A Natural Character assessment of the Okuku and Kaiapoi Rivers in the Waimakariri District, New Zealand.

GEOG309 - Research for Resilient Environments and Communities in Geography

Final Project Report

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LIST OF ABBREVIATIONS:

NC – Natural Character

NCV – Natural Character Values

NCF – Natural Character Framework

NCC – Natural Character Criteria

RMA – Resource Management Act

EXECUTIVE SUMMARY

- Natural character is essential to the health and wealth of New Zealanders, as well as supporting thriving ecosystems.
- Natural Character is a term used in the Resource Management Act (1991), but is undefined, which poses problems when trying to manage or protect waterbodies through policy.
- In this report, Natural Character is defined as a measuring system of how much of a water body is still in its natural form, without detrimental human interference.
- The research question is "What are the Natural Character Values of Okuku and Kaiapoi Rivers in the Waimakariri District?"
- Literature reviews were used to compile current research and develop a definition, framework and criteria.
- Natural Character Values were identified as decreasing from a river's source towards its mouth, as the rivers get closer to areas of rural and urban development and increasing anthropogenic modifications.
- The Framework and Criteria produced are well reproducible and are effectively applied to a range of environments across the Waimakariri District.
- This research project was unable to incorporate all indices due to time and data constraints. However, recommended future research to incorporate these, along with sufficient mana whenua engagement.

2.0 INTRODUCTION

The natural character of New Zealand's rivers contributes to the unique and distinct character of New Zealand (Environment Foundation, 2015). It increases people's quality of life, ability to appreciate and reconnect with nature and the economy through tourism and exports with New Zealand's 'clean green' image (Environment Foundation, 2015). High natural character also benefits plants and animals in supporting healthy ecosystems and biodiversity.

In Section 6 (matters of national importance) of the Resource Management Act (RMA) (New Zealand Government, 1991), it states that those who manage natural resources should understand and adhere to;

> *"the preservation of the natural character of the coastal environment (including the coastal marine area), wetlands, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use, and development"*
>
> - Section 6a, RMA 1991

Nevertheless, the natural character has not been defined (Bentley, 2015; Maplesden, 2000), which makes it challenging to manage and protect. Defining and assessing natural character will help monitor the state of rivers through management within the context of existing and emerging public policy.

The Waimakariri District is a small but thriving district just north of Christchurch (Garcia, 2019). The Waimakariri catchment has both meandering and braided rivers that are spring-fed or fed by rainwater or melting snow and ice (Environment Canterbury, 2017). The Kaiapoi and Okuku Rivers were chosen as the worked examples to contrast braided and meandering rivers,

as well as rural and urban contexts (**Figure 1**). However, this framework has been designed to apply to all rivers in the Waimakariri District.

