# IMPROVING CATCHMENT HEALTH WHILE REDUCING FLOODING: THE ŌPĀWAHO / HEATHCOTE RIVER STORY

***P. Christensen (CTN Consulting Ltd, seconded to Christchurch City Council)***

**ABSTRACT (500 WORDS MAXIMUM)**

The Ōpāwaho / Heathcote River catchment has a history of flooding and poor water quality. The impact of flooding was increased due to land settlement and channel damage as a result of the Canterbury Earthquake Sequence (CES) from 2010 onwards. The response to the effects of the CES through Christchurch City Council's (CCC) Land Drainage Recovery Programme (LDRP) was primarily to restore flooding to pre-earthquake levels. However, the flood mitigation infrastructure has also provided a significant opportunity to improve water quality and provide for some of the community aspirations for the Ōpāwaho / Heathcote River corridor. This demonstrates good practice in considering multiple values within floodplain management, and ensures the greatest return for the community from an investment of over $100 million in infrastructure.

CCC has a multi-value approach to stormwater management, aiming to deliver on the following six values: drainage, culture, ecology, heritage, recreation, landscape. Leading edge when introduced, this approach has been embedded into stormwater infrastructure delivery in Christchurch. This has ensured that the infrastructure delivered as part of the Ōpāwaho / Heathcote River floodplain management scheme has far wider benefits than just flood reduction.

Some of the 'non-drainage' results achieved by CCC adopting a multi value approach and obtaining input from a wide range of groups include:

- Wetland treatment of stormwater on two of Christchurch's most polluted streams (the Curletts and Haytons Stream tributaries)
- Sediment capture on the two most significant sediment sources for the Ōpāwaho / Heathcote River (Cashmere-Worsley and Hoon Hay valleys)
- Removal of contaminated sediments through dredging
- Planting of several kilometres of banks with primarily native vegetation
- Restoration of significant areas of wetland habitat drained for farming
- An urban forest (Te Oranga Waikura) co-located with a stormwater basin
- Filtration of a large (160 hectare) commercial/residential catchment with the largest proprietary treatment device in New Zealand
- Recreation areas, such as an area of tracks and open space of approximately 100 hectares
- Isolation of important bird habitat areas from predation
- Telling the cultural and heritage narrative
- Enhancement and extension of inanga spawning habitat
- Adoption of areas by local school groups to maintain and extend planting

Combined together, these represent a significant improvement in the health of the Ōpāwaho / Heathcote River catchment and provide a platform for ongoing improvement in catchment health. Community involvement in achieving these outcomes has been important, with stream care and river network groups engaged during the design and implementation phases.

This paper will provide examples of the multiple values achieved, describe the process undertaken to achieve this, and discuss the lessons learnt throughout the process.

**KEYWORDS**

**Floodplain management, restoring, healthy waterways, community, connecting, multi-value, Heathcote River**

**PRESENTER PROFILE**

Peter Christensen is a Surface Water Engineer with CTN Consulting Ltd and is based in Christchurch. He has a wide range of experience in surface drainage issues, including surface water modelling, stormwater treatment design and floodplain management.

# 1 INTRODUCTION

The Ōpāwaho / Heathcote River catchment has a history of flooding and poor water quality. The impact of flooding was increased due to land settlement and channel damage as a result of the Canterbury Earthquake Sequence (CES) from 2010 onwards. The response to the effects of the CES through Christchurch City Council's (CCC) Land Drainage Recovery Programme (LDRP) was primarily to restore flooding to pre-earthquake levels. However, the flood mitigation infrastructure has also provided a significant opportunity to improve water quality and provide for some of the community aspirations for the Ōpāwaho / Heathcote River corridor. This demonstrates good practice in considering multiple values within floodplain management, and ensures the greatest return for the community from an investment of over $100 million in infrastructure.

This paper will describe the context of the catchment, tell the 'big picture' story of the works in the Ōpāwaho / Heathcote River catchment currently, outline the multiple values achieved in each project, and discuss lessons learnt in the process.

# 2 CONTEXT

## 2.1 LOCATION

The Ōpāwaho / Heathcote River catchment has a length of approximately 25km and covers approximately 103 km² in the south-west of the city (Figure 1 overleaf). It is bounded in the south by the Port Hills, and flood events are heavily influenced by rainfall in the upper parts of the southern hill catchments. The upper catchment has both high infiltration areas and old swamp areas with extensive natural ponding. Along the base of the Port Hills the river is terraced, and the dwellings on the lower terraces are most vulnerable to flooding.

## 2.2 HISTORY

The 1856 Black Map is a survey plan that shows the original land formation, vegetation, waterways and wetlands of Christchurch at the time of European settlement. It is a useful indicator of the natural drainage and vegetation types that existed prior to urbanisation, and also often explains why some areas are particularly vulnerable to flooding.

