventional public participation (i.e. the current system is ineffective and public participation can impair the consultation process). This is contrasts with the examples in Chapter 5, namely Pickering, the Loweswater Care Project, and the Riverfly Monitoring Initiative, where participants contributed to decision-making that involved regulatory authorities. Therefore a shift to more inclusive or innovative methods may result in effective outcomes. Responses to these questions further support the initial findings (Section 6.1) that there are a series of social factors that need to be considered in the management of urban freshwater ecosystems, especially if everyone is deemed responsible for the health of these systems.

6.3 Drivers and barriers to public participation

Participants were asked questions relating to public participation. These enquired about the role of scientific and other types of knowledge, and the process of communication of scientific knowledge. They were also asked to share insights into successful public participation, as well as the drivers and barriers to public participation.

All participants believed that scientific knowledge played a critical role in generating solutions to urban freshwater problems. The initial expectation was that because participants came from different backgrounds (Table 6.1), some would have a different understanding of scientific knowledge, especially community group members. However, it is worth noting that many community group members are often highly educated, or have learnt about freshwater ecosystems through being involved in such groups (Section 7.1). Therefore, researchers and practitioners need to be wary that they may be 'preaching to the converted' when working with community groups and initiatives. P09 highlighted that there should be more effort made to investigate the outcomes of particular science 'solution packages'. An example was given where a particular group had a solutions package, but wanted to understand the effectiveness of it. "Can you tell me how much gain we will get in 2025 and 2030 by putting in these measures, what will that allow us to do in 2025 that we can't today" (P09). P12 reinforced the need for community-based initiatives and individuals to be involved in generating solutions alongside science. "You still need that community mandate, and political will, to make that change. But the changes that you do make, you want them to be the right changes." This aligns with P03 who considered that scientists can empower people by engaging them with scientific data. "You walk up to a bunch of lay people, and show them some real data from their stream, and how it is collected. This is a leap of faith that the scientist isn't telling false information, but this is where we can empower people." These examples demonstrate that science needs to be relatable and practical when trying to generate meaningful solutions to urban freshwater ecosystem health problems with the public.

All participants were then asked if they thought other types of knowledge should be included in creating solutions to urban freshwater ecosystem health issues. Respondents commonly expressed a belief that cultural or indigenous knowledge (e.g. mātauranga Māori) should be included, and local, historical and anecdotal knowledge was also considered valuable. P02 said that experiential-local knowledge was crucial as it often extends over generations, and can help understand how rivers respond to floods and other events. When asked why this type of knowledge should be included, participants responded that it "provide[s] a perspective that is not easy to quantify through science"

(P02). P09 supported this, stating that mātauranga Māori was gradually being blended with western science, and its use was being welcomed by both CCC and ECan. Participants also commented that there was value in lay people's observations. P13 stated that "science is observation plus measurement, and a little bit of theorising", and that Māori perspectives were also based on this sort of science. Furthermore, P13 stated that what drives management from a government perspective, is not what drives freshwater management from a Māori perspective, referring to the swimmability standards set by the previous government (Joy, 2015; Knight, 2018). These insights are generally consistent with the co-production literature presented in Chapter 2, which highlighted the use of different types of knowledge (including Māori knowledge) to generate meaningful solutions to wicked problems (such as addressing urban freshwater ecosystem health). The importance of mātauranga Māori and the relationship that Māori have with the freshwater environment was also raised (Section 1.2.2). Considering the wider context of this research, where everyone is responsible for the health of urban waterways, these findings place an emphasis on using co-production as a means of integrating both mātauranga Māori and public knowledge.

Participants thought that both science and other forms of knowledge could be integrated to help generate solutions to improving urban freshwater ecosystem health. Examples specified included the Cashmere Stream Care Group, the Avon-Heathcote Estuary Ihutai Trust and a stream care group in Hamilton. Non-freshwater examples were also given, including the implications of sea level rise for New Brighton residents, and the need to make relevant information accessible to them. Without using a specific example, P09 stressed a need for the gradual integration, or weaving, of knowledge that included mātauranga Māori. P09 proposed the term whiria ngā tāngata, which translates to weaving all the people together. P12, who holds a governance position at a regulatory authority, outlined that decision makers are real people and that contextualising scientific information with day-to-day experiences is an effective way to influence decision-making. Responses indicate that the use of various types of knowledge could be taken forward to co-produce meaningful solutions.

Participants judged the communication of scientific information to community-based initiatives, and the wider public to be poor. A community participant stated that some "professions have held jealously to the[ir] languages as a way to make themselves feel good, relevant and special" (P13). One regulatory authority representative (P08) implied that science communication was not the primary focus of their role. Their focus was to use science information to understand and support the compliance and consenting priorities in local authorities (i.e. regulatory responsibilities). This lack of willingness to communicate science information contrasts with the high level of public

interest and concern for urban freshwater ecosystems (Section 3.4), and exacerbates the inaccessibility of science information to help shape public opinion. However, P08 mentioned that with more resources a position could be created to collate and disseminate information to the public. In comparison, examples in Chapter 5 had environmental or government authorities supporting many of the initiatives (in addition to carrying out their regulatory duties). This included directly working alongside the public to generate solutions, such as in the Loweswater Care Project. Moreover, P06 implied that an interface between science and the community is needed. They outlined this was a freshwater management problem, because people will not engage with information if they do not understand it. This can be compared to the Pickering example in Chapter 5, where through co-production, experts assisted members of the public in understanding scientific information about flooding issues.

Some participants implied improvements to science communication had been made referring to the *Vision and Values* documents (CCC, 2016a), summary card documents and the swimmability ranking information available online. Recommendations for further improving science communication included school education programmes like Whaka Inaka (an inanga/whitebait monitoring and education programme described in Chapter 5), mailing out waterway report cards for local catchments in rates bills, the use of storytelling around natural history and decision-making, and public meetings with attendance by scientists. Some participants outlined how improved science communication could be achieved through the CWP. These findings on science communication have important ramifications considering everyone is responsible for the health of urban freshwater ecosystems. However, it is important to consider that improving science communication may not lead to environmental improvement. There are other factors to consider in generating measurable improvement, especially in freshwater ecosystems. This is discussed in Chapter 7. This can also be placed in the context of addressing the Urban Stream Syndrome (USS), where the syndrome is a matrix of intricate factors, and taking action on one particular issue may not result in overall positive change (Figure 1.1).

Successful public participation was broadly described, by community participants (GP4), as initiatives that empower the community to make their own decisions, and take their own actions, while being inspired to develop a connection with the river. Successful participation also involves integrating effectively with regulatory authorities as demonstrated in Section 6.2. More specific features mentioned by interviewees included having a plan, strong participation, people knowing why they are participating, presence and accountability of decision makers, and having a core of

dedicated people. All of these can help build the credibility required to deliver a project with the community. Central and local government participants (GP1, GP2 and GP3) described success in a similar manner, but with an emphasis on focussing where the energy is, and not being prescriptive. This means going to those who are interested and allowing them to drive the initiative. Participants stated that successful engagement should take scientific knowledge and blend it with the passion on the ground. These attributes of successful participation were demonstrated in the Loweswater Care Project and Pickering examples in Chapter 5. For example, both examples focused on affected people, allowed the community (or participatory energy) to drive the initiative, and blended scientific knowledge with local knowledge. A local authority respondent observed that participation is successful when the group members are achieving what they set out to achieve, stating that their organisation only supports groups with mutual goals. Additionally, P09 and P10 stipulated that public participation needs to appeal to different types of people (i.e. young and old) and be intergenerational to help foster their interest in the environment. These social factors concerning public participation did not feature in the case studies explored in Chapter 5.

Participants were asked to identify drivers of public participation. Drivers motivate an individual to participate (and to continue to participate) in an environmental based initiative (i.e. the Ōpāwaho Heathcote River Network or Cashmere Stream Care Group). Four key themes relating to these drivers are shown Table 6.3. Participants proposed drivers that are related to fostering participation, providing resources and support, and improving the function of groups (Table 6.3).

Table 6.3. Thematic table of drivers to public participation

Theme	Drivers
Fostering participation	• Empowering and motivating participants from different backgrounds to become involved • Explaining the task and wider vision/goal to ensure understanding and relevance • Developing key projects with realistic expectations • Ensuring participants feel that they are valued and making a difference personally • Generating sincere engagement from councils/regulatory authorities
Providing resources and support	• Making relevant information and knowledge available to answer questions • Ensuring groups have centralised support throughout the duration of the project • Investing in behaviour change • Providing sufficient equipment and resourcing • Investing rates back into the community to look after the river
Improving the function of groups	• Developing a good plan • Assigning roles (e.g. administrator, chairperson, treasurer and secretary) • Identifying community champions and other committed/dedicated people with drive and passion • Inviting the people closest to the issue to address it • Utilising and improving existing groups which others can join
Relationship between participants and the river	• Generating and fostering a relationship with the river • Encouraging collective guardianship • Bringing people to the waterway to learn

Informants, from the public or community-based initiatives (GP4), identified drivers such as getting support for activities and projects, having access to the relevant information to answer questions, creating engaging activities, having a good plan and having champions to drive the process (Table 6.3). P06 also said there was a need to connect and work with local authorities. “Every group is only as good as the people that are in it. It’s the ability to be able to make connections outside of your group to facilitate things happening. You can’t operate in isolation, it’s all tied into CCC and ECan” (P06). It seems that these groups are investing their participatory energies in trying to engage and connect with local authorities (or decision makers). Having sincere engagement was recommended as a driver by P03. This queries the institutional design of the participation mechanisms currently in place for public to engage with regulatory authorities. Institutional design is a key component in Figure 5.1 (the comparative model) and may have implications for future development of the CWP (Chapter 7) or other formal public participation and partnership initiatives.

An interesting driver theme was generating and fostering a relationship with the river (Table 6.3). P07 from GP4 stated there is a need to “create that element of obligation, to you personally, until they [the public or group members] attach themselves to the stream, and then that obligation becomes stronger than the attachment to you as an individual”. This suggests that members of community-based initiatives are driven to participate in urban freshwater decision-making by a relationship with their local freshwater ecosystem. Other themes can largely be considered to be consistent with most public participation activities (e.g. having time and resources), whereas a relationship with the river system is worthy of further exploration. Other drivers across the themes listed in Table 6.3, such as having passion to act, encouraging collective guardianship, and supporting those closest to the issues can be interlinked into the relationship theme. Therefore, this theme forms the foundation for discussion in Chapter 7. These threads provide rich insights into the motivation behind community-based initiatives to be involved in urban freshwater management or decision-making. Participants seem driven by a relationship with the river and want to encourage others to do the same. While a relationship with the environmental system did not feature in the case study analysis (Chapter 5), this could be an underlying theme that motivated those to participate (or return to participate in initiatives such as FreshWater Watch or Open Air Living Laboratories) (Table 5.1).

Participants were then asked to identify barriers to public participation. Barriers could be described as factors that which discourage or stop public participation. These factors may be institutional or personal. These are presented under four key themes in Table 6.4. In general, there was some overlap between groups on the barriers suggested. Barriers to public participation included being 'out of touch' with the health of the environment and the complexity of scientific information impairing connections with the river/environment. These barriers place importance on the relationship between participant and river theme as described above and emphasise the importance of effective science communication (Table 6.3).

Table 6.4. Thematic table of barriers to public participation

Theme	Barriers
Resourcing	• Inadequate funding at community level • Insufficient resources to consult and implement community desires
Limiting aspects of the public or the group	• A desire to protect the group (e.g. not allow for new idea or new participants) • A negative mindset • A lack of knowledge • Being busy and/or immersed in a consumerist life style • Lack of awareness of benefits of participation • Shortage of time • Inadequate skills • Lack of energy • Proving your credibility and success • Lack of awareness of application of what they are doing and whether it will have an outcome or impact • The feeling of powerlessness and wanting effort to be valued • Connection with the river/environment impaired by complexity of science information
Obstacles at operational level	• Poor institutional processes and lack of trust in a process • Shortage of dedicated people at regulatory authorities to help groups • Difficulties of working with local regulatory authorities • Absence of a connector between local and regional authorities (i.e. CCC, ECan and Zone Committees) • Finding people to develop a plan that will work • Knowing how to connect with others/who to connect with • Access to people who actually advise them on where their efforts would be best spent

	(i.e. a facilitator)
Ownership	• Land ownership • The ownership and control of waterways by regulatory authorities

Participants considered that people are busy and that it takes time to engage with formal processes (limiting aspects theme in Table 6.4). This was paired with insufficient funding and resources for local authorities to engage with community-based initiatives under the 'resourcing' theme. The barriers placed under the 'limiting aspects' theme are considered barriers because they "are the key factors that impact on the functioning of [volunteer groups]" (P06). Aspects of group functioning can be seen in Table 6.3, which also suggests that there is a critical, but complex, set of interactions that lead to the functioning of a group. This demonstrates that community-based initiatives require a particular skillset, and cannot rely on simply being a group of like-minded individuals. This was reinforced by P09, who commented about how groups can sustain themselves if they lose keystone members, having observed similar outcomes happen in a number of cases. Interestingly, aspects of group functioning were not apparent through the case study analyses (Chapter 5) and are not displayed on the model (Figure 5.1). Group functioning issues could have been worked through in the case studies by having leadership or facilitators (Component 5 in Figure 5.1), or were simply not documented. Group functioning seems to be an important aspect for developing and improving public participation initiatives, and this suggests a need to consider social factors in future public participation endeavours.