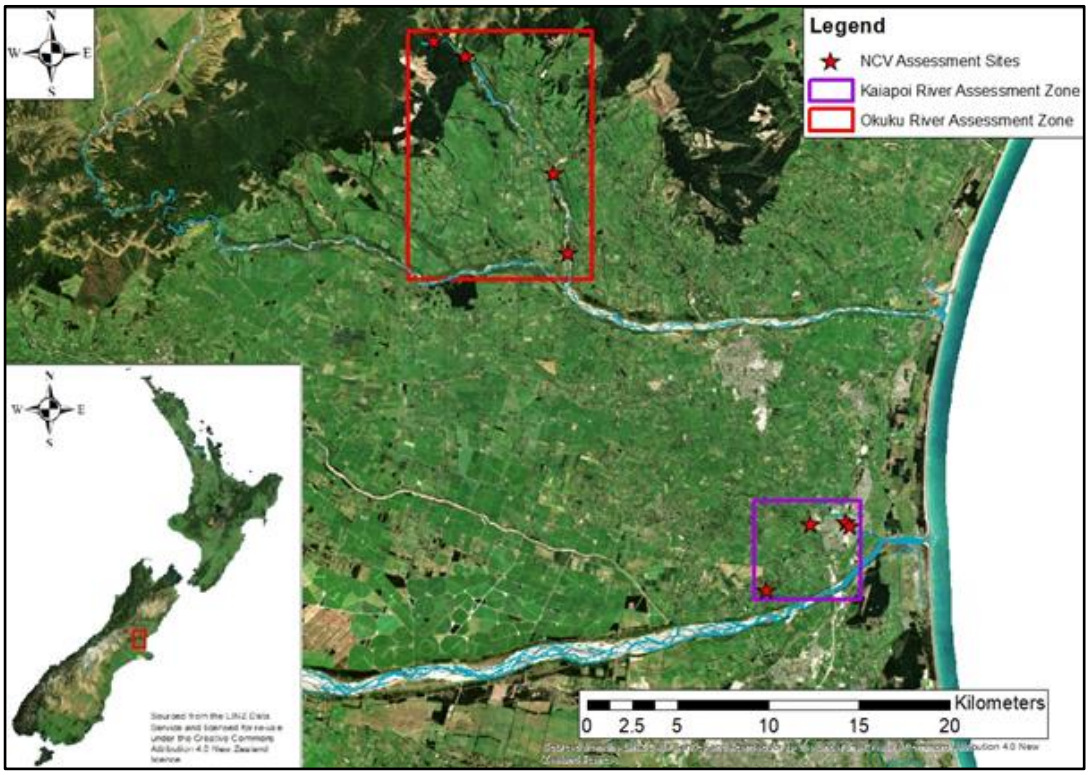

Figure 1: *These maps show the context of the two rivers within Waimakariri District, as well as New Zealand*

Okuku River is unenriched, has good recreation and fishing values and is made up with unmodified tussock (38%), native forest (19%), scrub (19%) and pasture (12%) (Suren *et al*, 2003). Okuku River starts near the Puketeraki range and flows into the Ashley River (**Figure 1**). Four sites were sampled along this river (**Figure 2**). There is a lack of knowledge on the Okuku River, which makes it an alluring river to study.

Figure 2: *The red stars on this map show the Okuku Catchment assessment sites. Site O1 starting in the top left of the map in native bush, through to O2 in partial bush and O3 as you follow the river down into farmland, with O4 being at the bottom right of the map near the Okuku-Ashley confluence.*

Kaiapoi River rises up from a spring northwest of Christchurch City (Winterbourn, 1978). Near its source it is surrounded by farmland and a fish hatchery. Then it flows eastbound across the Canterbury Plains (Winterbourn, 1978) through the centre of Kaiapoi Township (Knight, Giovinazzi, & Liu, 2012). Four sites were also sampled along this river (**Figure 3**).

Figure 3: *Red stars on this map show the Kaiapoi Catchment assessment sites. K1 is in the bottom left of the map, leading up to K2 at the edge of rural and urban, through to K3 and K4 in the top right of the map in central Kaiapoi town.*

In this study, natural character is defined as; a measuring system of how much of a water body is still in its natural form, without detrimental human interference. A framework that assesses the attributes of natural character and provides explanations to justify the assessment was designed. The research aim was to identify the natural character value of sections along Okuku and Kaiapoi rivers using this framework, whilst retaining the ability for it to be used in a variety of environments (reproducibility). This study's research question is:

What are the Natural Character Values of Okuku and Kaiapoi Rivers in the Waimakariri District?

3.0 LITERATURE REVIEW

Hughey (2013) developed the River Values Assessment System (RiVAS), a ranking tool for managers to help prioritize river values. Similar to this framework's purpose, Hughey mentions the RMA and the need for an assessment to aid legislation and policy. Hughey uses both objective and subjective measures. Unlike this framework, which was developed through literature, Hughey went a step further and selected a panel of experts to advise each value (i.e. kayaker for whitewater kayak values, an ecologist for native bird values). However, similarly, also used council members as a separate panel as a contrast to overlook the values. While the RiVAS framework looks similar in layout and scoring, it has a different intended use in that it informs values of a recreational nature. Both aid river management, but one potentially encouraging use of rivers, and the other putting a higher value on those that are untouched.

Hughey and Baker (2010) go into further detail on natural character in the RiVAS framework. They have the same view that the highest natural character comes with the least modification. Their expert panel also concluded that the natural character of a river is not just the wetted area but includes the margin and context beyond. Hughey and Baker assess the riverbed and channel, riparian vegetation and human-made structures like this framework. Inversely, they include water quality and flow measures which this framework did not.