*Figure 1: Ōpāwaho / Heathcote River catchment*

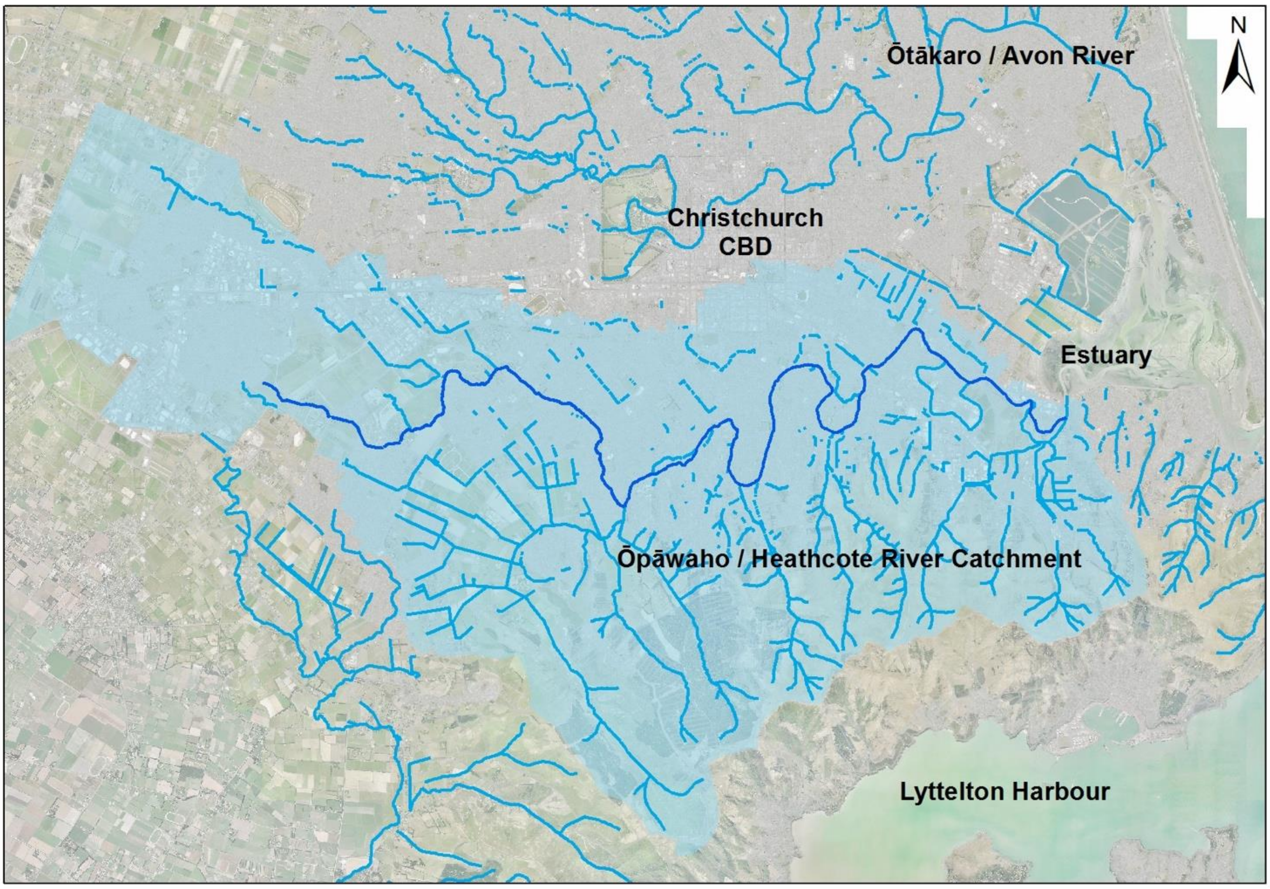
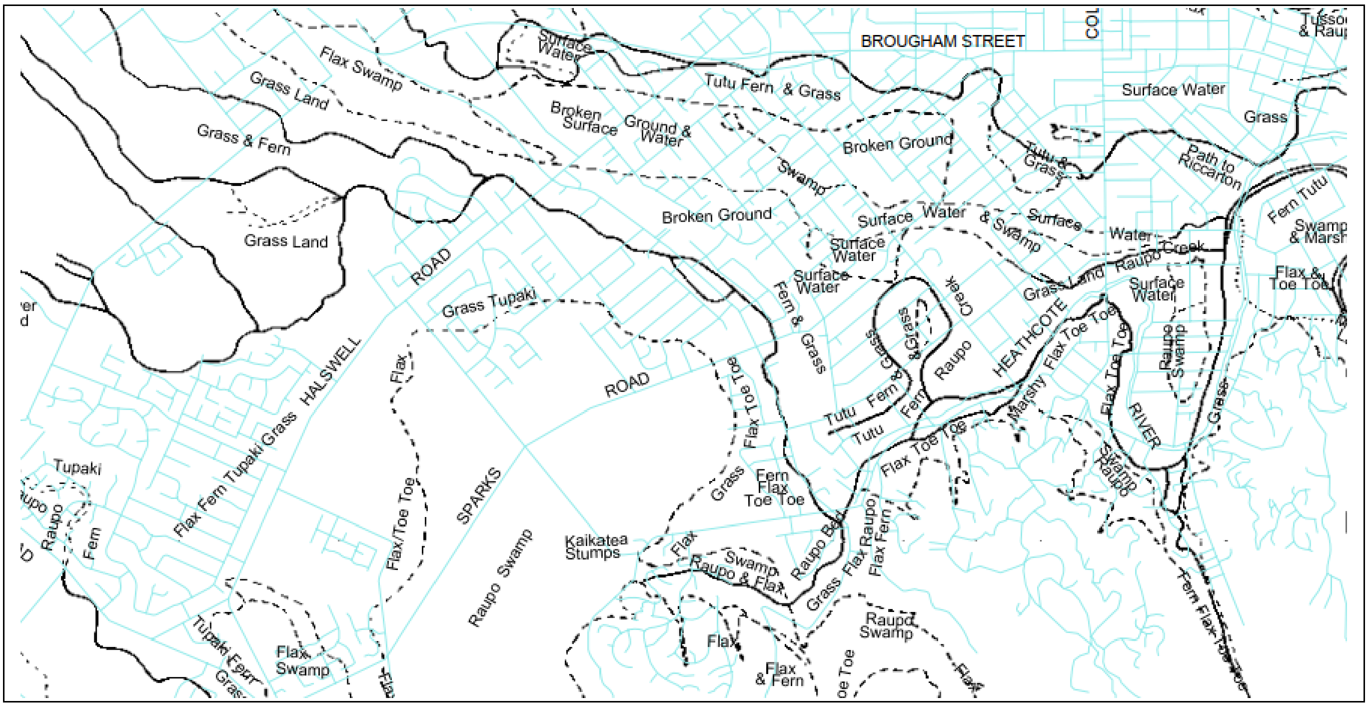