A barrier theme that stood out was 'obstacles at an operational level' (Table 6.4). This theme relates to poor institutional and regulatory systems, and inefficient mechanisms for individuals (or groups) to have their say. It also touches on challenges in working with local authorities. When asked if working with regulatory authorities was a barrier, one participant insisted that groups need to be proactive, as regulatory authorities "only understand what we need if we go and show them. I'm like a connector. If there is a problem, instead of complaining about it, we just get out and do it" (P06), as opposed to waiting for regulatory authorities to approach groups. The same participant said that having no connector between ECan, CCC, and the ZCs was a barrier. They suggested that one person, or agency, that works to create the linkages between all stakeholders would be beneficial. Additionally, GP6 participants mentioned ownership and control of freshwater

ecosystems, citing the previous management regimes in Christchurch (Chapter 3) and how aspects of this regime continue today. “As long as you’ve got a situation where the councils believe they own, manage, and control the waterways, and everyone else can fit in, then you are not going to get results” (P03). Furthermore, according to this interviewee, these regimes have discouraged people participating in management. Despite highlighting poor institutional processes as barriers, current and previous management regimes were not specifically identified as a barrier by participants in GP3 (staff of the regulatory authorities). This supports ownership and operational obstacles being barrier themes (Table 6.4). In addition, a GP2 participant stated “the fact that our waterways are degraded across New Zealand, whether urban or rural, shows that the RMA has failed to deliver” (P05). This suggests that the regulatory legislation (the RMA) is ineffective and that this could be contributing the operational obstacles theme. This is further demonstrated in Chapter 7.

These insights show that there are several barriers to public participation produced by institutional and regulatory systems. Feelings of powerlessness and efforts being under-valued were expressed by a GP4 participant. Therefore, operational obstacles are considered the overarching theme in relation to barriers to public participation. However, while institutional design is a key component of the comparative model (Figure 5.1), legislation is not specifically listed. This does not mean it is necessarily overlooked by the model. For example, the Riverfly Monitoring Initiative example (Chapter 5) described outcomes that related to legislation (e.g. the prosecution of polluters in court). Pickering and the Loweswater Care Project also implemented changes that would have possibly had legislative or regulatory ramifications. These insights identify that future efforts should be focussed on the operational obstacles to public participation. While barriers to public participation exist, P05 stated “I’m always impressed how individuals or groups, no matter what the barriers, still manage to get something done.” This highlights the devotion of community-based initiatives to overcome barriers to public participation.

There are many related drivers and barriers to public participation (Table 6.3 & Table 6.4). In this thesis, they have been discussed as distinct drivers or barriers, in order to gain an enriched understanding of the underlying factors (Chapter 7). Some participants said that all drivers and barriers interact. Identifying the drivers, and barriers, to public participation has provided a platform that can be used to construct meaningful future improvements in freshwater management regimes, and decision-making. This may have implications for community-based initiatives in the Ōpāwaho/Heathcote River catchment and is further discussed in Chapter 7.

6.3.1 Summary

Responses to questions in this category reveal that scientific and other forms of knowledge, such as mātauranga Māori, are important when generating solutions to urban freshwater health issues. The findings presented above indicate that co-producing knowledge may be a pragmatic method for freshwater management. Science communication is considered poor, and although not the primary focus of local authorities, it may be improving as a result of public concern. There is a range of drivers and barriers to public participation that fit under key themes. It is important to note that these interact, and are unlikely to be discrete variables with respect to public participation. The overarching theme to emerge out of the discussion of drivers is that participation is fostering a relationship between the freshwater system and people. This can be reinforced by a series of other drivers. In terms of barriers, the overarching barrier theme is the operational obstacles, including the legislative (or regulatory) system (i.e. the RMA) and the institutional processes that it entails. Group functioning dynamics (Table 6.3) also appear to be critical to public participation.

6.4 Application on the ground

The fourth group of interview questions queried the application of community-based initiatives and their characteristics in New Zealand, and Christchurch. Questions were designed to understand how Christchurch community-based initiatives could play a bigger role in improving ecosystem health. They also probed whether community-based initiatives should be provided with some form of oversight, or leadership (e.g. by professionals or academics), and what other forms of support would be valuable for these groups.

Government and council participants (GP1, GP2 and GP3) said that in order to play a larger role in improving ecosystem health, education was needed to help with public awareness and behaviour change. These participants suggested that community-based initiatives could spread positive environmental messages to the wider public, as well as continuing their advocacy (through working on formal submissions and placing pressure on regulatory authorities). In addition, P04 stated that to improve the care of urban freshwater ecosystems the public can be the “eyes and ears on the ground” to monitor compliance. However, this assumes that there is sufficient knowledge among members of the public to be able to carry out such duties. An example of this can be seen in the Riverfly Monitoring Initiative case study (Chapter 5), where data collected lead to the prosecution

of a polluter. The CSCG have collected sediment data for close to 10 years (Section 7.1) and, in line with the above, the community-based initiatives could be involved in monitoring compliance. However, this relies on having an effective institutional and regulatory system that enables such groups and data to be used, and ensuring that the data collected is sufficiently rigorous to be suitable as evidence in any formal proceedings.

A collaborative approach that connects groups and local authorities with centralised support was recommended. Participants were in favour of an initiative such as the CWP, as a means for groups to make progress on improving urban freshwater ecosystem health. This was reinforced by P09, who stated that the ZC could place more pressure on local authorities to support these groups. GP4 respondents implied that to play a bigger role, opportunities were needed for the public to engage with the river. P06 stated that it is about connecting people to their own environment in order to help improve the care of freshwater ecosystems.

P01 (a regulatory authority representative) did not believe that groups cannot currently play a bigger role, citing the need for more funding to form a partnership type approach. This could create a pool of resources and expertise across groups. Interestingly, P12 said that they were unsure if they (the regulatory authority) funded the groups and stated "as a councillor I would like to know how we could support them to do more…I don't think we fund them at all. Would it help if they had a coordinator? And would that be making more use of their time and energy on the other things?" This observation indicates that those in governance or decision-making positions have a limited understanding of current public participation in Christchurch. It reinforces the organisational disconnect. For example, although the Ōpāwaho Heathcote River Network formally submitted to CCC on the Long Term Plan (LTP) for Christchurch, expressing their support for the CWP to help community-based initiatives become more effective (Section 7.1), the CWP was unsuccessful in receiving funding through the LTP. This can be linked to the idea of operational obstacles being barriers as discussed in Section 6.3, because those in decision-making positions may be unaware of how to best assist community-based initiatives.

Participants thought that oversight or facilitation would be beneficial. One participant stated, "I think that is when they [community-based initiatives] are most successful" (P05). GP4 participants supported this, with P07 saying they would not have credibility without the support of science professionals. Another said that support to evaluate proposals generated by community-based

initiatives was required for two reasons: it ensures there is technical expertise, while also simultaneously ensuring robustness in the process. P06 stated that a facilitator was key in a community organisation to help move through the stages of a functioning community group. “We can all have the passion but facilitation is needed so they can help the group effect change and evolve.” They highlighted that the person needed to be skilled and removed or independent from the group. In contrast, participants from GP2 and GP3 implied that groups are their own entities, and should be striving to get the latest information on urban freshwater issues. P08 stated that little time was allocated to supporting these groups, despite regulatory authorities receiving a lot of requests from various groups. P12 outlined that while oversight or leadership may be beneficial, it could also be dis-empowering if it came from the top-down. Table 6.3 includes improving the function of groups as an important theme, and shows that this may involve having driven individuals or champions. This was supported by other GP4 participants. A contrast emerges between internal leadership and external facilitation. Groups may have community leaders yet still require external facilitation to engage in current public participation mechanisms, especially if such mechanisms are ineffective, as suggested in Section 6.2. For example, the Loweswater Care Project example, where community champions (farmers) started the group and then received support to implement change from various agencies (Chapter 5). Opinions highlighted the importance of operational obstacles as a barrier. GP2 and GP3 participants (from regulatory authorities) implied that leadership or oversight is not required for groups to play a greater role, despite GP4 participants stating that they require assistance to move forward. This might reflect a power imbalance (i.e. regulatory authorities seem to have greater power) (Table 2.5). Leadership and oversight are depicted in comparative model for public participation (Component 5 in Figure 5.1). Most case studies discussed in Chapter 5 had some form of leadership, while examples such as the Loweswater Care Project and Pickering case also benefitted from the leadership or oversight. In fact, these two cases share similar characteristics to Ōpāwaho/Heathcote community-based initiatives. Therefore leadership or oversight is likely to benefit these groups, especially considering the responses above from GP4 participants.

To gain a fuller appreciation how current initiatives could play a bigger role, participants were asked what sort of support would be valuable. Responses included having more resources and funding to help create a more organised and integrated approach (such as the CWP). The approach would include sufficient resourcing to fund facilitators, secretarial positions or administration assistance. This could assist with group functioning (Section 6.3). The approach would

simultaneously assist in making participation mechanisms more accessible by breaking down the barriers discussed above. Suggestions also included having a centralised and collective space for groups to use. In essence, the responses mirror those in Section 6.4, while addressing some barriers in Section 6.3 above, and reaffirming the need for a well-tailored collaborative approach.

6.4.4 Summary

This group of questions indicates there is a variety of ways that community-based initiatives could improve the care of urban freshwater ecosystems. Participants valued the idea of external support to help groups navigate complex processes and assist with group functioning. However, such support needs to be tailored to particular community-based initiatives to ensure it is not disempowering. Support for an integrated and collaborative approach was suggested to be of value. Insights obtained through responses have implications that can be taken forward to improve future initiatives and re-examine existing approaches to participation (Chapter 7).

6.5 Partnerships

Interviewees were asked for their perspective on the CWP (Section 3.5), which was a recurring theme throughout the interviews. Specific questions focused on participants' understanding and awareness of the CWP, and what aspects would be desirable for their group in such an initiative. Participants who were not asked this question during the interview were given the opportunity to answer it when the transcripts were returned to them for review (as part of the Human Ethics Application procedure). Responses to these questions are documented and summarised below.

A majority of the participants were aware of the CWP and thought it was worthy of pursuing as a contemporary freshwater management approach despite the initial iteration not receiving funding (Section 3.5). Desired aspects for a partnership approach are displayed in Table 6.5. Responses were similar across all groups, with a coordinated and collaborative approach commonly suggested.

Table 6.5. Desired aspects of a community water partnership

Aspects	Description
Resources	• Well prepared shared resources that community-based initiatives and organisations can all use • A contestable (but low administration) fund that community-based initiatives can access to undertake projects • Information source, support for NGOs in running projects, up-skilling etc • Shared/collective objectives moulded together for one funding application • Providing incentives to participate
Collaboration	• Collaboration on an equal basis where all parties have equal input and influence • Commitment between CCC and ECan to work with and support NGOs/community-based initiatives • Establish and maintain connections and linkages between the agencies and groups (with someone employed to do this) • Establish a framework for collaboration in projects and involvement in projects from the beginning rather than consultation at the end of the process • Sharing expertise, resources, working jointly on projects • Encouraging a forum where community-based initiatives can feel heard and that they are having an influence • Centralising passion, commitment and drive and pull community-based initiatives together into one collective voice • Allowing community-based initiatives to provide input with regards to desired outcomes and goals • Relationships and valuing one another and the work each group does • Coordinated approach/action plans
Support	• Support from local authorities/agencies • Properly resourced community-based social marketing approach to behaviour change • Information source, support for NGO in running projects, up-skilling etc
Process	• Co-jointly developing goals and the process • Raising community group capacity • Reducing barriers to undertake community initiatives/projects • Annual gathering to update what community groups are doing • Flexibility to evolve and develop further as future potential is revealed • Collective knowledge of the different groups and the opportunity for different groups to lead different things • Agreement on a big vision (high level concepts and addressing key issues in a big picture manner) • Educating the community to improve waterway health/achieve outcomes

	• Focussing on waterway health issues collectively, not just on stormwater, or isolated components • Aligned to big picture vision/strategy

Participants stated that a partnership was an opportunity to properly resource a community-based social marketing approach to behaviour change that simultaneously assists in eliminating barriers that groups face when trying to undertake a project. They emphasised that this would require the input of behaviour experts and social scientists to the process. A GP4 participant said that there could be a specific person assigned to help the groups, and this was supported by comments in Section 6.4. Other aspects included equality and having equal influence in collaboration scenarios. P11 indicated that central government would support and endorse environmental partnerships (between central and local/regional government). It was suggested that central government could set standards to help transition problematic industries away from polluting and invest money into a centralised process for working with community-based initiatives. Aspects identified as important for a partnership may be used to support the drivers and overcome the barriers presented above (Table 6.3 & Table 6.4).

P07 raised the importance of catchment-specific issues, implying that a poorly constructed initiative may result in wasted efforts or disengagement from particular groups. They stated that different groups would have their own goals and problems depending on their local stream and catchment dynamics. For example, sediment is of greater concern for the CSCG (Chapter 3 & Chapter 7) than for other groups. This is important when considering the USS (Figure 1.1) as different issues may drive the USS in different areas. Similarly, another participant stated that a partnership needs to consider waterway health, not just stormwater. A GP2 participant outlined that the best way to improve water quality would be to use street sweepers more often, but outlined this would have a detrimental impact on rates. It is simplistic to solely focus on pollutants entering from the stormwater system. While endorsing a partnership approach, the same participant stated “I just don’t think councillors had enough overview on it” (P12). This is an interesting comment given that community-based initiatives made submissions and presented evidence at the hearing for the LTP (Section 7.1). These examples imply the communication between GP2 (regulatory authority governance) and GP3 (regulatory authority staff) in their organisations is ineffective. It also shows a lack of knowledge on the issues facing urban waterways and the benefits of potential solutions such as the CWP. This evidence supports the organisational dis-connect outlined above (Section 6.4) and

has implications relating to the overarching barrier theme (e.g. a lack of investment in supporting or facilitating community-based initiatives). This also questions the purpose of the surveys carried out to elicit public opinions on environmental quality and issues (Section 3.4). Such a disconnect may compromise efforts in practice when working with community-based initiatives or implementing management strategies. These examples of organisational disconnects were also implied in Section 6.2 (the MOU example) and 6.4 (what support groups want). These are discussed later in Section 7.4.

Some participants were asked whether they were included in the development of the initial CWP. These were participants from GP3 (regulatory authority staff who contributed to the development of the CWP) and GP4 (members of community-based initiatives). There was some involvement of community-based initiatives but perhaps not at the start of the process with one participant from GP4 stating that the initiative was developed within council, and meetings were then held to determine how to advocate for it in the LTP process. In addition, they suggested that it needed more community involvement to develop its framework. This is an important point as community-based initiatives have asked to be involved in the process from the start to ensure that the collaboration process is meaningful rather than being brought in at the end. The development of the initial CWP is an initiative that could have been assisted by the comparative model (Figure 5.1) where starting conditions are critical (Section 5.2). Future iterations could consider using the model to assist developments.