Clapcott et al. (2018) developed a framework for freshwater managers to assess the biophysical ecosystem health of freshwater bodies. Clapcott assesses five components; physical habitat, ecological processors, aquatic life, water quality and quantity, which are mostly different to this framework being mainly focused on physical measurements. Clapcott admits their framework is based on western science and suggests it be accompanied by a Cultural Health Index (Tipa & Teirney, 2006).

Maplesden (2000) report is an interpretation of the natural character. Maplesden states that the Māori world view, traditions and expertise play a crucial part in the concept of natural character. However, when engaging with mana whenua, they were advised that incorporating Māori knowledge would require a separate process and report. The development of this framework also found that engagement with Māori required more time than was available, but this aspect of natural character is still vital. Maplesden states that natural character is on a spectrum from a built-up, modified environment to a pristine native environment, which is the same as the way this study has defined it.

The methodology Boffa Miskell (2018) used in their natural character, riverscape and visual amenity assessment comprised of just four indices; natural elements, natural patterns, natural processes and experiential/ perceptual - compared to the ten indices in this framework. While each is described further in their report, it does leave it very open to the user's interpretation. Boffa Miskell has an excellent description and schematic of the context, margin and active bed of single-channel and braided rivers which we have used in this report. The assessment is focused on the user describing the river section to justify the grading ('Very High' to 'Very Low'). In comparison, this framework focuses on a criterion in order to reduce subjectivity when scoring (1-5).

Gray (2018) developed a natural character assessment specific to braided rivers in Canterbury. This framework is based initially off the layout of Gray but adjusting it to suit both meandering and braided river. Rather than having a descriptor and indicator, this framework has a criterion which amalgamates the two. In the worked examples by Gray, there is no written reasoning to back up the score that was given, as this framework does. Gray incorporates water quality and fauna indices, unlike this framework. It lists the data source for these as Regional

council and NIWA as sources of this data, but this study found these sources unreliable and therefore excluded them.

In summary, current literature aided the development of this framework and provided insight to further expansion. Maplesden (2000) advise that incorporating a Māori component is vital, as does this study; therefore, it is recommended to expand on this section in the further development of this framework. Clapcott et al. (2018) had a hefty amount of physical measures, which have the potential to be added in this framework also. Like Hughey (2013), it would be beneficial to have the frameworks indices verified by experts.

Gray's (2018) assessment is only suitable to assess one river type, and Boffa Miskell's (2018) assessment tool was not entirely appropriate as it looked at only four attributes. Thus, calling for a need to define natural character specific to the Waimakariri District and its river types and with more in-depth attributes.

4.0 METHODS

A series of methods were used in order to assess the natural character of these rivers, including literature review, collaboration and meetings, field observations, and secondary data analysis. This assessment primarily involved the creation of a Natural Character Framework and Criteria, followed by data collection and analysis.

Methodologies for the assessment of natural character include what will be assessed, and how the indices will be assessed using a framework and criteria. Prior research is applied extensively in this study, which has been formed through collaboration as a group - conjoined

with the group supervisor and community partner. Prior research and collaboration have then been applied during field observations using the framework and criteria to assess the rivers.

4.1 PRE-FIELD WORK

Research (being gathered in the form of a literature review) is the primary method which makes up the core of the data. Primary data sources include Grey (2018), following assessment of natural character guidelines, and Boffa Miskell (2018), a natural character assessment. Additional sources were used to gather information. Iwi Management Plan (2013) produces information on how people engage with the natural environment. Belletti et al. (2015) reviews assessment methods for river hydromorphology. Wildhaber et al. (2014) relates to river morphology and sediment deposition, and Coomes et al. (2009), outlines human modifications on rivers.

Attributes, components, and indices have been applied to a framework of natural character (as seen in **Appendix D**). The framework outlines how the river will be assessed, supplying the basis of field observations. It uses ten indices with a score range of 1 to 5, scoring from 'Very Low' to 'Very High', respectively, as shown in **Appendix A**. The framework is the main driver for the assessment. The criteria explains what is being assessed, why it is being assessed and what features are present as examples, as seen in **Appendix E**.

Before entering the field, the assessment had to include what areas of the river were being assessed. As shown in **Figure 4** below, a schematic of braided and meandering rivers outlines the context, margin, and active bed of a river. Initially, the group were to assess the river in a 200 m context beyond the active riverbed. The measurement is to include lateral indices and

ensure the relevant components of biology and amenity values are assessed within a proper context.