*Figure 2: Sample of 'Black Maps' of upper Ōpāwaho / Heathcote River area showing waterways, swamps and vegetation cover in 1856 (Tibble, 1998)*



The main title of the history of the Christchurch Drainage Board (CDB) is 'Swamp to City' (Wilson, 1989). This too hints at the particular floodplain management issues faced in Christchurch, where relatively flat swampy land was drained to allow urban development. Being so flat, the changes from the CES, urban intensification and a changing climate have meant that flood vulnerabilities are quickly exposed. An example of the changes in the Ōpāwaho / Heathcote River catchment can be seen in Photo 1, where the floodplain that still existed in 1930 has since been filled in to further constrain the river corridor.

*Photograph 1: Ōpāwaho / Heathcote River floodplain circa 1930 (inset image shows a present day image at approximately the same location showing the filled in floodplain)*

## 2.3 HISTORICAL FLOODING AND FLOODPLAIN MANAGEMENT

A comprehensive summary of flooding in the catchment can be found in Wilson (1989) and ECan/CCC (1998), the latter noting that, 'since the 1960s floodwaters have reached heights above house floor levels on at least four different occasions (1968, 1975, 1977 and 1980)'.

The CDB was tasked with addressing flood issues up to 1989, and this primarily consisted of widening and deepening of the channel (dredging), a diversion channel (Woolston Cut), raising of approximately 20 houses, and the construction of Wigram East Retention Basin.

In 1998 a joint ECan/CCC floodplain management strategy (ECan/CCC, 1998) was developed, but the majority of the recommendations were not implemented, largely due to a period of weather lacking in extreme events.

Prior to the CES the catchment remained vulnerable to flooding, but the CES increased the vulnerability due to changes in drainage paths, lowering (and raising) of land levels, and damage to infrastructure. The impacts of the CES on land drainage were made apparent during a period of severe weather events that impacted Christchurch in 2013 and 2014.

The worst of these for the Ōpāwaho / Heathcote River were in June 2013 and March 2014, but there were other events, noticeably in April 2014, which also caused flooding. These events made very public what engineering analysis had already shown – that the Ōpāwaho / Heathcote River was significantly more vulnerable than prior to the earthquakes.

## 2.4 WATER QUALITY DEGRADATION

Sediment (both from urban and rural areas) and metals (zinc and copper) are the main pollutants in the Ōpāwaho / Heathcote River. It has recorded the worst water quality in Christchurch in both 2016 and 2017 (CCC, 2018). The impacts are consistent with urbanisation, with the added high sediment loads from unstabilised hill catchments. The surface soils of the Port Hills are primarily loess, and this is highly erodible and difficult to remove from the water column.

One of CCC's strategic priorities in the 2018-2028 Long Term Plan is a 'safe and sustainable water supply and improved waterways' to meet a community outcome of 'healthy waterways'. To meet these goals both source control and treatment facilities are required to improve the quality of stormwater runoff, and maximising the water quality gains from flood infrastructure is a cost effective means of doing this.

## 2.5 SIX VALUES FRAMEWORK

CCC has a 'six values' approach to water management (CCC, 2003), meaning that the following values are to be incorporated into system design:

- ecology
- landscape
- recreation
- heritage
- culture
- drainage

There are many examples of this approach throughout Christchurch, and one of the early ones, Wigram East Retention Basin, is being further enhanced through the works described in the paper. This approach was formally adopted in October 2000 (CCC, 2000), and was leading edge at the time. The strategy document stated,

*"Planned with imagination and sensitivity along with community consultation, waterways and wetlands can do much to enrich Christchurch. The challenge is to progress from the past thinking of responding to needs only with engineering solutions, to one in which an investment is made in forethought and sustainability." (CCC, 2000)*

This statement is as relevant today as it was nearly 20 years ago, and it is a cornerstone of approach to the current Ōpāwaho / Heathcote River works. Much is owed to those who pioneered this approach, and those who subsequently made it standard practice over the past 20 years.

