

2015

University of Canterbury
Waterways – Context and
Background



Sustainability Office
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University of Canterbury Campus Waterways: Issues and Options

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Executive Summary

The three streams flowing through the University of Canterbury Ilam campus (Ōtākaro-Avon, Ilam and Okeover) are a key natural asset of a campus already renowned for its attractiveness. The campus master planning process in 2015 presents an important opportunity to develop a long term vision for UC waterways, and plan for the best practice management practices required to achieve this vision.

The future of these streams must also be considered within a broader context of mana whenua, Te Ngāi Tūāhuriri perspectives and values, the Mahaanui Iwi Management Plan, and any State of the Takiwa reporting process available.

The Canterbury Water Management Strategy, the imminent Ōtākaro-Avon River Storm Water Management Plan, and increasing community expectations of responsible storm water management in the Ōtākaro-Avon river catchment must also be taken into consideration.

Key priorities for waterways on the UC campus include;

1. Ensure ongoing kaitiakitanga (guardianship)¹ by mana whenua, Te Ngāi Tūāhuriri of UC waterways, with an emphasis on restoring their potential as mahinga kai (traditional food and other natural resources and the places where those resources are procured and produced).²
2. Properly integrate extensive institutional and technological knowledge about UC waterways into the campus master planning process.



Restoring UC waterways requires a whole-of-community approach; Dr. Aisling O'Sullivan (Hydro-Eco Group), Ting Powell (post graduate student), and Darryl Cone (UC Grounds Supervisor) on Ilam stream December 2013.

¹ See <http://ngaitahu.iwi.nz/environment/>. Accessed 4 June 2015.

² <http://ngaitahu.iwi.nz/ngāi-tahu/the-settlement/settlement-offer/cultural-redress/ownership-and-control/mahinga-kai/>. Accessed 4 June 2015.

3. Conceptualise UC waterways as a Living Laboratory, where students have the opportunity to conduct research and develop key graduate attributes by applying lessons learned from restoring the Okeover stream to the Ōtākaro-Avon and Ilam streams.
4. Continue to support research conducted on campus which is designed to improve storm water quality in older suburbs in Christchurch such as Ilam.³ There is a pressing need for Canterbury and Christchurch-specific data to develop effective storm water management strategies and interventions which can contribute to the resilience of Christchurch in a climate change context, plus be applied to other parts of Canterbury.
5. Ensure storm water discharges to the stream from campus roads, car parks, and roofs continue to be treated to a level where water quality and in-stream ecosystem health is not compromised and improved.
6. Include ecologically sound storm water management practices which are integrated throughout the whole campus, with the long term aim of creating an exemplar storm water management park for research, training, industry engagement, and community demonstrations.
7. Ensure that landscaping for the riparian margins on Okeover between RSIC and CETF are coordinated and based on taonga species (with special significance on endemic species), and appropriately managed with mana whenua involvement. This should also include exclusion zones for trout and introduced species.
8. Restore the ephemeral section of Okeover stream on Ilam fields.
9. Provide a valuable community asset by offering a safe, pleasant environment for pedestrians and their hauora (well-being). The walking track along Okeover stream in particular is heavily used and much enjoyed by the local residents. UC waterways are a key feature of the proposed Greater Christchurch Perimeter Trail, which has the potential to offer significant opportunities for green recreation throughout the whole of Christchurch.

Acting on these opportunities will help to mitigate a range of risks, including unpreparedness for the effects of climate change, a reduced positive experience of campus grounds, a negative impact on water quality of headwaters or tributaries for the Ōtākaro-

³ <http://www.ccc.govt.nz/thecouncil/newsmedia/mediareleases/2013/201312041.aspx>

Avon river, a failure to integrate extensive institutional knowledge into mid and long term planning, and potential adverse impacts of the remediation of campus.

The value of the Ōtākaro-Avon, Ilam and Okeover streams to the UC community cannot be overstated. As the campus population intensifies over time, these streams will offer a natural green space that will secure and enhance the hauora or well-being of staff and students providing they are properly valued by, and integrated into, the campus master plan.

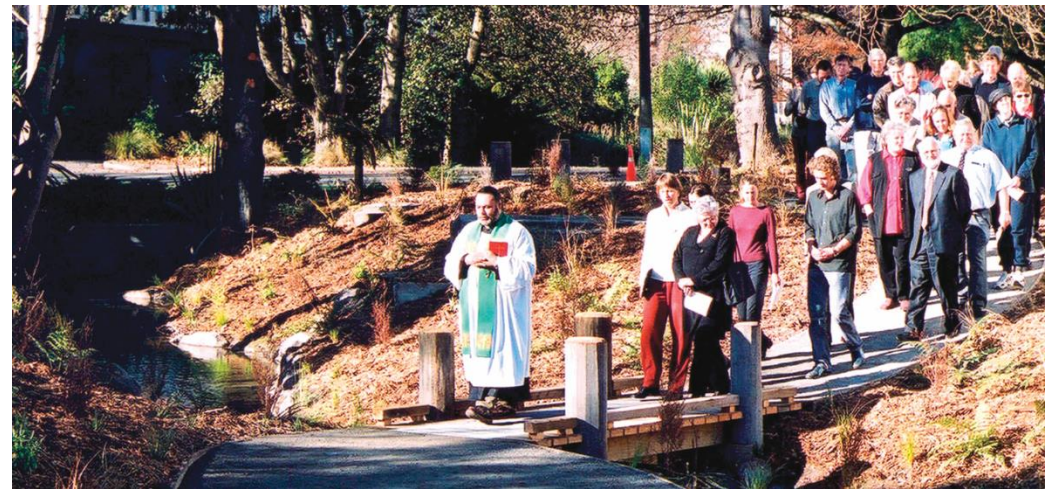
Introduction

This document is intended to inform the UC campus master planning process, particularly with respect to thinking about waterways within a landscape planning context. It

1. provides background information about the history of the three waterways flowing through the University of Canterbury campus; the Ōtākaro-Avon, Okeover, and Ilam streams.
2. examines some key issues and risks associated with these waterways within a wider contemporary context, including Ngāi Tahu/ Te Ngāi Tūāhuriri perspectives.
3. identifies significant potential opportunities for UC, which includes improving the ecological health of the waterways and how doing so could contribute positively to a wider Christchurch and Canterbury context.
4. outlines past interventions undertaken on the waterways and a series of proposed interventions yet to be considered or completed.