6.5.1 Summary

The examination of emerging themes helps gain a greater understanding of the role of community-based initiatives in improving urban freshwater ecosystem health while simultaneously providing ways to improve the CWP. Desired aspects of a partnership in Table 6.5 can be integrated into revisions of the current initiative ultimately generating a meaningful outcome. It seems that the partnership was created using a more top-down approach rather than a mutualistic process from the beginning. Combining the desired aspects and reviewing the existing documentation may yield beneficial results.

6.6 Conclusion

This chapter has presented findings pertaining to the drivers and barriers of public participation (Objective 1) and provides insights to understand these drivers and barriers in the context of the study area (Objective 2). Findings derived from the semi-structured interviews add contextual insight to those presented in Chapter 5 with relevance to the Ōpāwaho/Heathcote River catchment. These findings differed from initial expectations at the outset of the research. It was expected that there would be a divergence of opinions expressed around who is responsible for urban waterways, the types of knowledge that can be used to generate solutions, and the role the public have in decision-making. Instead, there is widespread agreement across most questions. Results from this chapter indicate that there is a series of intricate social and group processes that are in play for community-based initiatives that are working in river care at a local scale. Insights obtained through the semi-structured interview process can be paired with the case study comparison in Chapter 5 to understand the role of community-based initiatives in addressing urban freshwater ecosystem health issues. The combined insights provide a valuable foundation to re-develop and create new approaches to urban freshwater management, where groups can be effective in the co-production of knowledge, such as through a partnership with authorities. Findings from this chapter are summarised in Table 6.6. Chapter 7 provides a discussion of these findings exploring the linkages between finding from both Chapter 5 and Chapter 6 to gain an appreciation of how public participation and co-production can inform future urban freshwater management and decision-making (Objective 3).

Table 6.6. Summary of key of findings from Chapter 6

Section	Key findings
6.1	The state of New Zealand urban freshwater ecosystems is seen as poor Issues of concern differed-from addressing targets/priorities, to understanding the role groups played, and accessing support Change can be measured using scientific and social parameters
6.2	Everyone is responsible for the health of urban freshwater ecosystems The public already have the opportunity to participate in freshwater decision making but the mechanisms are broken, or ineffective at allowing this Legislation does not exclude public participation but it also does not empower public participation

6.3	Scientific knowledge is critical and other forms of knowledge can be used when addressing ecosystem health issues Science communication is poor but improving The overarching theme relating to drivers of public participation is fostering a relationship with the freshwater system The overarching theme relating to barriers is that of operational obstacles (the complexity of the regulatory system and navigating this as a community group)
6.4	Improving the care of freshwater ecosystems can occur through education and awareness paired with continued advocacy and collaboration Leadership and/or facilitation is thought to be beneficial for groups if devised with the group Other forms of support include the funding/resourcing of an organised and integrated approach
6.5	A centralised collaborative approach that is well resourced was commonly expressed as a priority for a community water partnership

Chapter 7. Significance of case studies and key themes to the study area

This chapter opens with author observations of the Ōpāwaho/Heathcote River community-based initiatives. The significance of findings from the case study analysis and semi-structured interviews are then examined in the context of the Ōpāwaho/Heathcote River catchment. The key driver (a relationship with the river) and barrier (operational obstacles) to public participation shape this discussion. These are then linked to insights relating to the city's proposed Community Water Partnership (CWP). The research findings are then applied to wider contexts (i.e. Christchurch, New Zealand and internationally). The conclusion links them back to literature and theory presented in Chapter 2.

7.1 Observations of the Ōpāwaho/Heathcote River community-based initiatives

Observations from key groups in the Ōpāwaho/Heathcote River catchment are important to gaining a rich understanding of the context in which these research findings apply. These observations were obtained through attending and participating in several meetings, projects and events that the groups ran during 2018. Observations were made from both the OHRN (Ōpāwaho Heathcote River Network) and the CSCG (Cashmere Stream Care Group).

7.1.1 Cashmere Stream Care Group

The CSCG formed in 2006, with the group becoming increasingly invigorated following the 2010/2011 Christchurch earthquakes when there were greater concerns for the health of the river. Members have been supported by credible scientists since their existence and meet when required (usually around 3-4 times a year). In 2018, the CSCG ran a tree-planting day in September to continue a restoration project that the group (with support from ECan and CCC) had commenced the year before in the stream headwaters (Figure 7.1). More than 30 people attended and ECan provided support. The event was held on private property where the headwaters of the Cashmere stream flows. The landowners are passionate about the group (as they are concerned about the health of the wider catchment) and wanted to contribute by planting their section of the stream. These landowners' dedication to fencing off and planting a portion of their property signifies the importance of creating a connection to the stream (as discussed in Chapter 6). Planting days are

important as members can feel like they are physically creating change, whilst engaging with the stream. This is likely to encourage their participation.

In August 2018, the group produced a newsletter with support from EOS Ecology that presented findings from their water clarity data collection that commenced in 2010. This was the first time that the group had published a synthesis of any of their water clarity data. Clear patterns were shown of decreasing water clarity from the top of the catchment to the bottom (Cashmere Stream Care Group, 2018b). The newsletter is visually appealing, making the data and associated patterns stand out for the audience (local people who have an interest in the health of the stream). It covered the different areas in the catchment and their relative water clarity change. In addition, images were used to show how sediment is deposited into streams, the impacts it has on stream health, and what the group is doing to address this (Figure 7.1) (Cashmere Stream Care Group, 2018b).

Figure 7.1. Top: Excerpt from the Cashmere Stream Care Group newsletter (August 2018). **Bottom:** One of their planting days held in September 2018. (Source: Cashmere Stream Care Group, 2018b and Will Keay, September 2018).

7.1.2 Ōpāwaho Heathcote River Network

The OHRN has a clear set of targets for action (Figure 7.2) that demonstrates their strategic intention to participate in urban freshwater management. This can also be linked back to the 'Oreo model' (Figure 3.5) where the network is the 'cream filling' between community groups and governance/regulatory authorities. The OHRN meets once a month with representatives of the different community groups making up the committee (Figure 3.4). Meetings usually consist of dealing with correspondence and planning events/projects/submissions. Presentations are often made by local experts on freshwater ecosystems and the waterway/stormwater network (e.g. a presentation on the city's sewerage and wastewater network). One particular meeting was facilitated by an ECan staff member and aimed to develop the roles for committee members in 2019 and identify actions for the coming year. This is of interest because it became clear that considerable energy and resources are required to have a well-functioning group (as described in Section 6.3). In 2018, the group was also awarded funding from the Rata Foundation to assist it in running events and activities (such as an annual photo competition).

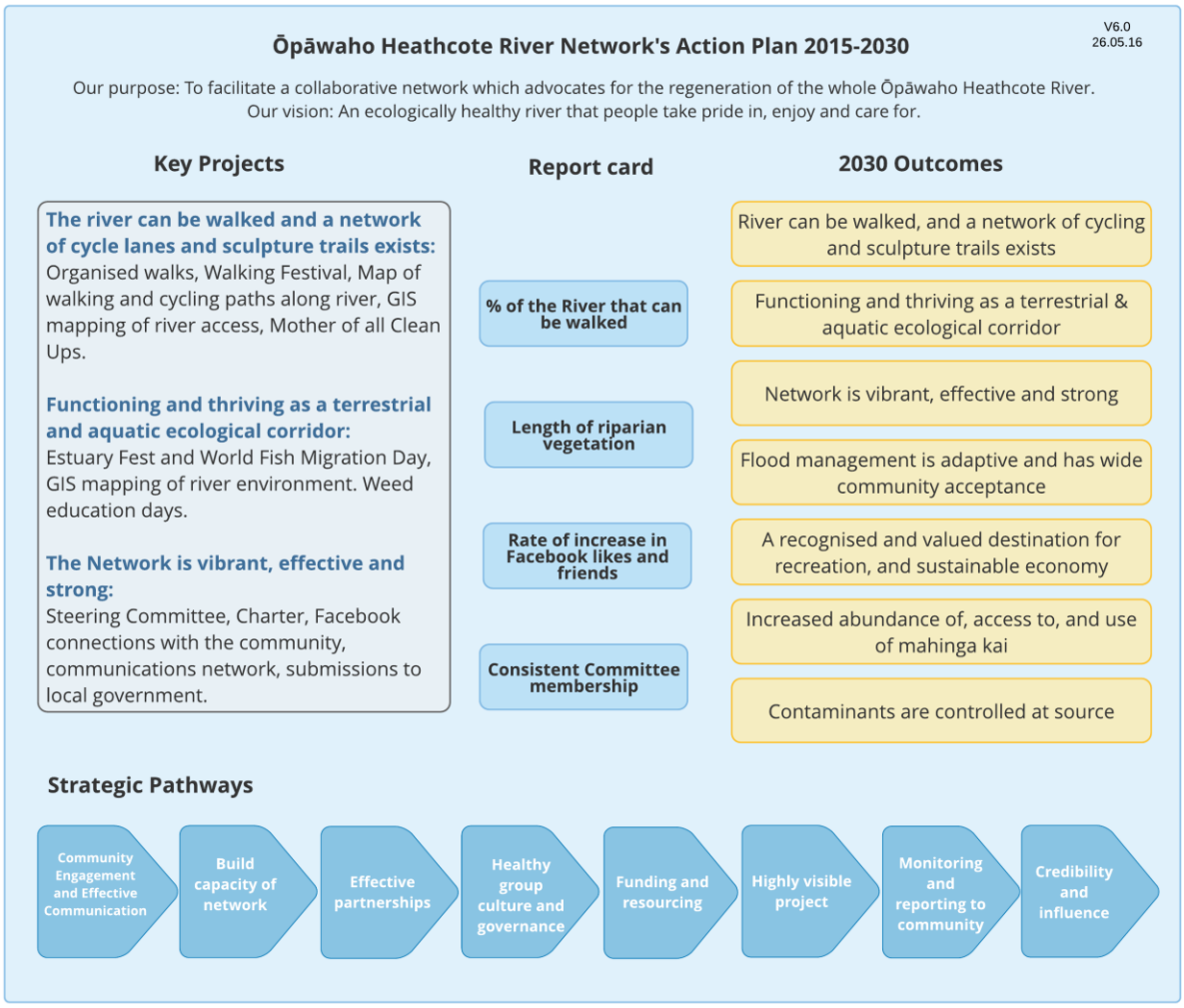


Figure 7.2. The Ōpāwaho Heathcote River Network action plan. This action plan can be connected to the 'Oreo model' shown in Figure 3.5. (Adapted from Ōpāwaho Heathcote River Network, 2016).

In 2018, to mark *World Rivers Day*, the OHRN ran a photo competition. There were three categories and photos had to be taken on the day to be entered. Figure 7.3 is a photo that was entered into the competition by the author under the *People and the River* category. The purpose of this event was to get people interact with the river and celebrate *World Rivers Day*. Photos from the competition are also used on the networks social media profiles to showcase the river from the community's perspective. This activity can be related to the overarching driver theme where the group is trying to encourage a relationship with the river, through using images on social media and publicly displaying entries at a local library. The competition was judged, and award ceremony attended, by several staff members from local authorities (ECan and CCC), as well as representatives from companies that sponsored the event. This demonstrates the connections that the network has made. This can be linked to Component 4 of the comparative model (Figure 5.1)

about having meaningful connections or relationships and is likely to have implications for future public participation initiatives. Participants in the Pickering example (Chapter 5), held a public exhibition, suggesting that the public communicating activities and results can be an important aspect for community-based initiatives. Another event held by the OHRN that encouraged a relationship with the river was the river walk that traversed a length of the river stopping at local reserves and other points to discuss the key features in the catchment.

Figure 7.3. An image entered into the *World Rivers Day* photo competition titled "A Top-Down Approach". This photo won the award for the *People and the River* category. (Source: Will Keay and Ben Karalus, September 2018).

7.1.3 Submissions

Another key action of the OHRN, in addition to planning and running events, is to make submissions to local government (Figure 7.2). In 2018 they submitted to the CCC Global Stormwater Consent (GSWC) and the CCC Long Term Plan (LTP). Whilst these submissions were completed by the OHRN, they represented the interests of the groups that the network comprises

(i.e. CSCG) (Section 3.5). Representatives of the OHRN attended the hearings for the submissions to present their evidence. Submission details for the LTP covered a range of points including the CWP, stormwater, waterway ecology and collaboration. Requests for these aspects included increased funding for improving the ecological health of the Ōpāwaho/Heathcote River through a council programme, the development of a Recovery Plan for the river with all stakeholders (CCC, ECan, Ngāi Tahu, OHRN and others), involvement of OHRN in CCC community projects, support for various stormwater infrastructure programmes and projects including identifying the Hayton's Stream Catchment (heavy in industry) as an important sub-catchment (A. Hasselman pers. comm., 2019). The submission stated the vision of the group (Table 3.3) and also criticised the CCC. "CCC must also face up to its responsibility to provide healthy waterways for its residents." (A. Hasselman pers. comm., 2019). Concern was also expressed on the lack of planned wastewater infrastructure upgrades. The submission also requested $1 million to fund the CWP. Despite input from these community-based initiatives, the CWP did not receive any funding through the LTP process (Section 3.5.1).