## 2.6 CCC CAPITAL PROGRAMME

The Land Drainage Recovery Programme (LDRP) was established in 2012 by CCC to understand the consequences of the earthquakes on the land drainage network within the city limits. Within the Ōpāwaho / Heathcote River catchment, the LDRP undertook investigations to understand the extent of the damage (through asset condition surveys), modelling, floor level surveys, and commissioned a number of issues and options reports. The LDRP was assigned budget for addressing post-earthquake issues within the Ōpāwaho

/ Heathcote River, and following the floods in July 2017 (the third significant floods since the CES) the Ōpāwaho / Heathcote River catchment works were fast-tracked. Over $100 million will be spent in the catchment by the LDRP.

As well as the earthquake recovery works, there are other significant growth and renewal associated stormwater management works within the catchment. The South-West Area Plan (CCC, 2009) set out a blueprint for stormwater management in the upper part of the catchment where the most significant growth was likely to occur. This identified the required attenuation and treatment facilities within the upper catchment, and work continues on these as development takes place.

# 3 THE BIG PICTURE

In catchment management it is helpful to step back to appreciate the whole picture. Managing the impacts of over a century of development intensification takes time, and if looked at project by project the change can seem small. However, when the whole picture is painted then progress can be seen. This builds confidence, showing that gains can be made, and this allows further progress to be made.

In the first part of this paper the big picture of the current works in the Ōpāwaho / Heathcote River catchment is described. A brief description will be provided of each project before summarising this into the big picture change occurring. While this paper is focused on current works, it is acknowledged that significant works have occurred in the past, examples of which are:

- Wigram East Retention Basin
- Awatea Basins
- Woolston Cut and Barrage
- Steamwharf Stream inanaga spawning habitat
- Ōpāwaho / Heathcote River spawning habitat creation

In addition to the capital works described above, the Christchurch-West Melton Zone Committee have identified Haytons Stream as a priority catchment within the catchment and are working with partners in the catchment to improve water quality outcomes.

## 3.1 CURRENT AND NEAR FUTURE PROJECTS

### 3.1.1 UPPER HEATHCOTE STORAGE SCHEME

The Upper Heathcote Storage Scheme consists of four new flood basins, with a total combined additional capacity over and above planned projects of 800,000m³. The total cost of the scheme is estimated at over $40M.

The location and timing of each of the basins is shown in Figure 3. Stages of each of these are in construction, with the full works expected to be completed by 2021. A brief description of the multi-value benefits of each storage area is provided below.

*Figure 3: Location of basins within the Upper Ōpāwaho / Heathcote River Storage Scheme*


### 3.1.2 EASTMAN-SUTHERLANDS-HOON HAY

This area utilises land purchased prior to the CES for stormwater management, as well as additional land since purchased to mitigate impacts of the CES, and will result in a number of flood attenuation basins, water quality basins and wetlands spread over an area of approximately 100 hectares (Figure 4). The scheme will provide water quality improvements to both existing and new runoff, and will add approximately 150,000 m³ of storage over and above that allowed for prior to the CES. In the Black Maps (Tibble, 1998) this area was shown as raupo swamp (Figure 2), and has long been identified as an area for floodplain management (CCC/ECan 1998).

The current works provide for wildlife habitat (a significant staging point between Te Waihora and Ihutai / Avon-Heathcote Estuary. The plan allows for extensive constructed wetlands, walking and cycling paths, sediment capture from the Hoon Hay Valley (one of the primary sources of sediment in the river), keeping stormwater out of the spring fed Cashmere Stream as much as possible, and naturalising two streams in the area.

Management of the discharge from the scheme will be via two actuated control structures to maximise the benefits achieved.

*Figure 4: Eastman-Sutherlands-Hoon Hay Landscape Masterplan Concept*

### 3.1.3 CASHMERE-WORSLEY VALLEY

The Cashmere-Worsley Valley has a large hill catchment which has a significant impact on flooding in the Ōpāwaho / Heathcote River. Identified by the CDB as a prime storage location, negotiations with landowners, as well as additional land purchase, was successfully concluded in 2018, allowing for the development of a scheme with over 300,000 m³ storage. In the Black Maps (Tibble, 1998) this area was marked as raupo swamp.

The key outcomes for this project are:

- Flood storage through two dams and actuated outlets
- Maximising sediment capture from the valleys (Photograph 2 shows the high sediment load from the hill catchments)
- Integration into the built and natural landscape, particularly in allowing for access to the Christchurch Adventure Park
- Low maintenance requirements

*Photograph 2: Confluence of Cashmere Stream (high sediment load) with an urban stream in May 2017 (image source unknown)*

### 3.1.4 WIGRAM WETLAND (HAYTONS STREAM)

Wigram East Retention Basin was originally constructed as the first stage of a much larger flood management scheme. The subsequent stages were not constructed however, although some retrofitting of treatment elements occurred later. It was one of the early experiments in the six values land drainage approach, and its success in this is apparent since it is now a site of ecological significance in the District Plan.