It was developed by the UC Sustainability Office in consultation with Tom Cochrane (Civil and Natural Resources Engineering), Darryl Cone (Supervisor, UC Grounds), Jon Harding (School of Biological Sciences), Angus McIntosh (School of Biological Sciences), Te Maire Tau (Ngāi Tahu Research Centre), and Jenny Webster-Brown (Waterways Centre for Freshwater Management).

Te Maire Tau (Ngāi Tahu Research Centre), Nigel Harris (Senior Projects Manager, AVC Maori), and Mary Boyce (Te Ohu Reo) reviewed this document for cultural content. Any engagement with Ngai Tahu and Te Ngāi Tūāhuriri as mana whenua must be through the Ngāi Tahu Research Centre.



Blessing of Okeover Stream planting c 2003

Background

University of Canterbury waterways – natural character

The University of Canterbury is located in the upper part of the Ōtākaro-Avon river catchment, which is about 93km². The Okeover and Ilam streams are tributaries of the Ōtākaro-Avon stream/river, which in turn continues to Te Ihutai/Avon-Heathcote Estuary. The Ilam stream enters the Ōtākaro-Avon stream near the UC Staff Club, and the Okeover stream enters the Ōtākaro-Avon river between Clyde road and Puriri street.

These streams arise from groundwater springs in the north and west of Christchurch. The springs are fed by shallow aquifers which are recharged by the Waimakariri river. Many springs in Christchurch have dried up or are significantly reduced due to drainage of wetland by capping and piping, combined with increased impermeable surfaces such as roads and houses. This has resulted in a drop of the water table overall and reduced flow through all streams.

Anecdotal evidence suggests that Okeover stream in particular was much wider than it is now, with an ex-neighbour recalling that he had to use a row boat to cross it in the 1950s.



Ilam Stream (c 1920), Photographer Unknown

As the campus developed, grassy lawns and exotic deciduous trees replaced native forest and wetland vegetation alongside the campus streams. Building developments and the traditional maintenance practices of mowing lawn to the edges of stream banks plus clearing aquatic vegetation from the streambeds resulted in extensive in-stream siltation. Whilst low in-stream flows have been supplemented by artificial inputs such as car park runoff and building discharges, these have inherently poorer water quality. The combined effect of all the above factors has been a loss of aquatic and riparian habitat, a decline in plant and animal species diversity, and an overall loss of intrinsic natural character in all three streams.⁴

More details about the ecological values for each waterway are provided in Appendices A, B and C.

UC Waterways and Mana Whenua, Te Ngāi Tūāhuriri

Te Ngāi Tūāhuriri is one of the primary hapū of Ngāi Tahu whose tribal boundaries (takiwā) centre on Tuahiwi. Tūāhuriri is our ancestor, from whom we all descend and we take our name from him. The following is a traditional Ngāi Tūāhuriri *pepehā*, or tribal statement of identity.

Ko Maungatere te Maunga

Our mountain, Maungatere (Mount Grey) stands above us;

Ko Waimakariri, ko Rakahuri ngā Awa

Our rivers – the Waimakariri and Rakahuri (the Ashley) – flow below;

Ko Tūāhuriri te Tangata

Tūāhuriri is our ancestor.



Te Ngāi Tūāhuriri marae

⁴ Contamination is by excess sediment inflow from storm water discharges and heavy metals (primarily zinc, lead, and copper).

Mahinga kai, refers to places where natural resources are produced and procured. Along with whakapapa (genealogy), mahinga kai, is the main axle upon which Ngāi Tahu identity with the natural environment revolves.⁵ The Christchurch area was utilised extensively as mahinga kai by Ngāi Tahu from the 1600s, and the Ōtākaro-Avon river was a highly regarded mahinga kai in the Ōtautahi/Christchurch area of food-rich wetlands. Tuna (eel), kanakana (lamprey), tuere (hagfish) and pātiki (flounder) and many other species were caught in the streams, and wai kōura (*Paranephrops planifrons*, a fresh-water species of crayfish) and waikakahi (*Hyridella menziesi*, a fresh-water bivalve mollusc) were collected from riverbanks.⁶ Wairarapa was the middle part of the Ōtākaro-Avon river, where Ilam stands today.⁷ Wairarapa was used as a temporary home by Ngāi Tahu during harvesting periods.



Mahinga kai/eels hanging to dry, 1906. Hagley Park, Christchurch. Photo courtesy of the Bishop Collection, Canterbury Museum, Ref 1923.53.672

In 2007, a cultural environmental health assessment of Te Ihutai/the Avon-Heathcote estuary and its catchment was undertaken by Te Rūnanga o Ngāi Tahu, in-conjunction with members of Ngāi Tūāhuriri and Ngāti Wheke. Data was collected at 30 river, estuary and coastal sites using the Takiwā cultural environmental monitoring and reporting tool. Assessment factors included suitability of harvesting mahinga kai, water quality, physical and legal access, degree of external pressure on site, degree of modification, and presence and abundance of native fish, bird, and plant species, as well as

⁵ Te Rūnanga o Ngāi Tahu (2004). State of the Takiwā, Cultural Monitoring and Reporting on the Health of our Environment. Scoping Document.

⁶ Williams, H (1957) *A dictionary of the Maori Language*.

⁷ Tau T.M. Goodall, A., Palmer, D., Tau, R. (1990) *Te Whakatau Kaupapa: Ngāi Tahu Resource Management Strategy for the Canterbury Region*. Aoraki Press, Wellington, New Zealand. (5:22).