The submission for the GSWC outlined seven issues of concern. These included the definition of stormwater network incorporating rivers and the ambiguity that arises in a prosecution scenario (i.e. a polluter could argue that a discharge directly into river is allowed as it is part of the "stormwater network") (A. Hasselman pers. comm., 2018). The fundamental issue raised in the submission was the development of an Ōpāwaho/Heathcote River Stormwater Management Plan (SMP). Reference was made to the legal submission of CCC "where the Council does not consider it necessary to include River Care Catchment Groups, such as the OHRN, in the development and review of SMP's" (A. Hasselman pers. comm., 2018). The legal submission stated that consultation with the local Zone Committee (ZC) and community boards is sufficient. The OHRN stated how they strongly disagree with this point. Reasons included (i) that the ZC will not be able to organise effective consultation and discussion with community groups within the proposed timeframe, (ii) that community boards may not have expertise on water quality or water management issues or a catchment approach, (iii) and that a Christchurch West Melton Sub-Regional Plan has not yet been developed to allow community groups to input their concerns (A. Hasselman pers. comm., 2018). The OHRN requested in their submission that the network is considered a key stakeholder and that consultation with them takes place on the Ōpāwaho/Heathcote River SMP. They stated that these requests are written into the conditions of the GSWC. There may be implications in this consent which encourage and formalise public participation by community-based initiatives (i.e. the CSCG

and OHRN). This may include being formally consulted on the SMP or other significant development activities that take place in the catchment. It may also encourage the wider public to participate in various initiatives.

These examples demonstrate the devotion of volunteer community-based initiatives to advocacy and inputting their opinions into environmental decision-making processes. Motivation to participate in such processes may come from having a relationship with the river system. Insights from Chapter 2 (co-production examples) and Chapter 5 (case studies) show that community-based initiatives add beneficial insights when decision makers provide to opportunity for public participation. Chapter 6 suggests that community-based initiatives in the Ōpāwaho/Heathcote River catchment may not have these opportunities. Moreover, the fact that the council does not deem it reasonable to work with such groups in this context supports the overarching barrier theme described in Chapter 6. Consideration of how groups are involved in formal planning mechanisms should be considered in future.

7.1.4 Summary of observations

Ōpāwaho/Heathcote River catchment community-based initiatives undertake a range of activities and projects driven by having an inherent connection with their local freshwater ecosystems. A key observation is that that the CSCG has an extensive dataset spanning many years and sites. This is valuable as this data helps them to shape their own opinions and develop a better understanding of the freshwater system and the issues present. This provides a foundation for future advocacy. In comparison, the OHRN are expressing their desires into decision-making processes through using the formal mechanisms administered by the regulatory authorities. This could be considered as co-production operating on a smaller, more localised scale (similar to the Pickering and the Loweswater Care Project case studies).

During a session at the 2018 NZFSS conference in Nelson on citizen science, an emphasis was placed on how data collected by community-based initiatives could be better used and how quality control assessments could be performed with the aim of further empowering groups. Insights derived in Chapter 5 and Chapter 6 show that data collected by community-based initiatives is not necessarily required for groups to engage with the formal mechanisms to present opinions (i.e. creating submissions to regulatory authorities). Community-based initiatives may also use formal

mechanisms without collecting data to input their perspectives (e.g. the OHRN completing submissions). Both groups also appear to have strong relationships with regulatory authorities. These align with the components and attributes presented in Chapter 5 (Figure 5.1).

Both groups are utilising creative and innovative means of engaging people with the waterways in an attempt to foster a relationship between the wider community and their freshwater ecosystems. These observations raise interesting questions about the role of data collection as a tool in informing opinions and creating submissions. The observations of this research suggest that community-based initiatives may not fit a bounded or defined 'mould'. Rather, they are flexible and adaptive to addressing their overarching problem such as freshwater ecosystem health. This is important as comparisons in this research have been made with a network (OHRN) and a group (CSCG), which may lead to inherent differences.

7.2 Significance of the research findings for the Ōpāwaho/Heathcote River catchment

Chapter 6 demonstrated that certain social factors characterise public participation in freshwater problem solving or management. These were suggested by participants across all interview categories in Chapter 6. Many social factors interact with the overarching driver theme of fostering a relationship with the river. This was summarised by a GP4 (community) participant, who said that public participation "is about an outcome that is helping a river but it is also feeds other needs, basic human needs, its connections with society and relationships. You can be a part of a river care group but it can give you more than just helping the river".

From Chapter 5, it seems that more active and community driven groups (Figure 5.2) may have social factors that play a role in driving public participation. Examples include the PCK where the public involved wanted to display their findings by running a public exhibition (Section 5.4.1) so that the wider community could see them. The LCP example had local farmers working towards finding acceptable solutions to lake eutrophication (Section 5.3). It is likely they are driven by a relationship with the lake, similar to Ōpāwaho/Heathcote groups and the river (Chapter 6). Larger more externally driven initiatives (e.g. Open Air Living Laboratories, FreshWater Watch and Whaka Inaka) could be helping to develop such a relationship in their respective locations (Table 5.1). Interestingly, Kellert et al. (2000) outlined that socio-economic outcomes were the result of

community-based natural resource management projects (Section 2.3), showing that social factors may pale a role in public participation initiatives.

The comparative model has valuable insights for public participation while also identifying where drivers and barriers may arise in an initiative. It provides a platform for the comparison of different examples of public participation despite inherent differences between them (Chapter 5). There appears to be a discrepancy between the comparative model and the social factors described in Chapter 6. These social factors are unlikely to operate in a binary fashion (i.e. they cannot simply be described or placed in a set category) and therefore may not be accounted for in the model (Figure 5.1 & Figure 5.4). This re-affirms the use of the semi-structured interview method to derive more comprehensive insights at a local scale (or in a local context). Understanding the social factors in tandem with the components and attributes in the model may help to derive meaningful and effective improvements to freshwater public participation initiatives.

Chapter 6 presented two primary social factors: (i) relationship with environmental systems and (ii) group functioning dynamics. Participants raised interesting notions about river or environments having human status, or being considered as legal entities, as a way of connecting to these systems. Examples of this include the Whanganui and Ganges Rivers (Hutchison, 2014; Kumar, 2017). Some also mentioned the Ngāi Tahu cultural mapping project, which maps and records Ngāi Tahu stories, and place names, into an online landscape for future generations (Te Rūnanga o Ngāi Tahu Ngāi Tahu, n.d.). The personified perspective of these systems may be an important aspect of fostering a connection with environmental systems. This reiterates the relationship that indigenous Māori in freshwater management sense as outlined in Chapter 1 and Chapter 2 as a factor to incorporate in contemporary approaches in New Zealand. This can also be linked to effective science communication (Section 6.3) and environmental narratives/storytelling (Section 7.6). An interesting observation is the role that collecting data has in groups participating in freshwater management (Section 7.1), and how this may have flow-on effects to establishing a relationship with the freshwater system. Developing and fostering a relationship with an environmental system may form the foundation for a range of social benefits for both individuals and communities. A connection with nature is thought to raise awareness of environmental issues (Brossard, Lewenstein, & Bonney, 2005), decrease stress and improve health and well-being (physical and mental) (Barton & Pretty, 2010; Hartig, Evans, Jamner, Davis, & Gärling, 2003). A sense of place may also be developed through a connection to natural landscapes (Brierley, Hillman, & Fryirs,

2006; Stedman, 2003). Public participation is also thought to re-connect people with nature (Devictor, Whittaker, & Beltrame, 2010), as urbanisation and market-based consumerism lifestyles are increasingly distancing society from the natural world and reducing levels of ecological or environmental knowledge (Pilgrim, Cullen, Smith, & Pretty, 2008).

The social processes that underpin group functioning were raised by participants although not apparent in Chapter 5 or displayed on the comparative model (Figure 5.1 & Figure 5.4). A participant from a community group stated that "half of the community group is about functioning as a community group and that is a challenge, it is not just saving the water" citing that an interest in group dynamics is required. This comment can be linked back to Tuckman and Jensen (1977), who illustrate the developmental stages of groups. There are several stages in the development in the formatting and functioning of a group. These stages of change can be linked to the comments made by GP4 participants about having a connector, facilitation and support for community-based initiatives (Table 6.3, Table 6.4 and Table 6.5). Despite possible issues in group functioning, it seems that groups still manage to achieve outcomes for their activities. Consideration of group functioning dynamics could be added to the comparative model (Figure 5.4).

McCallum (2003) and McCallum, Hughey, and Rixecker (2007) investigated community environmental management using several South Island case studies. Findings suggest that the complexity of such approaches is often overlooked. Social dynamics were documented as factors that need to be appreciated when assessing the expectations of community environmental management approaches. McCallum (2003) and McCallum et al. (2007) findings integrated with those in this thesis strengthen the argument for the inclusion of social factors in freshwater management and addressing urban freshwater ecosystem health (Figure 1.3). Published literature on the drivers and barriers to public participation in environmental decision-making can be difficult to find. Hobbs and White (2012) found that key drivers to participating in an environmental monitoring scheme were a personal interest in wildlife, the chance to contribute to conservation and the personal benefits derived from participating. These included learning about the environmental system (both at a small scale such as their garden and larger scale) and enjoyment or giving purpose to recording. Contrastingly, these findings were obtained through surveying participants where options were selected from a list, as opposed to interviews (Hobbs & White, 2012). Responses under the 'other' category of survey questions included health and well-being benefits. While the

drivers differ from those found in this research, they could be considered as attributes to developing a connection or relationship with the environmental system.

Barriers included a lack of awareness of the programme, a lack of motivation and a lack of accessibility to schemes (Hobbs & White, 2012). Having insufficient time or being too busy (Pope, 2005), a lack of confidence in being able to contribute (Hibbert, Piacentini, & Dajani, 2003) and a lack of awareness of opportunities as described in the Xiaoqing River Restoration case study were barriers identified in other research. Another barrier was also socio-economic deprivation as recorded by Pope (2005). The community-based initiatives in the upper Ōpāwaho/Heathcote River catchment (i.e. the OHRN and CSCG) are close to suburbs of higher socio-economic status. However, participation in these groups is not exclusive (i.e. anyone is able to join). Interestingly, barriers in the literature presented here also do not relate to the challenges of co-production (Table 2.5). In general, the barriers identified in literature do not align with the overarching barrier theme (operational obstacles), and are more related to personal circumstances (not having time or confidence to contribute). These personal circumstances may be addressed by the overarching driver theme of this research (e.g. a lack of motivation or confidence may not exist if a relationship between the river and participant exists). The use of school education programmes (e.g. Whaka Inaka in Table 5.1) is a means of engaging with a variety of socio-economic groups.

The groups of interest in the Ōpāwaho/Heathcote River catchment have carried out initiatives ranging from collecting data through to running events that connect people with the river (Section 7.1). Community-based initiatives have also shown to be capable of engaging with complex and formal processes which may have ramifications for developing a co-production approach for freshwater management. When considering where these groups may fit in Figure 5.2, the two groups in the Ōpāwaho/Heathcote River catchment use a mix of active and passive participation techniques and are both community driven. This is presented in Figure 7.4. While the CSCG collect data, this monitoring regime has been designed for their use only and is not part of a wider initiative (such as FreshWater Watch or Open Air Living Laboratories). Considering the similarities between the Loweswater Care Project and Pickering examples (Chapter 5), the Ōpāwaho/Heathcote groups can be placed in the upper right hand segment alongside the Loweswater Care Project. It is important to remember that Pickering was established with assistance from academics while both OHRN and CSCG were both initially products of community concern and interest. They now receive support from scientists and other professionals.

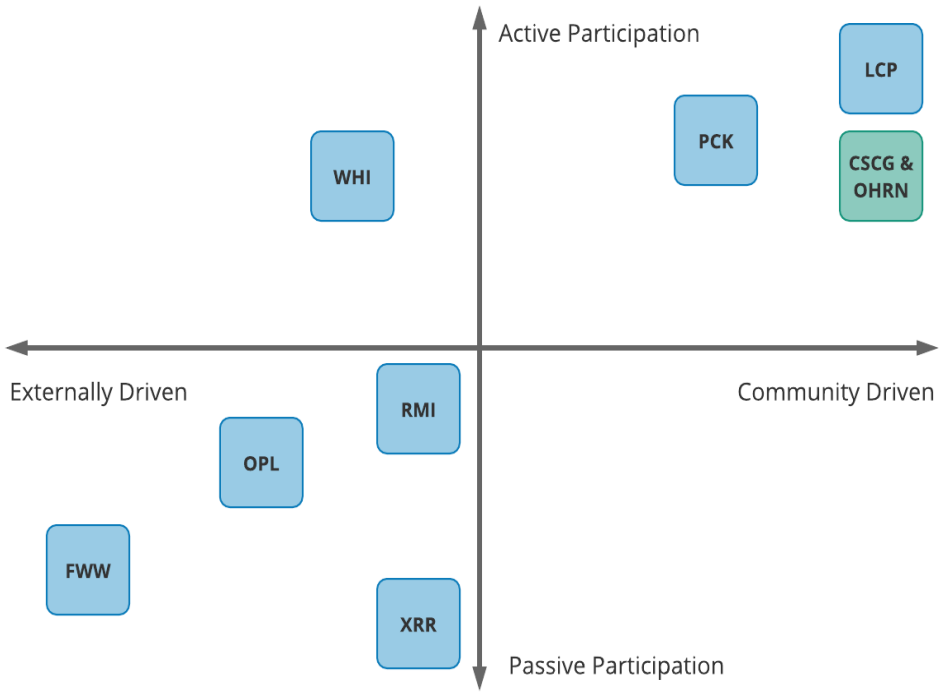


Figure 7.4 The matrix in Figure 5.2 reproduced displaying the relative position of the CSCG and OHRN (in green).

The findings of this thesis and those in literature show that social factors are important and may have implications for addressing issues such as the Urban Stream Syndrome (USS), where individual actions can impact upon the freshwater ecosystems. This raises questions pertaining to the role of the wider public and the co-production of solutions to encourage effective behaviour change. These are discussed next.

7.3 Supporting community-based initiatives and encouraging behaviour change

The overarching driver theme is fostering a relationship with the river as demonstrated by the Ōpāwaho/Heathcote River catchment community-based initiatives. However, the findings from Chapter 6 also demonstrate that everyone is responsible for the health of urban freshwater ecosystems with many adverse impacts originating from daily practices on private properties or other actions. While this research has focused on community-based initiatives, this raises a valid point around 'preaching to the converted'. Those people who are members of community-based initiatives or regularly participate are likely to practise good environmental behaviour. However, others may be unaware of the impacts resulting from their actions. This was raised by several participants and supported by P04 (Table 6.1) who implied that improvements could not be made

by the actions of regulatory authorities alone (Section 6.2). This places emphasis on individual or joint actions to address those activities (or behaviours) that contribute to environmental degradation. Such actions could also be encouraged through greater environmental literacy.