However, the upstream catchment is heavily urbanised, with a large amount of light industrial land use. It is recognised as having some of the worst water quality in Christchurch, and is a priority catchment for the Christchurch-West Melton Zone Committee.

To mitigate the impacts of the CES, investigations were undertaken into increasing the storage within the basin. It was identified that a significant increase in storage (250,000 m³) could be achieved through excavation in the park area surrounding the basin. Further, by adding in a wetland area of over 3 hectares, storage could be optimised while also achieving water quality outcomes by treating the outflow from the basin. This would also increase the habitat for the significant number of native birds who occupy the site, and also allow the separation of dogs from parts of the basin margins to reduce predation. Retrofitting fish passage is also being investigated as the basin is currently a barrier to fish passage.

The outlet from both the basin and the wetland will be remotely actuated to maximise flood storage.

### 3.1.5 CURLETTS BASIN AND WETLAND (CURLETTS STREAM)

Like Haytons Stream, Curletts Stream is also heavily polluted. Land had been purchased for a first flush basin and wetland but the project was scheduled for some time in the future. Modelling showed that storage in this area would have a benefit downstream, and so the project was fast-tracked and reconfigured to maximise storage, achieving a storage capacity of 130,000 m³.

As with other basins in the Upper Heathcote Storage Scheme, the outlet will also be remotely actuated, in this case allowing discharge of water stored in the first flush basin should severe weather be forecast. This allows the basin to have maximum capacity ahead of an event.

Once complete, the basin will be planted with wetland plants and the surrounding areas planted extensively with native trees and shrubs. The area will be accessible to the public from Mokihi Gardens and Annex Road, providing a new space for walking for nearby residents.

### 3.1.6 SPARKS ROAD WETLAND

Sparks Road wetland is not a flood recovery project, but is being constructed in the catchment to improve water quality. It will partly treat runoff from new development, but also treat approximately 60 hectares of existing development. As well as restoring the wetland habitat that existed in pre-European times, it also includes walking trails and open space. The project also took the opportunity to naturalise an adjacent drain, increasing the stream habitat in the area.

*Photograph 3: Sparks Road wetland being planted with wetland species*

### 3.1.7 BELLS CREEK

The Bells Creek flood management scheme consists of the following main parts:

- Richardson Terrace pump station and stormfilter
- Edmonds Park basin (and associated stream naturalisation)
- Te Oranga Waikura (urban forest flood storage facility)

Murphy et al. (2018) reported on the multi value benefits achieved through the Edmonds Park basin and Te Oranga Waikura. These values included:

- Lowering football fields by one metre and restoring the playing surface to allow flood storage (while maintaining it as a sports field)
- Naturalising parts of the stream to increase habitat
- Planting suitable (primarily kahikatea) trees into a flood basin to create a forested basin

In addition to those outcomes, the Richardson Terrace pump station was recognised as an opportunity to co-locate a proprietary filtration device adjacent to provide treatment to the 160 hectare upstream catchment to reduce the capital cost of treatment.

### 3.1.8 BANK STABILISATION

The banks of the Ōpāwaho / Heathcote River have long been prone to slumping, in part because many are constructed from fill and due to the waterway width having been compromised over the years (Photograph 1). The CES resulted in extensive slumping which needed addressing to regain waterway capacity and also to reduce sediment from erosion.

*Photograph 4: Completed bank stabilisation showing increased channel capacity*

Channel works along the Ōpāwaho / Heathcote River involves a balance between maintaining existing trees and space for roads and services, and attempting to make increase the room for the river (Photograph 4). The approach taken for the current bank stabilisation works is to maximise the room for the river (although not increasing the low flow channel width) while minimising impacts on trees and existing services. Wherever possible, apart from toe stabilisation and to protect other infrastructure, physical structures have been avoided to allow for future widening with minimal rework.

Balancing ecological/landscape and hydraulic/stability outcomes was difficult in the project. As can be seen in photograph 4, rocks were used to stabilise the toe of banks and reduce further instability through undercutting. However, from a landscape perspective rocks are not natural along the river, and undercutting provides significant habitat for native species. In some places pipes were placed to provide new habitat ('tuna townhouses'), and along the length of the works planting undertaken by the project will eventually provide shade and shelter and hide the rocks. This will take several years to establish, and engagement with the community was necessary to convey the time lag between what it looks like immediately following construction, and what the eventual outcome will be.

### 3.1.9 DREDGING

Dredging of the lower reaches of the Ōpāwaho / Heathcote River was undertaken regularly by the CDB until the late 1980s, but only isolated areas of silt were removed following that period. This allowed significant build-up of sediment in the Ōpāwaho / Heathcote River (Photograph 5). Hydraulic studies following the CES identified that dredging would reduce flood risk in frequent (e.g. less than 1 in 10 year ARI) events up to sea level rise of approximately 0.25 m.