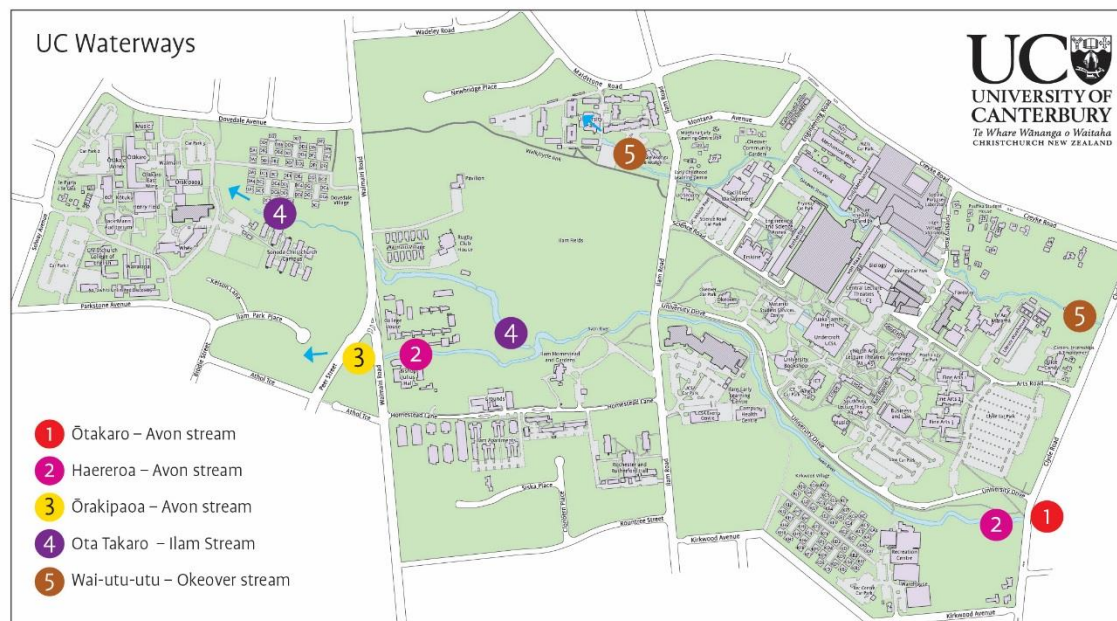
introduced species. Findings identified that 77% of the sites were in a state of poor to very poor cultural health overall.⁸ A further assessment in 2012 found that conditions in the Ihutai catchment remain poor, and are comparable to the 2007 findings.⁹

Stream names

This map illustrates the names of waterways flowing through UC property in both Te Reo and English.

Note that distinct sections of the waterway known commonly and as a whole as the Avon stream or river has different names in Teo Reo. For example, the Avon stream to the west of Waimari road is known as Ōrakipoa. From Waimari road to Clyde road it is known as Haereroa, and from Clyde road in an easterly direction, it is known as Ōtakaro.¹⁰

Wai-utu-utu-Okeover stream joins the Ōtakaro-Avon river east of Clyde road.



Names of UC waterways in Te Reo and English

⁸ Pauling, C. et al, (2007) State of the Takawi – Te Āhuatanga o Te Ihutai: Cultural health Assessment of the Avon-Heathcote Estuary and its catchment. http://ecan.govt.nz/get-involved/local-projects-community-groups/Documents/StateoftheTakiwaReport2007_Final_.pdf. Accessed 16.06.2015. pp 30-31

⁹ Lang, M. et al (2012) State of the Takawi – Te Āhuatanga o Te Ihutai: Cultural health Assessment of the Avon-Heathcote Estuary and its catchment. Pp 30.

¹⁰ Te Reo names confirmed by Te Maire Tau, Director, Ngāi Tahu Research Centre, December 2015.

Past Management

Prior to the 1990s, management of waterways running through UC campus' was undertaken primarily by Grounds, which employed a low-maintenance regime, including mowing lawn to the edges of stream banks and planting large, exotic trees or shrubs along the river banks.

This began to change in 1997, when Leanne O'Brien, an ecology/zoology student at UC started a project with the Christchurch City Council (CCC) and the Kākāriki environment club to improve the Ōtākaro-Avon stream. In 1998 Leanne was employed by the CCC to produce a preliminary restoration plan for UC's three waterways. Since then, the bulk of rehabilitation on UC waterways has been on Okeover stream, rather than on the Ōtākaro-Avon or Ilam streams.

Details about interventions for specific waterways are provided in Appendices A, B and C.

Research

Research on UC waterways started in 1999 by staff and students from the School of Biological Sciences, monitoring the invertebrate fauna in Okeover Stream. Since then, research topics have explored cultural identifiers, stream ecology, restoration ecology, water chemistry, storm water contaminants, GIS applications, and hydrology. UC waterways have also been used as topics for student labs, undergraduate and post-graduate projects and theses in Geography, Biological Sciences, Forestry, and Natural Resources Engineering (Civil Engineering) departments.



Pond by Engineering Building early 1990s



Pond by Engineering Building after remediation

UC Waterways Working Group

A UC Waterways Working Group was initiated in 2002 by Kate Hewson, the then Sustainability Advocate for UC.¹¹ Members included Jon Harding and Angus McIntosh from the School of Biological Sciences, Darryl Cone from Grounds, plus Aisling O'Sullivan and Tom Cochrane from Civil and Natural Resources Engineering. The group met on an ad-hoc basis and drove many of the rehabilitation initiatives, which included working with a range of off-campus stakeholders, particularly the Christchurch City Council.

Whilst the UC Waterways Working Group has not met regularly since the 2011 earthquakes, individuals in this group are still working or teaching at the university and hold between themselves extensive institutional knowledge about UC's waterways. They are very supportive of reconvening regular meetings.



Mātā (*Carex Secta*) on Okeover Stream

¹¹ Note that this is a different group from the Waterways Centre for Freshwater Management, and comprises of University of Canterbury research and general staff. The group works on campus-based waterway issues only.