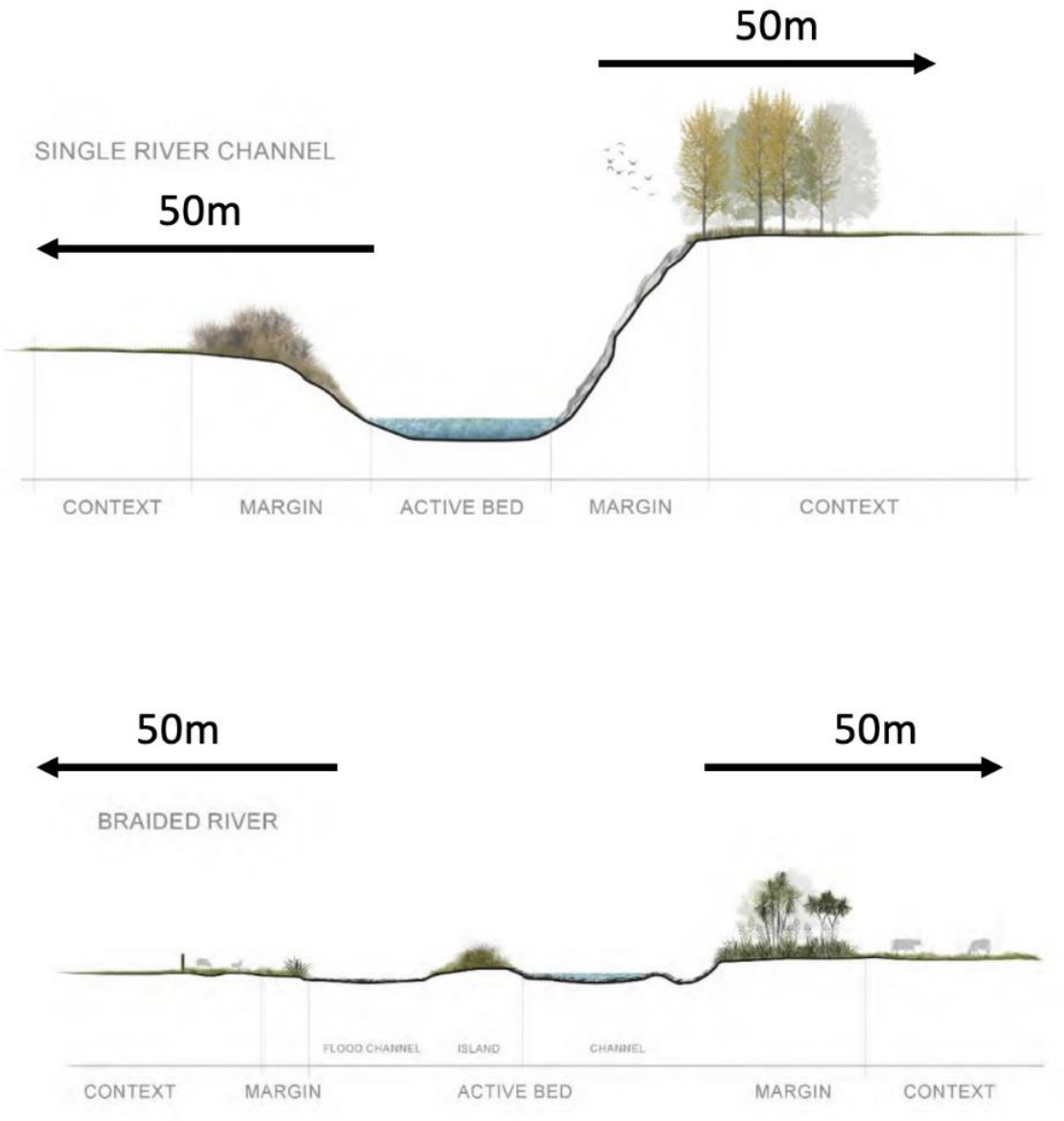

Figure 4: *Schematic of meandering and braided rivers and their context in which is being assessed. Source: Boffa Miskell. (2018). Natural Character, Riverscape & Visual Amenity Assessment. Prepared for Otago Regional Council.*

4.2 FIELD WORK

The group has applied the framework to chosen sites within the Kaiapoi catchment mainly through field observations. Field visits identified areas of accuracy and precision and any bias that may be met in the framework. Attuning the group into the framework eliminated bias and allowed ground-truthing of the framework and the group as assessors. Practice assessments of the Waimakariri and Avon River were conducted. The practice involved assessing two different sections of each river, ensuring ground-truthing and generating a review and questions to take back and re-evaluate before assessing rivers in the Kaiapoi and Okuku Catchment.