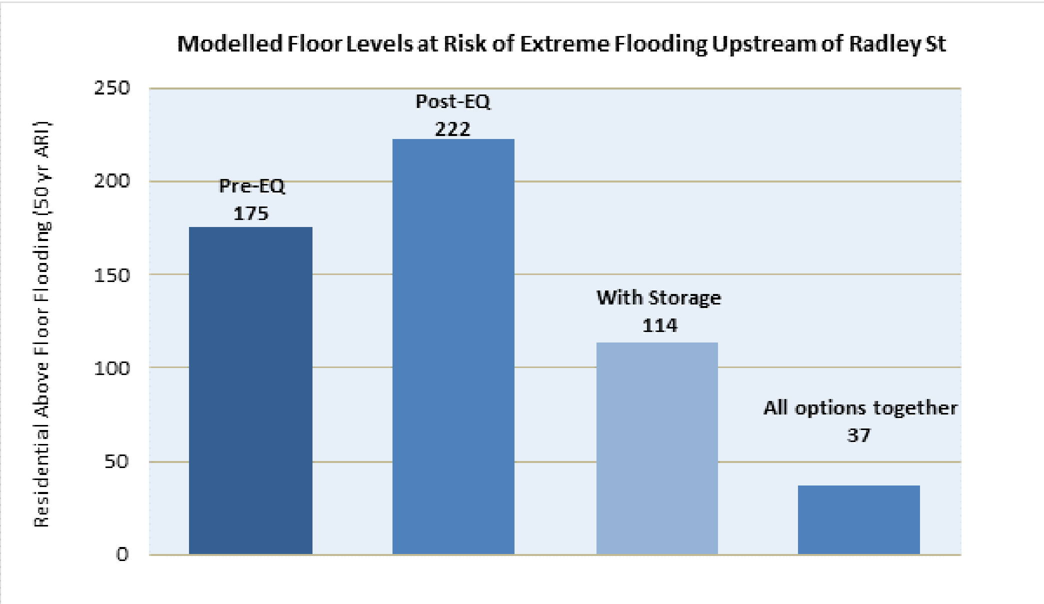
*Photograph 5: Siltation of the Ōpāwaho / Heathcote River showing reduced channel capacity (photo taken at low tide)*

Although dredging can have negative environmental outcomes, in this instance it provides the opportunity to provide offsetting benefits with the machinery mobilised to this area. One of these is the removal of contaminated sediments which can leach contaminants into the water column. In the lowest third of the area dredged the banks are steep, and while inanga should spawn in that location, it is hypothesised that they are prevented doing so by the unnaturally steep banks. The banks in parts of that section are being reshaped to make it more suitable for spawning. Other areas impacted by dredging are having invasive weed species removed, and are being replanted with native vegetation suitable for spawning. Much of the bank is grass as well which is difficult to maintain, and planting with native species which will ultimately require less maintenance.

## 3.2 BENEFITS ACHIEVED

Floodplain management remains the core objective of the works, and the benefits provided by the scheme are significant. In the 2% annual exceedance probability event (AEP), following the scheme the number of houses at risk of flooding above the floor in the current climate will be almost 20% of the pre-earthquake risk (Figure 5).

*Figure 5: Extreme flood risk along the Ōpāwaho / Heathcote River (2% AEP)*




In addition to mitigating flood risk, the flood management investment represents an opportunity to make a significant contribution to undo some of the impacts of urbanisation on the Ōpāwaho / Heathcote River catchment, and to achieve multi-value outcomes. Some of the 'non-drainage' results achieved by CCC adopting a multi value approach and obtaining input from a wide range of groups includes:

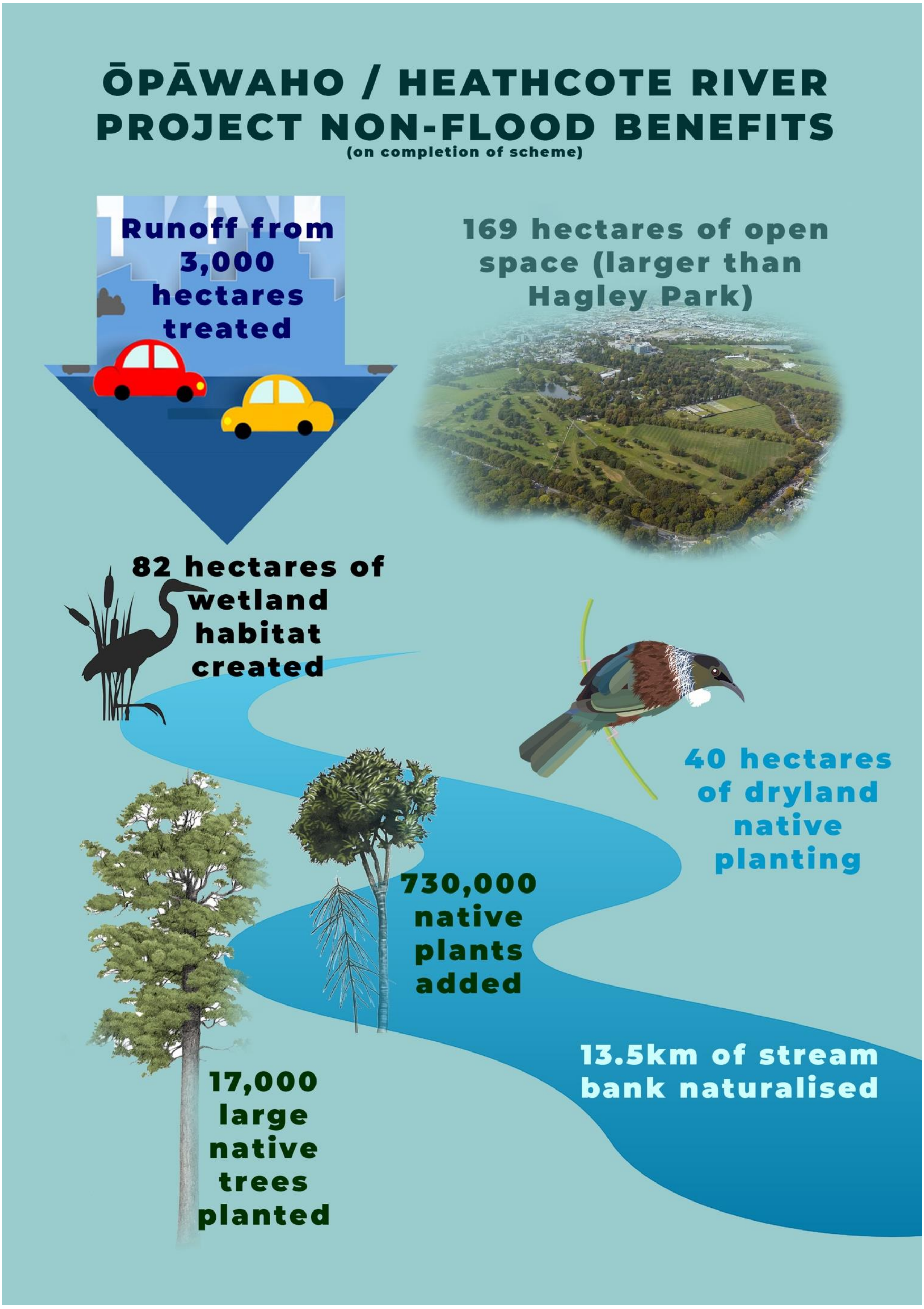
- Wetland treatment of stormwater on two of Christchurch's most polluted streams (the tributaries Curletts and Haytons Streams)
- Sediment capture on the two most significant sediment sources for the Ōpāwaho / Heathcote River (Cashmere-Worsley and Hoon Hay valleys)
- Removal of contaminated sediments through dredging
- Planting of several kilometres of banks with primarily native vegetation
- Restoration of significant areas of wetland habitat drained for farming
- An urban forest (Te Oranga Waikura) co-located with a stormwater basin
- Filtration of a large (160 hectare) commercial/residential catchment with the largest proprietary treatment device in New Zealand
- Recreation areas, such as an area of tracks and open space of approximately 100 hectares
- Isolation of important bird habitat areas from predation

- Telling the cultural and heritage narrative
- Enhancement and extension of inanga spawning habitat
- Adoption of areas by local school groups to maintain and extend planting

Putting all this together adds up to a significant change in the catchment. The infographic on the following page (Figure 6) shows the non-flood benefits achieved:

- Runoff from 3,000 ha treated (including hill catchments)
- 169 ha of stormwater management area (an area larger than Christchurch's largest park, Hagley Park)
- 13.5 km of stream banks planted and/or naturalised
- 82 ha of new wetland areas
- 40 ha of non-wetland native planted areas
- 17,000 large native trees planted
- 730,000 native plants established

*Figure 6: Ōpāwaho / Heathcote River non-flood benefits infographic*



# 4 LESSONS LEARNT

## 4.1 BENEFITS OF A SIX VALUES FRAMEWORK

Having an established framework for including multiple values provides the opportunity to incorporate aspects which might be outside of the core function of the facility. When members of the public visit a stormwater treatment wetland, most will not see it as a stormwater facility, but rather will view it as a wildlife refuge or amenity space. Providing tracks and viewing platforms, while not improving stormwater outcomes, results in a better outcome for the community. Without a six values framework embedded in CCC policy and culture, achieving multiple outcomes would be more difficult.

## 4.2 STAKEHOLDER ENGAGEMENT

Wide stakeholder engagement helps to ensure that floodplain management projects achieve outcomes which benefit the community over and above just flood risk reduction. For example, the Ōpāwaho Heathcote River Network (OHRN) is a collaborative network which advocates for the regeneration of the whole of Ōpāwaho / Heathcote River with a vision of "an ecologically healthy river that people take pride in, enjoy, and care for." OHRN members have had input into the replanting following the bank works and have provided valuable feedback on proposed mitigation measures. Working across organisations and inviting a more collaborative approach has allowed CCC to implement a flood mitigation project while achieve multiple aims.

Engagement with elected members, particularly through Community Boards, has been valuable in understanding the wider community aspirations that might be achieved through projects. Elected members also have wide networks in the community and are able to provide links between those implementing works and those who will ultimately benefit from them.

## 4.3 MORE THAN ENGINEERING – NEED COMMITMENT TO OTHER VALUES

Designers, particularly engineers and project managers, need to be committed to incorporating other values than drainage into a project. This needs to go beyond just listening to other ideas to actually becoming champions for other values. Designers and project managers have more control over the outcome than what may be seen as secondary disciplines. Therefore they need to champion non-drainage values to ensure that the best community outcome is achieved.