Current context

Te Ngāi Tūāhuriri

The Ngāi Tahu Claims Settlement Act (1998) is a statutory acknowledgement which is a recognition by the Crown of Ngāi Tahu's cultural, spiritual, historical and traditional association with specific areas of Crown owned land. It enshrines Ngāi Tahu mana and participation under the Resource Management Act (RMA) in these areas. Matapopore as mandated representatives of Te Ngāi Tūāhuriri therefore have significant input into the design, development and future management of waterways on campus.

Iwi management plans are afforded explicit statutory recognition under the Resource Management Act (1991), and waterway management on UC land is subject to the Mahaanui Iwi Management Plan (2013). This is a manawhenua planning document which provides "...a values... based policy framework for the protection and enhancement of Ngāi Tahu values, and for achieving outcomes that provides for the relationship of Ngāi Tahu with natural resources across Ngā Pākihi Whakatekateka o Waitaha and Te Pātaka o Rākaihautū".¹²



Kōura (freshwater crayfish). *Paranephrops zealandicus*
Photo by J Clayton

Ngā Take, or issues of significance relevant to waterway management on campus outlined in the Mahaanui Iwi Management plan include;

Issue WM1: Rights and interests.	Tāngata whenua have specific rights and interests associated with freshwater.
Issue WM2: Value of water.	Changing the way water is valued.
Issue WM3: Priorities for use	Priorities for use based on Ngāi Tahu values.
Issue WM4: Management of Water	Appropriate management scale, principles, tools and processes to deliver Ngāi Tahu cultural outcomes.
Issue WM6: Water quality:	The decline in water quality in the region as a result of point and non-point source pollution, low flows and loss of wetlands and riparian areas.
Issue WM10: Mixing of water:	There are cultural issues associated with the unnatural mixing of water between and within

¹² <http://mkt.co.nz/mahaanui-iwi-management-plan/Mahaanui-IMP-web.pdf> (pp.17).

	catchments.
Issue WM12: Beds and margins	Activities occurring within the beds and margins of rivers and lakes can adversely affect Ngāi Tahu values.
Issue WM13: Wetlands, waipuna and riparian margins:	Loss of wetlands, waipuna and riparian margins, and the cultural and environmental values associated with them.
Issue WM14: Drain management	Drain management can have adverse effects on Ngāi Tahu values, particularly mahinga kai.
Issue WM15: Invasive weeds:	The spread of invasive woody weeds and standing trees in the beds and margins of rivers.
Issue WM16: Coastal marine area:	The freshwater-saltwater interface is an important feature of freshwater management. ¹³
Issue P6: Storm water	The discharge of storm water in urban, commercial, industrial, and rural environments can have effects on water quality.
Issue P8: Discharge to land ¹⁴	Discharge to land can utilise the natural abilities of Papatūānuku to cleanse and filter contaminants, but must still be managed to avoid adverse effects on soil and water resources.
Issue TM1: Mahinga Kai	Loss of mahinga kai areas and opportunities in the takiwā.
Issue TM2: Indigenous biodiversity	The widespread loss of indigenous biodiversity has significant adverse effects on the relationship of Ngāi Tahu with ancestral land, water and sites, and the health of land, water and communities
Issue TM4: Restoration of indigenous biodiversity	Tāngata whenua have a particular interest in the restoration of indigenous biodiversity.

Ihutai, or catchment specific issues include¹⁵

IH3Decline in water quality	Poor water quality in the catchment as a result of discharges of storm water and other contaminants to water, and inappropriate land use and urban development.
IH4Urban wastewater	Urban wastewater is discharged into Te Tai o Mahaanui
IH5: Waipuna	Loss and inappropriate management of waipuna as a result of urban development and redevelopment.
IH6: Modification of waterways	Physical modification of natural waterways in the catchment for flood control, drainage, storm

¹³ Issues WM1-16, Ibid, pp 76

¹⁴ Issues P6, P8. Ibid, pp 102

¹⁵ Issues TM1,2,4 Ibid, pp. 231

Subsequent to the 2011 earthquakes, Ngāi Tahu identified a range of key guiding principles for the Christchurch recovery and rebuild, which are also relevant to waterways planning and management as UC's campus' are also remediated and rebuilt. These include¹⁷

- Ngā Wai Tūpuna: Protection and enhancement of waterways and the appropriate use/reuse, treatment & disposal of water.
- Ngā Otaota Māori: Protection and enhancement of indigenous flora, fauna, habitats, ecosystems, & biodiversity, particularly those associated with waterways and wetlands
- Wāhi Tapu/Taonga: Acknowledgement, protection, enhancement and appropriate development and interpretation of culturally significant sites and areas.

Any future planning and day to day management of UC waterways must incorporate relevant elements of mana whenua Environmental Benchmarks and the Remediation and Rebuild Toolkits developed and used by mana whenua. These are available on request from the Ngāi Tahu Research Centre.

Canterbury Water Management Strategy

The Canterbury Water Management Strategy (CWMS) was established in 2009 to address critical water management issues in Canterbury. The CWMS vision is "To enable present and future generations to gain the greatest social, economic, recreational and cultural benefits from our water resources within an environmentally sustainable framework." The strategy sets out targets for water management in Canterbury for the next 30 years. Targets most relevant to UC waterways include¹⁸

1. Kaitiakitanga: actively involve rūnanga in water management and decision making. Increase the community understanding of customary values and users. Protect wāhi taonga and mahinga kai waterways.

¹⁶ Issues IH3,4,5,6, Ibid, pp231

¹⁷ Ngāi Tahu(n.d) Whakaoratia Ōtautahi: Ngāi Tahu aspirations for Christchurch Recovery and Rebuild. (<http://ngaitahu.iwi.nz/wp-content/uploads/2013/06/Whakaoratia-Otautahi.pdf>). Accessed 17/06/2015.

¹⁸ <http://ecan.govt.nz/get-involved/canterburywater/about-strategy/overview/Pages/summary.aspx>

2. Ecosystem health and biodiversity: protect, restore and prevent further loss of habitats and species in all natural aquatic environments – from the mountains to the sea – ki uta ki tai.
3. Environmental limits: set and achieve flow, catchment and nutrient limits consistent with all the target areas.
4. Recreational and amenity opportunities: maintain and improve existing diversity and quality of recreational sites, opportunities and experiences.