Environmental literacy can be broadly defined as an awareness and concern about the environment. The term also encapsulates an understanding of associated environmental problems. Environmentally literate citizens and societies are equipped with environmental (or ecological) knowledge, skills and motivations to derive solutions to current problems and to prevent new ones (Capra, 1996; McBride, Brewer, Berkowitz, & Borrie, 2013; North American Association for Environmental Education, 2010). In this context, the term is used to describe members of the public having an understanding of their impacts on freshwater environments and altering their behaviours accordingly. Environmental literacy can be linked to the idea of reworking a community water partnership. Murdock and Sexton (1999) define a community environmental partnership as "voluntary, collaborative activities jointly undertaken by communities and businesses, regulatory agencies, or nongovernmental organisations to take shared responsibility for… protecting environmental quality, or improving the use of natural resources" (p. 379). A partnership operates on the premise of shared responsibility where all parties contribute equally to the approach in order to share the benefits which are summarised in Table 7.1 as suggested by interview participants (Table 6.5) and Murdock and Sexton (1999). Partnership approaches can also backfire when public participants feel unrepresented, their advice not valued or the process is unaccountable to the public (Murdock & Sexton, 1999). The Xiaoqing River Restoration example in Chapter 5 is a good example of this (Section 5.4).

Table 7.1. Benefits of community environmental partnerships (Adapted from Murdock and Sexton, 1999)

Partnership benefits	
Educate sponsors on community attitudes	Provide a forum for public involvement in environmental decision making
Educate participants and public on proposed issues	Improve public support for decisions
Allow regulatory authorities to deal with smaller groups of the public rather than the whole community	Assist in developing community control over decisions made by local industry (or authorities)
Assist in making industries (or authorities) accountable to the communities they operate in	Ensures participation by affected citizens to address environmental justice issues

Findings from Chapter 6 imply that a partnership could be a beneficial method to address drivers and overcome (or mitigate) barriers to public participation. A partnership demands a twofold purpose. The approach needs to empower and connect community-based initiatives, while simultaneously encouraging pro-environmental behaviour through developing environmental literacy in the wider public. There is also an opportunity to integrate pre-established programmes and initiatives. The CWP (Section 3.5.1) and its desired outcomes (Table 3.4) serves as a good platform to co-produce solutions to freshwater ecosystem health issues. However, refinements may be required (Section 7.3.4.).

7.3.1 Community-based initiatives

A partnership approach allows the desires (Table 6.5) to be incorporated into future management regimes. In general, desired attributes raised by interview respondents (Table 6.1) were focused on establishing a well-resourced collaborative approach that supports community-based initiatives. A partnership should support community-based initiatives to navigate regulatory and institutional systems to allow them to continue their advocacy (i.e. addressing the overarching barrier theme). This research indicates that community-based initiatives are only one means of generating improving urban freshwater ecosystem health. In conjunction with their activities and events, these groups have demonstrated they can and do play a role in encouraging and developing environmental literacy among the wider public. Therefore a partnership approach needs to (i) offer support to existing community-based initiatives to navigate and participate in the regulatory systems and processes (e.g. creating submissions and attending hearings) and (ii) have provisions for groups to engage with the wider public to help foster connections to the system. The approach needs to be flexible to allow groups to run their own activities. For example, events such as river walks and photo competitions to encourage the wider public to engage with the river. This may result in people developing greater awareness of environmental issues (or environmental literacy) and alter their behaviours. It may also motivate them to participate in initiatives or become a member of the group committee. The approach also needs to support groups to act as the collective voice of the river and the wider public, by providing assistance to participate in formal regulatory and planning processes (Section 7.1). Finally, the approach also needs to allow for the co-production of solutions to freshwater management issues with local authorities, such as those in the Loweswater Care Project and Pickering examples (Chapter 5) or the integration of different knowledge types (Section 2.5).

7.3.2 Societal behaviour change

From this research it is clear that freshwater ecosystem health issues (such as the Urban Stream Syndrome) are a multi-faceted issues for which everyone is responsible. This demands changes at several scales intersecting society (individuals through to businesses and legislators). A partnership approach needs to incorporate mechanisms to foster connections with the environment and develop environmental literacy, which may, ultimately lead to changes in behaviour. Community-based initiatives play a critical role in facilitating with such an approach by engaging people (Section 7.1) and disseminating key messages. There is also a role for businesses and other entities to be involved, creating an integrated approach (e.g. Gelita and The Tannery in Section 3.5).

Environmental literacy could be developed using pre-established projects or initiatives. Several projects exist in New Zealand and further afield. Million Metres was formed from the mandate put forward at the Transit of Venus conference in 2012 to work collectively to restore waterways in New Zealand to a state of ora (Māori term representing being alive or healthy), wellbeing and abundance (Million Metres, 2019a). The goal of Million Metres is clear: plant one million metres of riparian zones along New Zealand waterways by 2050 (Million Metres, 2019a). Million Metres works in partnership with several sponsors to implement their programme and include large companies such as *The Body Shop* and *Alsco* (provider of hygiene services) who donate to the running of projects. Several projects have been completed to date (Million Metres, 2019a). Million Metres allows groups and individuals to participate through setting up projects that can be completed in a local area. Million Metres is a widespread project throughout New Zealand, meaning that a local project (i.e. planting riparian zones along parts of the Ōpāwaho/Heathcote River) could be a goal embedded into a local integrated approach such as the CWP. While Million Metres is largely a tree planting initiative (i.e. will not result in direct changes to the ecological integrity of a freshwater ecosystem), this project allows individuals to participate, further develop environmental-literacy, whilst collectively achieving a larger goal (planting one million metres of riparian planting). A key barrier from this research was public participants not feeling valued or their work not making a difference. The inclusion of an initiative like Million Metes within an integrative approach may result in increase participation satisfaction leading to returning participants. This initiative also provides a method of creating measurable goals to show progress that can be made. A Million Metres project has been completed in the Ōtākaro/Avon catchment and

one seeking funding for the Huritini/Halswell River catchment (Million Metres, 2019b). A project could be set up for the Ōpāwaho/Heathcote River by interested groups.

Through the interview process (Chapter 6), participants suggested the involvement of businesses. It is about ”that environmental-social conscience of people. It is a big money spinner…They are out there, in all shapes and forms. You look at your Bunning’s and Mitre 10’s, they are all into that community stuff. We need to encourage them to go beyond the BBQ out the front!” (P09). This demonstrates that companies should be supporting environmental initiatives that involve communities. Interview participants also recommended involving schools, such as through the Whaka Inaka education programme. Running environmental place-based education programmes where local schools study their local waterway can greatly increase the awareness and connection of a community with their waterway (e.g. through children taking home messages to their family). This was evident in the Whaka Inaka example (Table 5.1), where 650 school students were engaged through the field education programme (EOS Ecology, 2016b). This culminated in school students presenting to CCC and ECan councillors about the importance of riparian management and inanga/whitebait spawning, which resulted in CCC implementing a ‘no mow’ trail (CCC, 2016b). The OHRN have plans to work with local schools on a project to explore litter in stormwater drains. At a broader scale, there are several global companies that support environmental causes such the Freshwater Watch case study that was supported by HSBC and the Open Air Living Laboratories case study that was supported by the Big Lottery Fund (Chapter 5). The use of established initiatives and projects could have an active role in the CWP and could operate at a smaller scale along the river corridor. For example, Gelita and the Tannery in Christchurch financially supported the Whaka Inaka case study (Chapter 5) and have a vested interest in improving the health of the river (Napier, 2014).

In 2018, Dairy New Zealand established an initiative titled *‘The Vision is Clear’.* The initiative aims to address the urban rural debate by encouraging members of the public to collect rubbish from the beach or river (Dairy New Zealand, 2018). The advertisement is displayed across several platforms including radio, TV and internet. This approach has been met with criticism and cynicism from the media with some commenting that the dairy industry is using diversion tactics to shift the blame for degraded rural waterways away from the agricultural sector (with their approaches targeting activities in urban waterways) (Mitchell, 2019). On the other hand, it is another mechanism for encouraging people to foster a connection with their environment through asking people to

participate in various activities (e.g. collecting rubbish from the river and/or keeping drains clear), which may assist in addressing factors of the USS (Figure 1.1). However, it is difficult to know how this will work in practice as no robust method to understand the efficacy of the initiative has been provided. Despite criticism, this initiative is a good example of an industry stepping up to show some interest in environmental issues and presents an opportunity for other industries to follow suit (e.g. the automotive industry where oils and brake pads pollute waterways). Like Million Metres, this is another initiative that could be incorporated under a broad integrative approach to encourage the development of environmental literacy or an ethic of care.

WSP-Opus (a large consultancy firm) has envisioned an initiative named *'Adopt Your Local Stream'*. There are currently several options that are being considered of relevance to this research. Possible initiatives seek to align with Million Metres (as described above) as opposed to developing a new approach that sits in isolation (i.e. supporting pre-established programmes) (L. Foster, pers. comm., 2019). Actions under these options include stream assessments by WSP Opus specialists, assigning community group members key project roles, guiding and educating groups through project requirements such as obtaining consents, securing funding and exploring further sponsorship. The final step entails the development of a stream rehabilitation plan (L. Foster, pers. comm., 2019). Each year, WSP-Opus will support an established stream community group in Auckland, Wellington and Christchurch (L. Foster, pers. comm., 2019). WSP-Opus will provide annual support of around $36,000 to $90,000 in sponsorship depending on the options and components selected (L. Foster, pers. comm., 2019). It is worth noting the integrated nature of the WSP-Opus approach by using existing initiatives. Such an approach could also include global initiatives like FWW or OPL that are widespread initiatives that have established and standardised monitoring protocols (Chapter 5). Both the Dairy New Zealand and WSP-Opus initiatives are good examples of how industries or corporate entities can contribute to addressing urban freshwater ecosystem health issues and encourage public participation (both for wider public and groups). An integrated approach allows for the connection and support of such programmes alongside existing groups. These initiatives may lead to encouraging and generating behaviour change, although an appreciation of effective behaviour change mechanisms are required.

7.3.3 Effective behaviour change mechanisms

An integrated partnership approach seems appealing and may yield positive outcomes, but measurable outcomes are needed. Assessing the efficacy of the examples listed above is complex. Only a small proportion of behaviour change can be attributed to education and awareness (Kollmuss & Agyeman, 2002). Mechanisms exist for actively encouraging behaviour change including incentives or subsidies (Kollmuss & Agyeman, 2002). Such mechanisms could be integrated into a partnership approach alongside insights from Chapter 6 (drivers, barriers and desired aspects). Ideally, investment is made into effective and measurable mechanisms of behaviour change that are then used when developing an integrative partnership approach. Furthermore, there is also a need to consider the environmental or ecological outcomes of such approaches. Figure 1.1 depicts the complexity of urban freshwater ecosystem health problems. To achieve ecological change a diverse approach is required to address many of the factors involved in such issues (Chapter 1 & Chapter 3). If fostering of environmental literacy can lead to effective behaviour change, there is the potential to create positive change. Such approaches could be paired with ecological restoration to address other limiting elements (i.e. degraded habitat). Moreover, a greater understanding of environmental literacy may result in decisions that are better supported by the wider community (as suggested by findings in Chapter 2, Chapter 5 & Chapter 6). There is an opportunity for future research to undertake a multi-criteria assessment of the mechanisms and initiatives implemented and their impacts on urban freshwater ecosystem health. A well-tailored integrated partnership approach where existing initiatives (Section 7.3.2) are nested within a broader partnership has the potential to provide meaningful outcomes both socially and ecologically.

7.3.4 Re-working the proposed Community Water Partnership (CWP).

An opportunity exists to re-develop the CWP using the findings from this research. The existing partnership provides a foundation on which to build upon. A partnership approach needs to align with the overarching driver theme, developing a relationship with freshwater ecosystems. The findings of this research and the discussion above demonstrate that there are several pragmatic ideas that could be included. The CWP needs to focus on supporting local community-based initiatives in their activities and advocacy, while encouraging the wider public to engage with freshwater ecosystems and thus ultimately altering their behaviour. Partnerships are an important piece of the

‘Oreo model’ as shown by Figure 3.5, therefore creating a meaningful partnership may have implications for how the OHRN operate and function. Improving environmental literacy is particularly important if members of the public are considered the “eyes and ears” on the ground for regulatory authorities. Participants from community-based initiatives indicated that they were not included in the development of the initial CWP (Section 6.5). The redevelopment would also entail an opportunity to co-produce a meaningful partnership with community-based initiatives involved from the beginning. This allows the drivers and barriers to public participation (Table 6.3 & Table 6.4), and desired aspects for a partnership (Table 6.5) to be incorporated first-hand through direct input from interested groups. The CWP could also operate on the fundamentals of co-production (Section 2.5).

The approach needs to enable community ‘buy in’, placing an emphasis on the role of community-based initiatives in how this is fostered. The discussion above presents insights into how businesses may be involved in a partnership approach using external sponsorship and stakeholder support. Such an approach may be a pragmatic way of funding such an initiative. However, future research is required to gain an appreciation of how a partnership approach will remain self-sustaining over time (like the Loweswater Care Project example in Chapter 5 which has been active since 2002). Integrating community group projects with pre-established initiatives (e.g. Million Metres) may have multiple benefits, including contributing to an overarching goal (i.e. riparian planting) and providing an opportunity to engage with the system, while still aligning with the vision of the group. These may lead to intermediate wins (Section 5.3) which are important for maintaining moral in community-based initiatives, where members volunteer their time in an increasingly time-poor society. A formal partnership would allow groups to be at the forefront of co-producing solutions that impact their local waterways with direct support from regulatory authorities, while simultaneously encouraging pro-environmental behaviour change through the use of effective mechanisms. The updated comparative model (Figure 5.4) could serve as a ‘tool’ to aid the redevelopment of the CWP.