Design and review teams should also be truly multi-disciplinary. An example of this was in the design of Eastman Wetlands where input was provided from one of the Park Rangers who is an ornithologist. He was able to point out that the site of the wetland was a significant feeding area for wading birds (although it just looked like a muddy paddock). While a wetland will create habitat for some birds, it would result in the displacement of the birds already using it. Input from other disciplines helps to avoid blind spots, and while not every need will be able to be incorporated, it at least provides transparency for why an alternative outcome was selected.

## 4.4 TRAIN CONTRACTORS TO WORK ACROSS DISCIPLINES

When aiming for a multi-value outcome, it is important to convey this to those responsible for undertaking the physical works. An example of this is bank stabilisation, where rock placing crews were trained up by an ecologist for several days so that they understood how to place the rocks for maximum ecological benefit. Another example is requiring designers and contractors to incorporate natural variance into basin shapes to achieve a less 'engineered' look.

## 4.5 MORE THAN A PROJECT –LONG TERM INVOLVEMENT FROM THE COMMUNITY IS CRITICAL TO SUCCESS

This is difficult within the project lifecycle, and needs input from those who work in the community longer term. At Te Oranga Waikura a primary school across the road has adopted a corner to take care of and use as an outdoor classroom. This type of engagement helps to improve the likelihood that longer term outcomes are achieved.

One of the challenges with this approach has been working around waterways and consideration of the health and safety of those involved. In many areas the landscape contractor undertakes the majority of the planting, but smaller areas away from water and steep slopes are identified for community planting days. The most successful interactions have largely been with established community groups already working in an area (e.g. OHRN), so wherever possible using existing networks is important.

## 4.6 BENEFITS REVIEW

This is a task yet to be incorporated into projects, but in my observation there is too often a gap between what the original designers envisaged and the ultimate outcome. This is often a small detail, such as the size of an orifice outlet, but checking whether the design works as planned is important to long term performance. Termed 'benefits review', this step is often left out of the project lifecycle. Unlike a road, where a pothole is readily apparent, poorly functioning stormwater facilities can operate for years without it being apparent that their function is compromised. It is recommended that a benefits review phase is considered in design contracts to monitor and comment on performance for at least two years following commissioning. While an additional cost to the project, this would result in savings in the long term and better environmental outcomes.

## 4.7 BALANCING OUTCOMES

A multi-value approach requires a balancing of outcomes between competing objectives. For example, while bank widening and removal of all the existing trees and replanting with native plants would achieve immediate hydraulic benefit and long-term landscape benefit, the immediate loss of canopy and large trees would have negative ecological, landscape and amenity outcomes. Balancing outcomes may require a longer term perspective than just a project lifecycle, so that works are undertaken which form the foundation for longer term works.

Input from the community and other stakeholders, as well as multi-disciplinary teams, helps to navigate between competing outcomes and provides a wider perspective than just engineering in making decisions on compromises. Not all outcomes desired will be achieved, but this provides for a transparent process to reach compromises.

## 4.8 TELL THE STORY!

Telling the story is important to educate the community on what is being achieved through stormwater management systems. The news on water quality is usually negative, but there are positive stories to tell. Telling these stories gives confidence to the community that improvements are being made, and this encourages them to change their habits and take better care of their waterways too. It is also an opportunity to educate people about how the stormwater from our own properties and roads around us makes its way to streams, and what can be done about it.

# 5 CONCLUSIONS

The current works in the Ōpāwaho / Heathcote River catchment represent a significant step to undo the adverse effects of over a century of intensive human settlement within the catchment. Urban development affects the hydrological regime, increases runoff and vulnerability to flooding, and degrades water quality. While most of these impacts can only be partially mitigated, this represents a step in the right direction and provides a foundation for future improvements. Stepping back and reviewing the big picture in works undertaken shows that significant steps forward can be made in urban catchments.

Through the Ōpāwaho / Heathcote River floodplain management projects flood risk will be reduced to almost 20% of what it was pre-earthquake in a 2% AEP event. In addition, runoff from over 3,000 hectares will be treated, 80 hectares of new wetland created, and 169 hectares of open space will be preserved for the future. The planting of over 17,000 large trees and over 700,000 smaller trees and plants will have a positive impact long into the future.

The 2000 CCC Natural Asset Management Strategy (CCC, 2000) contains the following quote from Bill Karaitiana and Maria Tait:

> *"Kia tiakina te mauri ora o nga arawai repo, kia hapai ai te wairua whakaora o nga tangata"*
>
> *(Protect the mauri of the resource and raise the spirit of the people in the management and guardianship of the waterways and wetlands.)*

These are wise words which are well heeded. By protecting the mauri of our waterways and wetlands we raise the spirit of the community and protect and improve a treasure to pass on to future generations.

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Thanks to all the staff at Christchurch City Council and at various consultancies who have contributed to the projects described within this paper. I also acknowledge the contribution of the many residents along the Ōpāwaho / Heathcote River who have shared their knowledge and understanding of the nature of flooding along the river and how it affects them, and also the input from the Ōpāwaho Heathcote River Network.

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