Zone Committees are responsible for developing water management programmes that give effect to these targets for their respective areas, by making recommendations for the best way to manage water in their area. These recommendations are then presented to appropriate regional and territorial councils to guide relevant water management policies. Zone committees are made of community members, council representatives and Rūnanga. UC lies within the Christchurch West Melton Zone.¹⁹

The Christchurch West Melton Zone published a Zone Implementation Plan (ZIP) in 2013, which gives effect to the targets set by the Canterbury Water Management Strategy.²⁰ Priority issues relevant to UC waterways identified in this ZIP include;

1. Enhancing and managing waterways for recreation, relaxation and amenity.
2. Improving surface water quality and safeguarding surface water flows.
3. Enhancing degraded ecosystems, indigenous biodiversity, valued introduced species and landscapes.

The Christchurch West Melton Zone committee has identified a range of actions to be implemented which address these issues. The University of Canterbury could be an exemplar in demonstrating an 'on the ground' commitment to these recommendations and actions by building on an extensive programme of stream remediation which has a history of nearly twenty years.

¹⁹ <http://ecan.govt.nz/get-involved/canterburywater/committees/chch-west-melton/Pages/default.aspx>

²⁰ <http://ecan.govt.nz/get-involved/canterburywater/committees/chch-west-melton/Pages/cwmz-zip.aspx>

Ōtākaro-Avon River Storm Water Management Plan and other initiatives

The Ōtākaro -Avon River Storm Water Management Plan (SMP) is due to be released for consultation by the Christchurch City Council in June 2015. This could have implications for how UC waterways need to be managed long term.

The Ngāi Tahu Claims Settlement Act (1998) also applies to the Ōtākaro-Avon River SMP, and Ngāi Tahu is therefore a stakeholder in this plan. Matapopore as mandated representatives of Te Ngāi Tūāhuriri have significant input into the design, development and future management of the Ōtākaro -Avon River Storm Water Management Plan.



Waikāka, or Canterbury Mudfish (*Neochanna burrowsius*).

In addition to the Ōtākaro-Avon river SMP, significant investment is being made by the Crown and the Christchurch City Council into Te Papa Ōtākaro-Avon river precinct in the central city (\$96m).²¹ There are also substantial, unprecedented community aspirations for the 'red zone' around the Ōtākaro-Avon river, which include proposals for;

1. multiple contact-water recreation activities or facilities
2. a mahinga kai exemplar project
3. an 'Eden NZ' project.²²

The above plans and projects could well result in higher expectations of water quality from communities downstream from UC. A proactive approach integrated into the campus planning process should help to anticipate, and meet these expectations.

²¹ <https://ccdu.govt.nz/projects-and-precincts/te-papa-%C5%8Dt%C4%81karo-avon-river-precinct/faqs>

²² <http://www.avonotakaronetwork.co.nz/projects/projects-home.html>

UC Draft Sustainability Strategy

The UC Draft Sustainability Strategy was developed in 2011. It signalled there is a significant potential to improve UC's ecological impact through restoring UC's waterways and addressing on-site storm water issues. It proposes a series of activities which encompass short, medium and long term goals over a period of ten years from 2012 to 2022.²³

UC Campus Master Plan

A Campus Master planning process is to be conducted in mid-2015. It is essential that the lessons learned from nearly twenty years of stream care activities on campus is integrated into this planning process and any further decision making about UC waterways and campus planning in general.

UC Draft UC Landscape Concept

The Sustainability Office has developed a Draft Landscape Concept in consultation with a range of key stakeholders, which is intended to help immediate landscaping designs as part of specific remediation projects and also to inform the forward-looking Campus Master Plan. It presents a brief landscape history of the Ilam Campus, summarises current thinking and suggests five themes that the new Landscape Plan should take into consideration (namely enhancing native biodiversity, stream restoration, healthy mahinga kai, edible campus and historical connections). In particular, the Draft Landscape Concept notes that works started on the Okeover stream should be prioritised and completed. This includes a significant redesign of the northern side of Ilam fields along the ephemeral stretch of the stream.²⁴



Tuna or eel (*Anguilla dieffenbachii*). Photo by Rohan Wells

²³ http://www.sustain.canterbury.ac.nz/documents/Draft_Sustainability_Strategy_summary.pdf

²⁴ http://www.sustain.canterbury.ac.nz/sustainability/DRAFT_UC_Landscape_Concept_2014-2022.pdf

UC Research

Current research relevant to management of waterways on UC Campus is listed in Appendix F. UC is in a very good position to make sound, evidence-based decisions on appropriate interventions on its own land, plus contribute to planning for the overall future of Christchurch and Canterbury. UC research on waterways is also contributing to;

1. The Natural Environment Recovery Plan.
2. Christchurch West Melton Zone Implementation Plan.
3. Canterbury Water Management Strategy, via the Storm Water Management Forum.

Risks Associated with UC Waterways

Below is a summary of risks associated with UC waterways and ongoing management of them by the University of Canterbury.

Risk	Impact
Remediation of campus/new build sites	Negative impact on receiving environment (e.g. reduced water quality, increased sediment in stream bed).
Flooding	Significant rainfall event overwhelming drainage and/or having a negative impact on existing in-stream-biota.
Unpreparedness for the effects of climate change - e.g. flooding, temperature rises, or draught. ²⁵	<p>Increased instances of flooding</p> <p>Drought effects on waterways</p> <p>Reduced positive experience of campus grounds.</p> <p>In stream ecological values further reduced.</p> <p>Potential public health issues (e.g. mosquitos)</p>
Reduced positive experience of campus grounds.	Negative reputational effect for UC from students and staff
Negative impact on water	Negative reputational effect for UC in wider Christchurch community, particularly within the

²⁵ This is already noted in existing risk registers (e.g. Engineering Services).