7.3.5 Summary

This section has presented several options about how to develop a wider environmental consciousness and supporting groups using an integrated partnership approach. These options largely align with key findings from Chapter 6 and can incorporate existing initiatives (Section

7.3.2) to collaboratively address issues of concern. This may create steps in addressing urban freshwater ecosystem health problems by initiating a prevention type approach by increasing the environmental literacy of wider society. While such suggestions may not yield direct alterations in the ecological integrity of a freshwater system (Figure 1.3), they may have positive indirect impacts (e.g. such as fewer contaminants entering river systems). However, robustly assessing these changes may prove challenging. A role also exists for regulatory authorities to address the barriers to this research and assist in facilitating community-based initiatives through the institutional and regulatory processes.

7.4 Legislative systems and regulatory processes

While a partnership approach may yield beneficial outcomes from addressing urban freshwater ecosystem health, there is a need to consider other factors. The overarching barrier theme in Chapter 6 was operational obstacles, including navigating the regulatory or legislative system for managing natural resources. Several participants commented on various other factors that can be related to the regulatory system and its institutional design throughout the interview results. An intriguing example exists in the Ōpāwaho/Heathcote River catchment and concerns the Cashmere Stream. This example was raised by interview participants and discussed at community-based initiative meetings. A developer was issued with a land use consent to construct a 380-house subdivision that required excavation of land (CCC, 2016c). The land use consent specifies that appropriate mitigation features are required to ensure sediment does not enter adjacent waterway. CCC granted the subdivision and land use consent in line with s30 of the RMA (RMA, 1991). Sediment impairing the water clarity of the stream is a primary concern for both the CSCG and the OHRN (Chapter 3). It appears that the developer is operating under a global stormwater discharge approval for the entire south-west Christchurch area which is administered by CCC (B. Paterson, pers. comm., 2019). This permits sediment to be discharged into the “stormwater network”. The stormwater network includes particular classes of waterways (i.e. the Cashmere Valley Drain that joins the Cashmere Stream) (Figure 7.5). The discharge approval has no specific sediment load or discharge limit specified in the conditions of the consent (ECan, 2012). The normal process is for sediment discharge consents to be granted by the regional authority under s30 of the RMA (RMA, 1991). A participant from GP3 (Table 6.1) implied that this consent was not being well monitored and that the conditions of the consent were being breached, with excessive amounts of sediment visible in the waterway and minimal erosion and sediment control in place (Figure 7.5). James and

Adamson (2017) detail that, in general, consents for sediment discharges lack appropriate conditions for volumes of sediment discharged, and are not well monitored for compliance. This also reveals an inconsistency in the ways in which consents and their conditions are managed within an area, catchment and region (i.e. under the same regulatory authorities).

Figure 7.5. Construction of the Cashmere Estate subdivision in September 2018. Sediment was discharged directly into the Cashmere Valley Drain (shown in image) that flows directly to the Cashmere Stream, and onto the Ōpāwaho/Heathcote River. There also appears to be minimal sediment run off prevention in place (i.e. silt fences between works and stream). (Source: Will Keay, September 2018).

This example is disappointing due to the presence of very active and devoted community-based initiatives in the Ōpāwaho/Heathcote River catchment (Section 7.1). For example, the CSCG have collected data for a long period of time and are actively advocating for the health of the stream. The definition of stormwater network was also submitted on by the OHRN in their GSWC submission (Section 7.1.3). Such examples could have detrimental impacts to community-based initiatives from the increase in uncertainty and decreased trust in RMA process. Recently, the CSCG were awarded over $36,000 of fine reparations (from the forestry company, held in trust by ECan) to improve the

quality of the stream (ECan, 2018). This was due to large amounts of sediment being released into another tributary of the Cashmere Stream from non-consented (i.e. illegal) forestry operations (ECan, 2018). This example is valuable because it raises a key point and supports comments on the organisational disconnect made in Chapter 6. It appears that regulatory authorities are working against themselves. A consent has been approved for a discharge to take place and not monitored for breach of conditions. Meanwhile, community-based initiatives are being awarded large sums of money to improve the health of the stream (from ECan) and CCC are generating a partnership to formalise the relationships with these groups and instil trust in regulatory processes. Such actions will likely jeopardise a partnership approach. In addition, this is likely to discourage the wider public from participating and changing behaviour due to a loss of trust in efforts being made. This may lead to a positive feedback cycle of discouragement in public participation, where groups or individuals no longer want to participate as they feel their efforts being compromised. This can be linked back to the challenges of co-production in Section 2.5, where power relationships (i.e. the regulatory authority not following standards set) can influence the outcome. If a partnership approach is selected, it needs to be centred on proactive management as opposed to reactive (giving penalty money to groups while granting discharge consents or creating a partnership to work with community-based initiatives while ignoring their duties and functions). In short, a reactive and siloed management approaches will not lead to freshwater ecological health improvement.

GP4 (community) participants expressed their concerns about examples like this with one stating "the only area that we feel [we are] being let down in, is the conditions of consent for developments are not specific for outcomes, or [have] unacceptable outcomes." The person further expressed frustration at the lack of mitigation features (e.g. sediment settlement ponds) that need to be implemented when developing land stating that "those things happen long after the bulldozers have started and the earthworks begin. Those should be put in 12 months in advance and stabilised, but they are not". P02 said that there was a poor reference condition (i.e. because the system is degraded further pollution is justified as it wont worsen the condition of the stream) being used to make decisions. They said that councillors can be reassured that any introduced activity approved by council will have minor impacts, or environmental consequences, as these systems are already degraded and are made up of tolerant species (similar to USS). However, a GP3 participant stated that this was what is required under the RMA (i.e. the reference condition of the system is at the time of application being submitted). This is a concern as the regulatory system may also facilitate the shifting baseline syndrome, where each application takes the existing condition as the 'baseline'

for environmental decision-making, instead of the desired condition (McMurtrie, 2017). The baseline syndrome may prevent the ability to improve waterway health overtime (). The short-sighted actions of authorities at the centre of the developing the CWP are simultaneously undermining its progress and effectiveness. This raises concerns around the RMA system and how regulatory authorities may address urban freshwater ecosystem health issues in future. This demonstrates that regulatory authorities have a poor institutional design (Component 4 in Figure 5.1 & 5.4) for public participation. This example can also be attributed to the wider organisational dis-connect and reductionist thinking as illustrated throughout this thesis (in particular Chapter 1, Chapter 3 & Chapter 6). Changes to the RMA through Stage Two of the reform process may lead to provisions that result in more effective freshwater management outcomes (MfE, 2018).

This example of sediment discharges also raises questions around the definition of the 'sustainable management' which forms the underlying premise of the RMA. The ineffectiveness of the RMA was outlined by interview participants in Section 6.3 and also documented by Joy (2015). In addition, it questions whether freshwater management is of priority in New Zealand. For example, a long-term (50-100 year) plan or management strategy for New Zealand's freshwaters or wider environment from central government does not exist. Perhaps such a plan would identify the role of individuals and communities in improving the state of New Zealand's freshwaters. This reflects the role of government in addressing freshwater issues. Knight (2018) expressed concerns on the role of central government politics and their support for economic development. However, she also considers that it is unfair to blame the degradation of freshwater ecosystems primarily on central government. Knight (2018) also suggested that improvement relies on all New Zealanders, stating that the New Zealand psyche is still characterised by an antagonistic relationship where the benefits of environmental systems are exploited by individual industries, or companies, as opposed to society as a whole.

7.4.1 Summary

This section demonstrates the complexity of the resource and environmental management system across multiple levels. It helps to clarify and strengthen the overarching barrier theme. Regulatory authorities need to consider how decisions that are made under their respective duties and functions can impact the role of public participation in freshwater management. Evidence also suggests that the RMA may not currently be a suitable tool for managing freshwater environments. The RMA

reformulation may provide an opportunity for both regulatory authorities and community-based initiatives (who have a proven track record in using formal mechanisms) to advocate for changes that benefit public participation in freshwater management. This may make formal mechanisms more readily accessible by establishing appropriate forums to co-produce solutions resulting in joined up actions.

7.5 Relevance to theory and literature

Lessons from this research can be placed back into a theoretical context as denoted by Figure 4.1. In general, findings show that community-based initiatives and individuals view freshwater systems in a manner similar to the ecosystem approach by Tansley (1935) (Chapter 1). They consider themselves as part of the ecosystem and attempt to foster a connection with it, while understanding that they have an impact on the system from their actions. The connection to place was exemplified by one participant who highlighted that the health of the river, or environment, is the health of the people (or the mana of the environment reflects the mana of the people). Ōpāwaho/Heathcote River catchment groups have a rich understanding of ecological health from both natural and social perspectives (Figure 1.3) that are laced with practical observations. Findings validate ecological health as a system-wide approach that incorporates social components and interactions. These perspectives also align with the three conceptual changes in ecology stated by Berkes (2004) (Section 2.1).

Participants across all groups suggested that freshwater management was problematic with different groups and disciplines operating in silos. This was also demonstrated with the Cashmere Stream sediment example above (Section 7.4). Operating in silos and the organisational disconnect of regulatory authorities illustrates the reductionist thinking identified by Tansley (1935) where it is necessary to break down a problem into smaller units in order to study them. Similarities can also be drawn to Callon's (1999) three models of public participation (Section 2.5 & Table 2.3). Findings demonstrate that regulatory authorities are carrying public participation in line with a hybrid form of Model 1 and 2 (Callon, 1999) (Table 2.3). Particular examples include the current ineffective regulatory management (Section 7.4) approach and the poor communication of science information to concerned members of the public (Section 6.3). GP4 (community) respondents also implied they were bought in at the end as a "token" collaboration for tightly managed consultation. This includes when CCC were generating the CWP (Section 6.5). A range of participants stated that

the mechanisms for participation are inaccessible (Chapter 6). Finally, in the legacy issues around freshwater management GP6 participants were concerned that whoever is controlling the system has discouraged public participation. While interview participants from GP1, GP2 and GP3 put forward meaningful suggestions to how community-based initiatives may play a role they are largely constrained by the systems in which they administer (i.e. the RMA) as shown in Section 7.4.

A prominent concept in ecological restoration literature is the 'field of dreams hypothesis' (Palmer, Ambrose & Poff, 1997). This operates on the premise that if physical ecological restoration is undertaken the aquatic ecosystem will restore itself without further intervention, or 'build it and they will come' (referring to the expectation that if a habitat is restored it will be naturally colonised by biota that will benefit from the improved habitat). This concept fails to take account of colonisation barriers, ecological interactions between species, and other ecological parameters that create a well-functioning ecosystem (Palmer, Ambrose & Poff, 1997). Similarities can be drawn when translating this hypothesis into the context of this research. Despite the opportunities for re-working a partnership (Section 7.3), it seems that regulatory authorities are investigating urban freshwater ecosystem health issues, but their measures to address them may not be the most suitable in generating effective outcomes. For example, the top-down creation of a partnership that does not use the most efficient mechanisms of creating pro-environmental behaviour change, or excludes the social factors such as those encompassed in this research would be wasted efforts. Finally, the CWP approach seems to detract from the various operational obstacles for community-based initiatives that may exist in legislation, such as the organisational disconnect and reductionist thinking demonstrated by examples herein. This approach does not account for the multi-faceted and complex nature of issues such as the USS. The social factors derived from this research may also have implications for ecological restoration (Palmer et al., 2005; Suding et al., 2015).

In the Ōpāwaho/Heathcote River catchment, there seems to be a dysfunctional relationship between community-based initiatives (and the public) and regulatory authorities (across multiple levels) with respect to urban freshwater management or addressing urban freshwater health issues. Community group members are focusing their efforts on fostering a relationship and placing themselves within the freshwater ecosystem, while also maintaining a well-functioning group. Regulatory authorities are engaging in a top-down science-centric manner of controlling freshwater ecosystems to meet targets and address priorities. However, this can be attributed to the system of resource management they operate under. The current approach may cement the cycle of wicked problems and continue to

drive a positive feedback loop (Section 2.3). A more mutualistic relationship between these parties could give rise to a series of effective management solutions. Such a procedure should align with the third model of public participation by Callon (1999), where solutions and knowledge are co-produced between both parties (Section 2.5). This would allow for a more innovative and community centric method of addressing urban freshwater ecosystem health issues (supporting the ecosystem approach described above). While this seems critical, participants across all groups outlined regulatory authorities are making changes to how they incorporate public participation into freshwater management regimes. Adapting to public concern and investigating participatory solutions reveals a desire to improve urban freshwater ecosystems. A conceptualisation of this is displayed in Figure 7.6. Such an approach uses the foundations of co-production to integrate several aspects distilled from this research that are relevant to the Ōpāwaho/Heathcote River catchment. This approach may advance drivers, and mitigate barriers, to public participation.

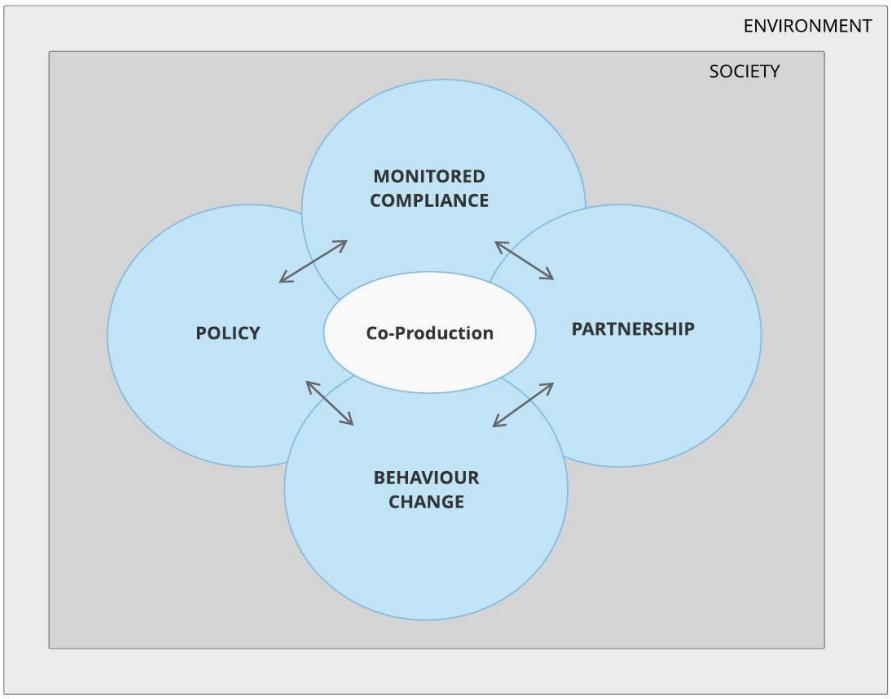


Figure 7.6. A pictorial representation of how an integrated approach may operate in practice. This is contextualised to the Ōpāwaho/Heathcote River catchment.