<p>quality of headwaters or tributaries for the Ōtākaro-Avon river, with an ongoing loss of existing instream biodiversity.</p>	<p>Ōtākaro-Avon catchment, by being held partly responsible for ongoing impacts on the stream (e.g. copper from heat exchangers and sediment from building works).</p> <p>UC seen as failing to support the Christchurch West Melton Zone Implementation Plan or extensive remediation activities lower in the catchment.</p>
<p>Loss of institutional knowledge, or failure to integrate it into short, mid and long term planning.</p>	<p>UC academics and Grounds staff have decades of experience and knowledge about UC waterways. Failure to integrate this, and years of evidence-based research into future planning for the waterways could result in significant inefficiencies, inappropriate decisions, and lack of joined up, whole-of-systems thinking.</p>

Key opportunities

UC waterways provide significant opportunities for the University of Canterbury, which would enhance its reputation with key local, regional and national stakeholders, plus provide a quality student experience of the campus environment and learning opportunities. These include;

1. Ensure ongoing kaitiakitanga (guardianship by mana whenua, Te Ngāi Tūāhuriri of UC waterways, with an emphasis on restoring their potential as mahinga kai (traditional food and other natural resources and the places where those resources are obtained). This could be achieved by supporting research which assesses the role of mahinga kai as biological engineers to effectively remove metals and other contaminants from the waterway and along riparian zones.
2. Properly integrate extensive institutional and technological knowledge about UC waterways into the campus master planning process. This could be achieved by re-establishing the UC Waterways working group to provide good technical advice to the Campus Master Plan and ongoing management, plus ensure that extensive institutional knowledge is not lost. Membership could include representatives from the School of Biological Sciences, Hydro-Eco Group, Grounds, Sustainability Office, Waterways Centre for Fresh Water Management, and Ngāi Tahu Research Centre.
3. Conceptualise UC waterways as a Living Laboratory, where students have the opportunity to conduct research and develop key graduate attributes by applying lessons learned from restoring the Okeover stream to the Ōtākaro-Avon and Ilam streams. Significant opportunities exist to consolidate and formalise this valuable function.
4. Continue to support research conducted on campus which is designed to



Research on Okeover Stream



improve storm water quality in older suburbs in Christchurch such as Ilam.²⁶ There is a pressing need for Canterbury and Christchurch-specific data to develop effective storm water management strategies and interventions which can contribute to the resilience of Christchurch in a climate change context, plus be applied to other parts of Canterbury.

5. Ensure storm water discharges to the stream from campus roads, car parks, and roofs continue to be treated to a level where water quality and in-stream ecosystem health is not compromised and improved.
6. Include ecologically sound storm water management practices which are integrated throughout the whole campus, with the long term aim of creating an exemplar storm water management park for research, training, industry engagement, and community demonstrations.
7. Ensure that landscaping for the riparian margins on Okeover between RSIC and CETF are coordinated and based on taonga species (with special significance on endemic species), and appropriately managed with mana whenua involvement. This should also include exclusion zones for trout and introduced species.
8. Restore the ephemeral section of Okeover stream on Ilam fields.
9. Provide a valuable community asset by offering a safe, pleasant environment for pedestrians and their hauora (well-being). The walking track along Okeover stream in particular is heavily used and much enjoyed by the local residents. UC waterways are a key feature of the proposed Greater Christchurch Perimeter Trail, which has the potential to offer significant opportunities for green recreation throughout the whole of Christchurch.



Okeover wetlands by Engineering after restoration

²⁶ <http://www.ccc.govt.nz/thecouncil/newsmedia/mediareleases/2013/201312041.aspx>

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- Darryl Cone (Supervisor, UC Grounds)
- Nigel Harris (Senior Projects Manager, AVC Maori)
- Jon Harding (School of Biological Sciences)
- Angus McIntosh (School of Biological Sciences)
- Te Maire Tau, (Ngāi Tahu Research Centre)
- Jenny Webster-Brown (Waterways Centre for Freshwater Management).

Appendix A: Okeover Stream

Characteristics

- The catchment of Okeover stream is approximately ~61 ha. Just over 40% of the catchment is impermeable roof, roads and car parks.
- Anecdotal evidence suggests that the stream flow was much larger than it is now, with an ex-neighbour recalling that he had to use a row boat to cross it in the 1950s.
- The reach upstream of Ilam road is ephemeral, which means that it is dry except when it rains and storm water flows into the stream bed. Part of this section flows through a box drain. There is predominantly exotic planting along both stream banks in this section of the stream.
- Over time, the bed of Okeover stream became too wide in places, creating slower flows and siltation, which in turn was affected by problems with aquatic weeds which require ongoing maintenance.
- The flows downstream of Ilam road are fed by UC's air conditioning system most of the time. Whilst the water provided to the stream by the air conditioning infrastructure is essential for flow, it is not benign. There has been copper contamination from deteriorating air-conditioning pipes and roofs made from copper on campus. This included Erskine, Engineering and Commerce buildings.
- In 2005 culverts were identified as a barrier to caddisfly dispersal, significantly affecting biodiversity values by restricting recolonization and recruitment to populations. Low caddisfly populations in turn effects the food resources available for other species in the stream.
- The Hydro Eco Group has been monitoring the water quality in Okeover since 2006. Monitoring has identified metals including zinc (from vehicle tyres and roofs), copper (from brake pads as well as UC buildings), plus contaminants such as pesticides and paint.
- Research has also established that planting stream margins and creating habitat was not enough to restore stream life, and that the next phase of interventions needs to focus on water quality.
- A site by the stream (next to Te Ao Mārama) is wāhi mahi harakeke, or a place used for cultural harvesting and soaking of harakeke (flax).



Okeover Stream between Ilam road and Engineering Road, prior to restoration

Completed interventions

It should be noted that UC Grounds Maintenance has played a key role in supporting the material improvement of Okeover stream.

- 1997 – 2001 major landscaping (including wetlands established beside College of Engineering) from Clyde to Ilam Roads in partnership with CCC, Kakariki, and UC Grounds Maintenance. Approximately \$120,000 was provided by CCC.
- Environment Canterbury (ECAN) also supported Okeover projects with in-kind time from its water quality scientists and funding for summer student scholarships.
- Grant proposals and funding received for a range of projects from 2002-2007.
- c. 2002/2003 –endangered Waikākā or Canterbury mudfish reintroduced. This was initially successful, however the mudfish population is now absent, and was probably predated by arokehe or long finned eel (*Anguilla deiffenbachii*).
- c 2002/2003 – endangered waikōura (freshwater crayfish) reintroduced. Initially successful, but probably killed by an acute pollution event.
- c–2005 – meanders established behind School of Forestry, altering stream bed and planting stream banks with species of ethno-botanical interest.
- copper roofs and piping removed whenever possible from contributing buildings.

Community Engagement

Okeover stream interventions have also had a spectrum of social goals, which sets it apart from the Ōtākaro-Avon and Ilam streams. Goals include including raising awareness and appreciation within the University and the local community of the campus streams; enhancing people's understanding of the streams' physical processes, species, communities, and ecosystem functioning; and increasing participation in developing the vision for the waterways. Examples of projects include

1. a wāhi mahi harakeke site next to Te Ao Mārama, which demonstrates cultural harvesting and soaking of harakeke.
2. UC hosted a Waterways Forum in February 2007, which show-cased research practices and interventions on Okeover, with the intention to encourage greater interaction amongst researchers and practitioners.



Okeover Stream between Ilam Road and Engineering Road during restoration

3. In 2009/2010 ECAN supported a Summer Sustainability Scholarship project with the UC Sustainability Office to map the Okeover catchment using GIS. All 800 households in the catchment were contacted, and a stream reference group was developed by ECAN. A pamphlet was distributed to local residents in 2011. This showed the importance of the stream and how to prevent the stream becoming re-polluted. Following the distribution of the pamphlets, an afternoon workshop was held to inform people about the local stream and its habitat.
4. In 2012, UC hosted a car wash event, designed to raise awareness in the local community about the need to wash cars on a grassy area, or use a 'dry' cleaning product hosted.

Current issues

Riparian stream planting has been beneficial, but further interventions are required to improve water quality.

- There is a risk of institutional knowledge about Okeover Stream being lost, along with a failure to integrate this into Campus Master Plan
- Failure to integrate extensive evidence-based research into long term management of UC waterways.
- Apparent lack of coordinated landscape design between RISC and CEFT buildings.
- Considerable planting and bank maintenance changes have fixed some problems, but the sediment legacy remains in the stream.
- The stream continues to be affected by storm water not filtered by riparian areas because it is directly piped to the streams.
- Need to improve water quality overall, particularly from the ephemeral stretch of river. The challenges associated with this are relevant at a Christchurch-wide scale in general.



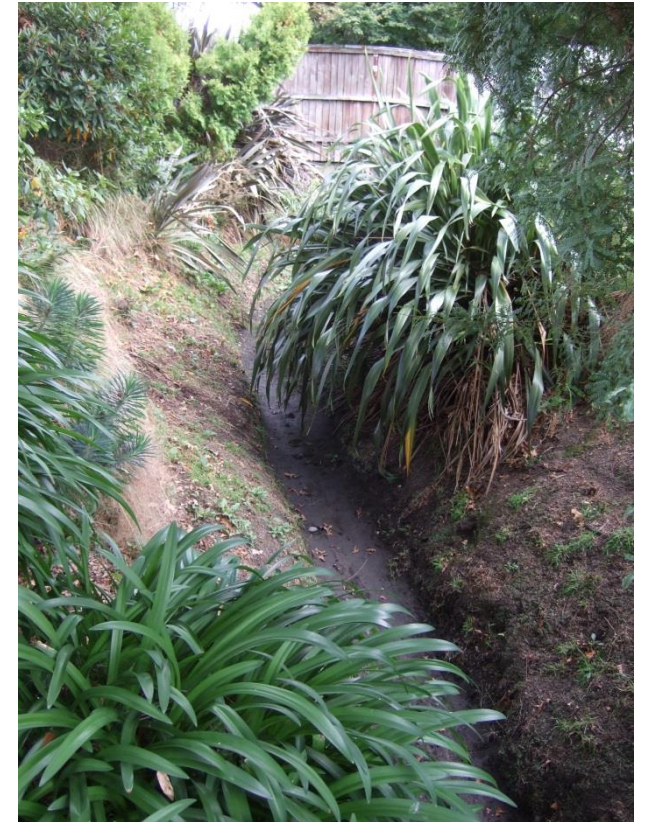
Okeover Stream Between Ilam and Engineering Road, Early 2000's

Opportunities

1. Continue with implementing the Okeover ecological corridor, revisiting the feasibility of past proposed interventions within the context of the Campus Master Plan. Naturalising the ephemeral stretch of Okeover that runs along the north of Ilam fields should be prioritised.
2. Assess the role of aquatic mahinga kai as biological engineers to effectively remove metals from the waterway and along riparian zones.²⁷
3. Continue the use of the stream as wāhi mahi harakeke, or a site for cultural harvesting and soaking of harakeke.
4. Reinvigorate community engagement with local residents within the catchment. This could also apply to the Ōtākaro-Avon and Ilam streams.
5. Fund proposals for storm water management measures on the RSIC site (e.g. filter, wetlands, and rain garden).

Proposed treatments or enhancements

- c. 2008 – develop wetlands in the ephemeral reach in Ilam Fields to improve water quality downstream. UC holds at least two documents which outline a range of recommendations for this part of Okeover.
- car park in front of SBS partially converted to wetlands, which in turn was intended to treat storm water run-off from SBS.
- remove culvert by entrance into Engineering to extend wetlands to assist fish passage, replace with a bridge.
- place boulders to create backwater habitats
- treatment of storm water pipes for sediment control



Ephemeral stretch of Okeover, northern boundary of Ilam fields.

²⁷ Kainamu, A. (2013) *An assessment of the value and feasibility of mahinga kai at UC (including assessment of potential urban contaminant effects on mahinga kai development)*. Christchurch. UC Sustainability Office, Ngāi Tahu Research Centre, and the Waterways Centre for Freshwater Management.