7.6 Application/implications for other areas

Insights and observations of this thesis have implications for the practice of environmental management in Christchurch and further afield. The remainder of this chapter provides a brief

discussion on the wider implications of the research insights. It places the findings in wider Christchurch and New Zealand contexts before moving onto the international scale.

7.6.1 Wider Christchurch

This research has been focused on eliciting insights relevant to the Ōpāwaho/Heathcote River catchment. However, many of these findings are not exclusive to that catchment and will apply to other areas. For example, it is likely that both the overarching driver and barrier themes (i.e. developing a relationship and operational obstacles) will be the same for other areas. Currently, a significant part of the Ōtākaro/Avon River catchment is being considered for future use as a result of the Residential Red Zone planning following the 2011 earthquake event. A public consultation process carried out by Regenerate Christchurch (the authority responsible for the planning of this area) released a range of options. These were largely focussed on incorporating multiple values put forward by members of the public, and include ideas for a living laboratory, flooding protection and areas of ecological restoration (Regenerate Christchurch, 2018). Such approaches largely agree with the findings of this research and may allow people to access the river and engage with these environmental systems, ultimately fostering a connection.

A potential Residential Red Zone project (external to the regeneration plan) is Eden Project New Zealand (EPNZ), an ecotourism and social enterprise venture that focuses on Christchurch's relationship with water (Eden Project New Zealand, 2018). It emphasises custodianship, reciprocity, respect and environmental enhancement. EPNZ may offer a range of opportunities for community-based initiatives including; (i) a designated centralised location for groups to meet and plan and (ii) sessions to educate groups on freshwater ecosystems and ecology (both theoretical and practical) (iii) a display of current information for the different catchments in Christchurch in line with monitoring. As a social enterprise, EPNZ could support community-based initiatives and the wider public, with social enterprises reinvesting their profits into the community or environment. This provides a greater opportunity for investment and support of community-based and environmental initiatives than is possible under business or industry initiatives (e.g. those discussed in Section 7.3.2). This could benefit both EPNZ and the wider public.

Participants suggested that waterways could be Christchurch's narrative to help shape the city and allow people to identify with it. Storytelling was also stated as a way to improve science

communication (Section 6.3). Christchurch is already known as the *Garden City* and has a history with freshwater (Pawson, 2000; Wilson, 1989; Watts, 2011) (Chapter 3). Cronon (1992) outlines that narratives "remain our chief moral compass" (p. 1375) in environmental history, stating that narratives explain our actions and change the way we act in the world. Assigning a holistic story to Christchurch could help shift social marketing, such as advertisements by Christchurch NZ (an arm of CCC that is focused on improving tourism in Christchurch), towards pro environmental behaviour and ultimately encourage people to care for freshwater systems. Recently, a public submission forum was opened to gather opinions on the design of a building canopy for Cathedral Square in the city centre (CCC, 2019). Opinions are sought for a design based on braided rivers where columns are shaped like braided riverbeds. Such a narrative could contribute to shaping the story of Christchurch and assist in improving the care of urban freshwater ecosystems by elevating the profile of natural systems. Through this, individuals may foster a relationship with freshwater ecosystems and develop a greater environmental conscious (or environmental literacy) ultimately leading to effective behaviour change.

7.6.2 New Zealand

The findings of this research can be transferred to a wider New Zealand context. While some aspects are Christchurch-specific (i.e. the CWP approach) a broader examination of the results reveals some beneficial insights for shaping community-based and public participation initiatives in other catchments including rural areas. It is worth noting that resource management in both Christchurch and New Zealand is regulated by the RMA. Therefore, consenting issues such as the example in Section 7.4 likely occur throughout the country. However, in other parts of New Zealand there are different local and regional authorities, which may monitor compliance differently. More generally, developing an integrative partnership to support local groups and encourage public behaviour change may have different outcomes depending on the given regulatory authorities' approach to freshwater management and collaboration with local community-based initiatives. However, this research demonstrates that a comprehensive investigation into local community-based initiatives and other existing groups is required before tailoring a specific approach to ensure groups are included. For example, exploring the dynamics of Project Twin Streams (Project Twin Streams, 2019) in Auckland or The Friends of the Maitai in Nelson (Friends of the Maitai, 2014), before committing further resources and support towards these initiatives. This would ensure the most effective use of this support for those involved.

Partnership type approaches could have beneficial outcomes in New Zealand with findings in this research showing that government may support such an approach (Section 6.5). However, future research is needed to robustly assess the benefits of partnerships. The comparative model developed for this research (Figure 5.1 & Figure 5.4) may also be used to guide the development of a partnership approach. In addition, an integrative partnership approach that includes industry and business support may be helpful in other areas, with many of the initiatives discussed in Section 7.3.2 operating at a national scale.

In April 2019, Ministry for the Environment and Statistics New Zealand are expected to release the latest edition of *Our Environment* report (MfE, 2019). The last report was released in 2015 and covered the condition of Water, Air, Soil (MfE & Stats NZ, 2015). This new report is likely to have new insights into the state of urban freshwaters and urban freshwater contaminants, and provide recommendations for addressing these that could include community-based approaches. It will be interesting to see whether the release of this report will be followed by resource management guidelines (e.g. a national policy statement) for addressing contaminants that impair urban freshwater ecosystem health. For example, there is already speculation about new government guidelines for vehicle brake pads to reduce copper inputs to waterways (Bryan, 2018). In essence, ongoing policy development may create potential for change.

7.6.3 Internationally

The analysis of several case study examples of environmental problem solving that included public participation in Chapter 5 indicates that the wider findings of this research will be meaningful in other areas. However, there are two aspects that need be considered. Firstly, as Section 7.4 illustrates, there needs to be political will to address complex environmental issues within the regulatory authorities that have governance of natural resources. Moreover, the overarching governance mechanism (i.e. the equivalent to the RMA) needs to not hinder public participation. This includes either directly or indirectly (i.e. such as having split responsibilities between regulatory authorities leading to poor management practice, as demonstrated in Section 7.4). Where powers for decision making lie within multiple departments and organisations, effective communication and planning is required to avoid an organisational disconnect resulting in opposing actions, as shown in the example above. A key example of this working effectively is in the RMI example (Chapter 5) where the initiative uses standardised bio-monitoring protocols which allowed

the data to be used to prosecute a polluter (De Fiore & Fitch, 2016). Secondly, there needs to be issues of public concern that are complex enough to allow the public to participate. Freshwater health has a strong public focus in New Zealand, with stormwater a particular concern. At a smaller scale, the Ōpāwaho/Heathcote River catchment has some unique problems (e.g. sediment). Other components of the USS may be of greater concern or have a bigger role in other locations. Therefore an in-depth understanding of the issue at the right scale is required prior to involving public.

Christchurch and New Zealand have a large number of community-based initiatives where other countries may have more. As the findings of this research demonstrate, it is not possible to force the establishment of community-based initiatives. Therefore, when trying to address complex environmental problems in other countries or areas, there is a need to consider what the problem of concern is and identify at what level community-based initiatives exist or what involvement members of the public already have. When working with the wider public, the use of appropriate mechanisms is critical to ensure success. Improving environmental literacy paired with appropriate behaviour change mechanisms is likely to help address complex issues. Implementing such initiatives alongside a more focussed approach with local community-based initiatives may lead to beneficial results.

In essence, public participation approaches need to be targeted to solving issues of concern and remain to flexible to existing initiatives. It needs to tie in with local, regional or national resource governance mechanisms. This is likely to yield results in other places but an appropriate assessment is required. The model derived and validated during this research (Figure 5.4) may aid in this process.

7.7 Conclusion

This chapter has placed the findings extracted from this research in the context of the Ōpāwaho/Heathcote River catchment, before relating it back to theory and wider implications. Through this discussion, a management conundrum has been presented, where efforts in encouraging public participation are being compromised by poorly managed regulatory responsibilities. A reformed integrated partnership may support community-based initiatives and encourage behaviour change. This partnership approach aligns well with the overarching driver

theme identified in Chapter 6 and can be readily adapted to incorporate existing initiatives. However, the operational obstacles such as the legislative system, compromises the effectiveness of a partnership approach. Furthermore, it may diminish trust, subsequently discouraging public participation when the public, see their efforts overridden (or negated) by regulatory authorities that are working with them in a partnership. To make progress in improving urban freshwater health, proper planning needs to take place to ensure positive change can be implemented. This approach can be visualised by Figure 7.6. Chapter 8 provides a series of recommendations and future research points to aid further development in this area.

Chapter 8. Conclusion

A social science approach (as outlined in Chapter 4) generated invaluable insights pertaining to the role of community-based initiatives in improving urban freshwater ecosystem health. The examination of seven case studies from different locations (Chapter 5) using the comparative model (Figure 5.1 & Figure 5.4) demonstrated key facets of public participation in environmental initiatives. This was followed by the use of semi-structured interviews to contextualise and detail the findings with respect to the study area, the Ōpāwaho/Heathcote River catchment. The reflexive nature of the semi-structured method enabled further exploration of emerging themes such as the proposed Community Water Partnership (CWP) (Section 3.5 & Section 6.5) and how insights derived from these methods are related. The methods employed allowed a comprehensive understanding of public participation and environmental problem solving to be obtained. The final chapter of this thesis reviews the research objectives, comments on how they were achieved and their wider significance. A series of recommendations future research directions are detailed. The chapter concludes with a summary of the overarching research question.

8.1 Reviewing the research objectives

The first objective of this research was to identify the drivers and barriers to public participation in environmental problem solving. This objective was achieved in multiple ways. Through the development of a model (Figure 5.1 & Figure 5.4) and the subsequent analysis of seven case studies of public participation from different locations (Chapter 5), an indication of where drivers and barriers may arise in a public participation initiative was gained. Using semi-structured interviews provided contextual insights into the drivers and barriers to public participation for the study area, the Ōpāwaho/Heathcote River catchment. This validated the use of the semi-structured interview method paired with a case study example exploration. The overarching driver theme as identified is the development or fostering of a relationship or connection between people and the freshwater system. The overarching barrier theme is navigating and engaging with the resource management system that is used to regulate in New Zealand (or operational obstacles). These insights were discussed in Chapter 7, allowing meaningful implication for a co-production approach to future management to be extracted.

The second objective of this research was to determine how the drivers and barriers are expressed in the context of improving urban freshwater ecosystem health in Christchurch, in particular the Ōpāwaho/Heathcote River catchment. Drivers and barriers were identified and discussed in the context of the Ōpāwaho/Heathcote River catchment and then placed in the context of one the emerging themes of this research, the CWP (Chapter 7). Considering the overarching driver and barrier (Objective 1), discussion focused on solutions and initiatives for fostering a relationship with freshwater ecosystems and how these could be included in an integrative partnership approach. A range of pre-established initiatives exist that could be incorporated into a partnership approach to assist community-based initiatives while encouraging wider behaviour change in the Ōpāwaho/Heathcote River catchment and further afield. Examples include 'Million Metres' and Diary New Zealand's, 'The Vision is Clear' initiative. The overarching barrier theme was clarified and discussed through the use of an example in the Cashmere Stream, where efforts by the group to improve waterway health were seemingly being undermined by permissive resource consent conditions for sediment discharges by developers. Understanding these drivers and barriers in a local context allows more meaningful future management suggestions to be made that pertain to the persistence of both local Ōpāwaho/Heathcote River community-based initiatives but also the issue of urban freshwater ecological health.

The final objective of this research was to demonstrate understand how public participation and various forms of knowledge can be co-production can be used to inform urban freshwater management and decision-making. Findings from this research indicate that several forms of knowledge can be used to inform urban freshwater management and decision-making. The discussion of research findings support the use, and development, of a co-production approach and demonstrate how different types of knowledge can be incorporated within an integrative partnership. Such an approach allows for community-based initiatives to be supported to overcome barriers while incorporating the innovative solutions derived by such groups. The approach would also encourage the promotion of environmental literacy and behaviour change through the use of the pre-established initiatives. Research findings show that community-based initiatives and regulatory authorities have different approaches to urban freshwater management. A shift away from current regimes of urban freshwater ecosystem management to more inclusive regimes such as co-production should be considered.

Findings and discussion support and encourage the reformulation of the CWP. A reconfigured approach can integrate desired outcomes suggested by participants to create a more community centric approach. In addition, a partnership would allow regulatory authorities to reconsider their role in environmental management and address issues identified in this research such as reductionist thinking and organisational disconnect. Management practices can then be adapted accordingly, potentially leading to more effective outcomes for urban freshwater management. A version of this approach was presented as a poster at the NZFSS conference in Nelson, with the aim to visualise what an integrated approach would entail (Figure 8.1). Finally, social factors should be considered in a redefined freshwater management approach, as addressing freshwater ecosystem health issues can involve changing social actions and behaviours. Existing frameworks and literature of such approaches were discussed in Chapter 1 and Chapter 2. This places an emphasis on fostering environmental literacy and behaviour change, which aligns with the identified overarching driver theme.

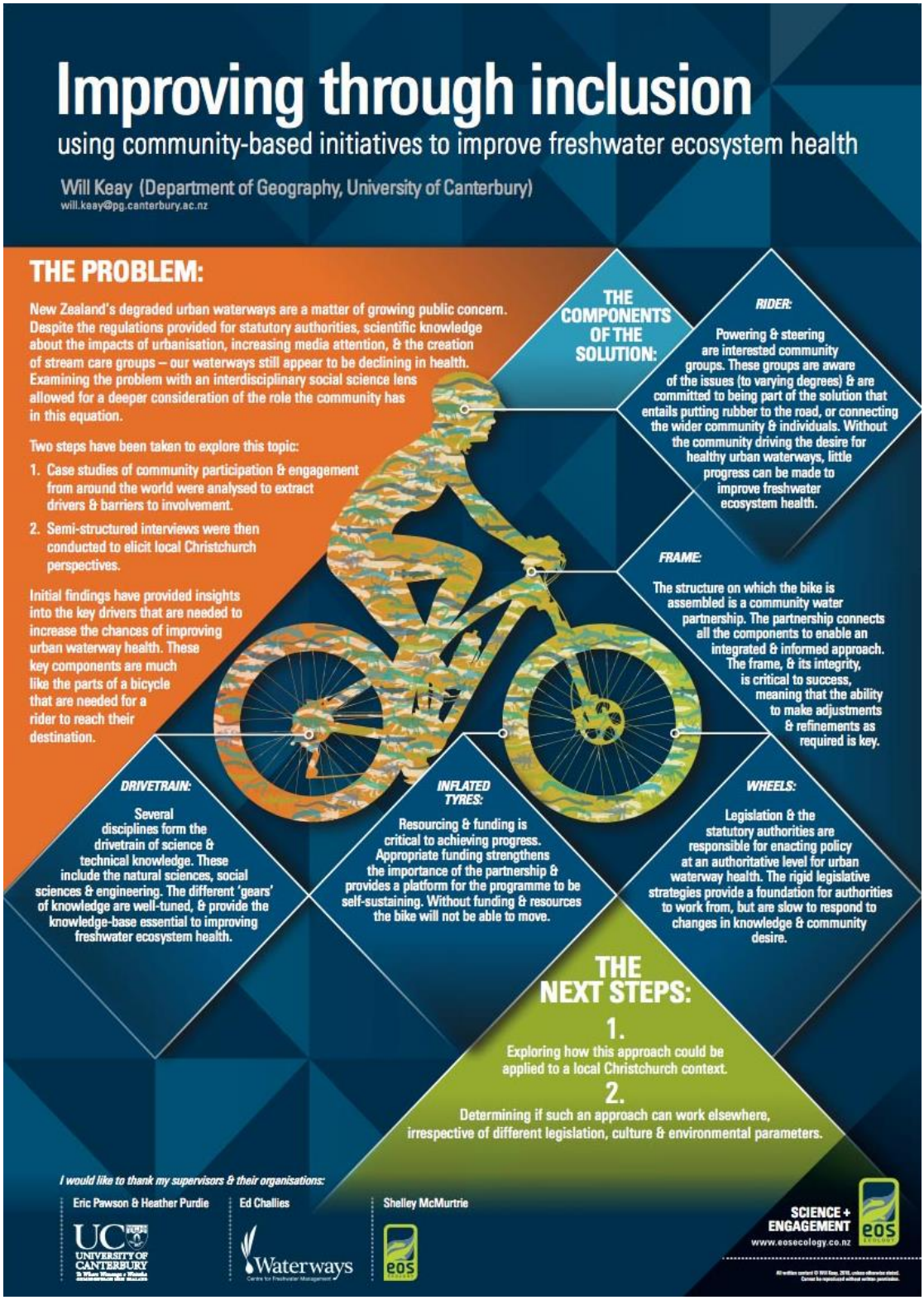


Figure 8.1. A poster presented at the 2018 New Zealand Freshwater Sciences Society conference by the author. This portrays the integrated approach (Figure 7.6) using the analogy of a bicycle. The bicycle requires all components to function in order to move forward. (Source: Will Keay, 2018).

8.2 Recommendations

During this research Ōpāwaho/Heathcote River community-based initiatives demonstrated they have the capability to being involved in freshwater management. Christchurch freshwater management has the skeleton of good public participation processes. However, refinements are needed to ensure effective public participation and involvement from both community-based initiatives and regulatory authorities. Presented below are a series of recommendations that may assist in creating beneficial outcomes for urban freshwater management both now and in the future.

1) Community-based initiatives should continue to pursue participation and advocacy via the formal mechanisms (such as generating submissions), while undertaking activities within the catchment to engage the wider public (e.g. photo competitions, public restoration activities, etc.).

2) Community-based initiatives continue to create innovative ways to engage people with freshwater ecosystems and seek appropriate funding or sponsorship to do so. For example, using multi-media boards to display images, upcoming events, monitoring data and other information. These could placed at specific sites in the catchment where people regularly view or engage with the river.

3) Community-based initiatives should consider using ideas from pre-established initiatives (i.e. Million Metres) when developing their activities. This may allow groups to reap the wider benefits of external efforts/inputs, whilst maintaining and boosting local engagement, through contributing to a larger picture (e.g. planting one million metres of riparian zones).

4) Local authorities invest in social marketing, science communication and effective behaviour change mechanisms, realising that collectively everyone is responsible for the health of urban freshwater ecosystems.

5) An integrative partnership with foundations in co-production is developed between community-based initiatives and local authorities. Such an approach would allow local authorities to continue to build relationships and offer support to community-based initiatives who are seeking to be involved in management. Key elements could include focusing on creating mechanisms for individuals and groups to express their opinions in decision-making, while regulatory authorities take a more holistic approach to their duties

(i.e. consenting and compliance). The CWP provides the platform to establishing this but requires modifications to be most effective.

6) Central government and local authorities work towards creating a centralised vision and plan for New Zealand's freshwaters matched with more stringent standards that are enforced through reformed legislation or National Policy Statements.

8.2.1 Future research

While the findings of this research present ways forward, there is a need for future research to take place. There are possible research opportunities which may help to further validate and strengthen the results of this research allowing a more effective implementation in future research scenarios. These suggestions are:

- Exploring whether a partnership approach can be contextualised for other areas (locally and globally) irrespective of cultures, laws and other factors. Chapter 5 demonstrated case studies had beneficial outcomes in their respective locations. This suggests that each is context specific and may not work in other locations. For example, solutions derived from the Loweswater Care Project are contextualised for addressing lake eutrophication in the Loweswater catchment and may (or may not) be transferable to other areas.
- Economic, social, cultural and ecological investigations into the benefits of implementing a partnership approach (both long term and short term) and ways to measure this. Findings can then be compared to inform future management decisions.
- Assuming a higher level of environmental literacy is developed, investigating the role of groups of people (i.e. recreational users such as lake swimmers or mountain bikers) in generating solutions to urban freshwater management problems. This could also include schools.

8.3 Improving urban freshwater ecosystem health in New Zealand

The primary goal of this research was to examine, *can community-based initiatives facilitate progress on improving urban freshwater ecosystem health?* Christchurch community-based initiatives play a critical role in addressing complex urban freshwater ecosystem health issues such

as the Urban Stream Syndrome (USS). However, they are only one part of the solution. Public participation and co-production may be used in addressing urban freshwater health issues. A well-tailored integrative partnership may provide a method for implementing change. Such an approach would have provisions for supporting community-based initiatives in their activities, including advocacy, while also encouraging more widespread behaviour change in society. While community-based initiatives play a pivotal role in working towards improving urban freshwater ecosystem health, it is important to remember that these groups cannot be forced into regimented management structures. They are groups of passionate individuals acting out of concern for the freshwater ecosystems they have developed a relationship with. Therefore, any management approach needs to have considerations in place for these groups. Regulatory authorities also have a role to play in addressing urban freshwater ecosystem health issues. Findings show that while there may be existing initiatives for addressing factors and effective mechanisms for altering behaviours that contribute to issues such as the USS, there are organisational and legislative attributes that can compromise positive changes being made by community-based initiatives and public. This presents a management conundrum that requires addressing before the benefits of a partnership approach will begin to show.

This thesis has provided several insights into addressing urban freshwater ecosystem health issues. These insights may be effective in improving urban freshwater ecosystem health following further research and subsequent refinements to management approaches. The findings suggest that there is a range of social factors and processes which relate to improving urban freshwater ecosystems, illustrating the multi-disciplinary nature of urban freshwater management. Therefore, urban freshwater ecosystems require unique and effective management regimes (such as those specified in this research) in order to improve freshwater ecosystem health. Addressing urban freshwater ecosystem health requires a shift away from traditional resource management practice (characterised by streamside interventions) to a more holistic catchment approach that focuses on behaviour change and considers social factors. This research has established that the management of environmental systems pertains to influencing social actions as opposed to controlling environments. A more holistic approach to freshwater management can create a nexus of the four well-beings (environmental, social, cultural and economic). This may have ramifications for other societal and environmental issues in other domains.

Christchurch is in a position to be a leader in contemporary urban freshwater management both in New Zealand and further afield. Existing community-based initiatives in the Ōpāwaho/Heathcote River catchment have demonstrated their devotion and audacity to participate in urban freshwater decision-making whilst creating opportunities for the wider society to engage, understand and develop a relationship with urban freshwater ecosystems. With the creation of an appropriate forum that includes these groups, Christchurch has the fundamentals of working towards being a leader. Such an approach would shift away from reactive and reductionist thinking, towards the inclusion of the public and empowering them through co-production to generate meaningful solutions approved by the wider public.

Good science is fundamental, but there is a need to incorporate other disciplines, taking a multi-faceted approach to examining urban freshwater issues. It seems fitting to challenge those with an interest or concern for freshwater ecosystems to consider the role that social science has in informing contemporary freshwater management. Other factors that stretch beyond traditional freshwater science (e.g. social factors) need to be considered when addressing urban freshwater ecosystem health issues to achieve effective and meaningful outcomes.

"New Zealand's environment has been substantively changed in a time span that is very short in evolutionary terms….We are what we are today because of our past. We cannot undo history - we can only learn from it." *The State of New Zealand's Environment, 1997 (Ministry for the Environment).*

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Appendix A: Information sheet for interview participants

Department of Geography
Email: will.keay@pg.canterbury.ac.nz
10 July 2018

Making progress on improving urban freshwater ecosystem health.

Information Sheet for Interview Participants

My name is Will Keay and I am currently completing an MSc thesis investigating how urban freshwater ecosystem health can be improved through community-based initiatives. The purpose of this research is to explore an alternative means of improving urban water quality that differs from current practices. A key part of this research is to investigate how community based initiatives can be integrated into current freshwater management regimes and what barriers exist for public engagement in such processes.

I am conducting interviews with experts and stakeholders in urban freshwater systems in Christchurch. You have been selected as a potential participant based on your knowledge and experience in this area. If you choose to take part in this study, your involvement will be to participate in a semi-structured interview discussing how community-based initiatives may help to improve urban freshwater health in Christchurch and New Zealand. This will take between 60 and 90 minutes. All data collected will be stored in a password-protected environment and will only be accessible by my supervisory team and myself.

Participation is voluntary and you have the right to withdraw at any stage without explanation or penalty. You may ask for your raw data to be returned to you or destroyed at any point. If you withdraw, I will delete all information relating to you. However, once analysis of raw data starts on 1st of September 2018, it will become increasingly difficult to remove the influence of your data on the results.

The results of the project will be used in a Masters research thesis and may be further published, but your identity will not be revealed without your explicit prior consent. To ensure anonymity and confidentiality, no identifying data will be stored with the interview data, and all data will be stored securely, with no access to any person except my supervisors and myself. Data collected is to be stored for up to 5 years and will destroyed within 5 years from the thesis completion date (i.e. March 2024). However, a thesis is a public document and will be available through the UC Library.

Please indicate to the researcher on the accompanying consent form if you would like to receive a copy of the summary of results of the project.

This project is being carried out as a requirement to complete a Master of Science degree in Geography by Will Keay under the supervision of Emeritus Professor Eric Pawson, who can be contacted at eric.pawson@canterbury.ac.nz. He will be pleased to discuss any concerns you may have about participation in the project.

This project has been reviewed and approved by the University of Canterbury Human Ethics Committee, and participants should address any complaints to The Chair, Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

If you agree to participate in the study, you are asked to complete the consent form and return a physical or digital signed copy to Will Keay (will.keay@pg.canterbury.ac.nz).

[Will Keay]

Appendix B: Consent form for interview participants

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Department of Geography
Email: will.keay@pg.canterbury.ac.nz
10 July 2018

Making progress on improving urban freshwater ecosystem health.

Consent Form for Interview Participants

- ☐ I have been given a full explanation of this project and have had the opportunity to ask questions.
- ☐ I understand what is required of me if I agree to take part in the research.
- ☐ I understand that the audio of this interview will be recorded.
- ☐ I understand that participation is voluntary and I may withdraw at any time without penalty. Withdrawal of participation will also include the withdrawal of any information I have provided should this remain practically achievable.
- ☐ I understand that any information or opinions I provide will be kept confidential to the researcher and supervisors, and that any published or reported results will not identify the participants or link them to their particular organisations without prior written consent. I understand that a thesis is a public document and will be available through the UC Library.
- ☐ I understand that all data collected for the study will be kept in locked and secure facilities and/or in password protected electronic form and will be destroyed after five years.
- ☐ I understand the risks associated with taking part and how they will be managed.
- ☐ I understand that I can contact the researcher Will Keay (will.keay@pg.canterbury.ac.nz) or supervisor Eric Pawson (eric.pawson@canterbury.ac.nz) for further information. If I have any complaints, I can contact the Chair of the University of Canterbury Human Ethics Committee, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz)
- ☐ I would like a summary of the results of the project.
- ☐ By signing below, I agree to participate in this research project.

I **give permission/do not give** permission for relevant information to be attributed to my organisation. (Please strike out one option).

Name:_____Signed:_____Date:_____

Email address *(for report of findings, if applicable)*:_____

Please return the completed forms to Will Keay (will.keay@pg.canterbury.ac.nz) as either a physical or digital copy.

[Will Keay]