Appendix B: Ōtākaro-Avon Stream

Characteristics

In the mid-2000s, an assessment of the ecological health of the section of the Ōtākaro-Avon stream which flows through UC land identified that aquatic flora, fish and invertebrate fauna communities are degraded, partly due to silt sediment that is depleted of oxygen.

Interventions

1997 – 1999 planting of indigenous species from Waimairi Road to Ilam road, plus University Drive adjacent to UCSA building by Kākāriki. There was some anecdotal evidence that these plantings resulted in a moderate improvement of in-stream habitat.

Current issues

1. Bridges crossing rivers inadequate.
2. Lack of quality amenity values on the north side of the river due to University Drive.
3. The weir and water wheel creates a backflow in the river channel, plus acts as a barrier to fish passage.

Opportunities

Extend Living Laboratory concept to the Ōtākaro-Avon stream and undertake base-line research including,

- Survey Ōtākaro-Avon stream on campus land for gradient
- Map and take photos of storm water pipes
- Install gauge meters
- Conduct water quality data monitoring.

1. Extend ecological corridor concept to Ōtākaro-Avon where possible (recognising the value of existing Ilam Gardens).



Student Engagement: Planting on Ōtākaro-Avon stream, late 1990s

2. Further stream-side planting of indigenous plants.
3. Improve amenity values, particularly on the UCSA building site.
4. Extend community engagement project, similar to that conducted for the Okeover stream to the Ōtākaro-Avon stream catchment, with a special emphasis on including UCSA.

Appendix C: Ilam Stream

Compared to Okeover and Ōtākaro-Avon streams, Ilam stream has had no research conducted on it and no known formal interventions, other than standard maintenance practices by Grounds.

Key Characteristics

- The waterway up to the Staff Club is considered to be the Ōtākaro-Avon stream only. Ilam stream flows into the Ōtākaro-Avon at this point.
- There is between 700-800 meters of stream (which runs roughly east-west from Ōtākaro-Avon stream to Waimairi road) that could benefit from interventions.
- Sonoda/Dovedale has a spring that feeds into the stream. There is also a feed from Johns road.
- The weir and water wheel creates backflow in the river channel, plus acts as a barrier to fish passage.
- Water is usually pumped from the weir up to College House to provide a water feature. If this pump is turned off, water volume in the stream is negligible during periods of low rainfall.
- In-stream biological values are probably negligible on all indicators.
- Exotic plantings along both stream-banks.



Ephemeral section of Ilam Stream

Community Concerns

- College House expects Ilam stream to be flowing on a daily basis. This is partly for aesthetic reasons, but staff have a perception that it acts as a barrier between College House grounds and Waimairi Village. In dry periods, this is only achieved because water is pumped up from Ōtākaro-Avon stream. College House do not pay for the cost of pumping water to this feature, the cost of which is unknown. There is no incentive for College House to change their ideas about the water feature or how water is used in the stream.
- Water wheel feature at the intersection of the Ilam and Ōtākaro-Avon streams will also be a very important feature to the local community. It was shifted from a farm from the bottom of the Port Hills. This has historical significance as it was used to generate electricity at one point.
- Concerns have been expressed by the public to Grounds staff about the low level of Ilam stream.

Opportunities

1. Extend Living Laboratory concept to the Ilam stream and undertake base-line research including,
 - Survey Ilam stream on campus land for gradient
 - Map and take photos of storm water pipes
 - Install gauge meters
 - Conduct water quality data monitoring
5. Extend ecological corridor concept to Ilam where possible (recognising the value of existing Ilam Gardens).
6. Establish wetland.
7. Further stream-side planting of indigenous plants.
8. Improve amenity values.
9. Extend community engagement project, similar to that conducted for the Okeover stream to the Ōtākaro-Avon /Ilam stream catchment.
10. Stream area next to College House could be a good habitat for mudfish, provided precautions are taken to protect mudfish from predators.

Appendix D: Stakeholders in UC Waterways

- School of Biological Sciences/Freshwater Ecology Research Group. Jon Harding and Angus McIntosh
- Civil and Natural Resources Engineering. Tom Cochrane and Aisling O'Sullivan.
- Ngāi Tahu Research Centre
- Te Ao Mārama
- Waterways Centre for Freshwater Management
- Kākāriki – student campus environmental club
- UC Sustainability Office
- Engineering Services, in particular Grounds (Darryl Cone)
- ECAN
- CCC
- Christchurch West Melton Zone Committee
- Ilam and Upper Riccarton Residents Association
- Neighbours of The Ilam Stream (NOTIS)
- College House

Appendix E: Awards received

- 2001: 'Native Garden Award' (Christchurch City Council).
- 2004: 'Landscape design' New Zealand Pride of Place Landscape Awards
- 2011: 'Green Gown' award from the Australasian Campuses Towards Sustainability (ACTS) for its continuous improvement of Okeover Stream.

Appendix F: Current Research Relevant to Management of UC Waterways

Natural Resource Engineering/Hydro-Eco Group

- Funding agreement formalised with CCC for a storm water research project which investigates characteristics of storm water from typical urban catchments (e.g. roads, roofs and car parks), with the aim to identify a toolbox of treatment systems for Christchurch.
- Student projects:
 - modelling and optimisation of different treatment trains for the campus catchment
 - monitoring green roof modules on the engineering building
 - developing remote logging of water quality in the Okeover and Ōtākaro-Avon streams quantifying atmospheric deposition in different catchments in Christchurch.
 - Development of a storm water modelling framework to quantify pollutant loads from different urban surfaces

School of Biological Sciences

The School of Biological Sciences has collected ecological monitoring data on four sites on Okeover Stream since 2000, plus more sporadic data for the Ōtākaro-Avon stream. Other work includes

- Effects of heavy metals on biota
- Introducing biodiversity (wai kōura, mudfish, and mayfly) by adding in-stream habitat
- Investigating the effects of culverts.

For a catalogue of prior past research conducted on UC waterway issues, visit

<http://www.sustain.canterbury.ac.nz/research/campusresearch.shtml>