Going on to assess the Kaiapoi and Okuku sections, the group has split into two teams to ensure the non-subjectivity and bias of the framework. Observation of the sites stimulated consistency in assessment, including assessing rivers in normal conditions and the extent of what should be assessed. **Figure 1** shows the areas in which were assessed when out in the field. Initially, it was suggested the area assessed by the framework as 200 m beyond the active riverbed. Upon assessment, it was necessary to note we assessed up to 50 m each side of the river margin due to anything past this becomes terrestrial. It is no longer connected to the river system. Therefore, upon collaboration, it was agreed that 50 m was a suitable area to assess on each side of the river margin, as shown in **Figure 4.**

Areas of the river focused on during assessment and field observation on are outlined in **Figure 1** and are explained by the natural character variation the group wish to assess.

4.3 POST-FIELD WORK

Frequent collaboration between the group, community partner and supervisor determined the aims of the assessment to answer the research question. After initial consideration of indices outlining the framework along with examples, a final approach to scoring the Okuku and Kaiapoi rivers was determined. Historical imaging provided by Canterbury Maps (2020) is a secondary data source having much influence on the final score of each river. With the aid of a literature review, post-field observations targeted a decision on the specific indices that should be incorporated. This involved restructuring the framework, excluding indices and developing on others. Community partner Daniel and the team at the Waimakariri District Council have had a clear vision from the start, which meant the research question has not eminently changed to that initially proposed in the project outline. James and Daniel have given good feedback for the group to answer the research question.

The indices chosen and applied to natural character assessment have been incorporated for varying reasons based on literature review, collaboration, and data collation. Natural Character Indices from the Biology component, such as 'Streamwise' and 'Lateral', are essential for the existence of organisms and how they move within the environment. Diversity components include 'Flora Variation' and 'Detrimental Impact of Flora'; these indices include how biodiversity affects habitat and their influence on the ecosystem. Channel Morphology components include 'Riverbed' and 'Fine Sediment Prominence', which demonstrate the different components of a river and how these may influence how the river environment functions. The Natural Processes component includes the 'Erosion' and 'Fine Sediment Transport' indices and how these may affect a river systems natural ability to change. A 'Historical Comparison' shows the change in a river over time; this is an assessment tool to use after field observation. 'Mahinga Kai' and 'Experiential' indices from Amenity Values, base

river condition on the value of natural resources and the relationship between humans and the environment.

5.0 RESULTS

In this section, each of the eight assessment sites in the Waimakariri District are reviewed, and their relative Natural Character Values are broken down. Each site's assessment area (**Figures 1a-8a**) are displayed along with field photographs (**Figures 1b-8b**) showing the nature of each site with a description of what was present. The overall Natural Character Value of each site is lastly given on the NCV continuum (**Tables 3-10**) as seen in **Table 1**.

Table 1: *Natural Character Value continuum showing how each sites score is categorised between 'Very Low' and 'Very High' NCV.*

≤ 1.4 = Very Low	**1.5 - 2.4 = Low**	**2.5 - 3.4 = Moderate**	**3.5 - 4.4 = High**	**≥ 4.5 = Very High**
Very low natural character value due to very high anthropogenic influence	Low natural character value due to high anthropogenic influence	Moderate natural character value due to moderate anthropogenic influence	High natural character value due to low anthropogenic influence	Very high natural character value due to very low anthropogenic influence

The natural character component scores from each assessment site are compiled in **Table 2**, which also identified the overall Natural Character Value of each site. In this table, it is identified that along each river assessed (Kaiapoi and Okuku), the NCV decreases the further downstream a site is located. This downstream influence is linked to an increase in anthropogenic modifications, as the rivers get closer to areas of rural and urban development. In **Appendix G** of this report, there are the specific reasons (with explanations, notes and scores) for all ten NCV indices at all eight assessment sites.

Table 2: *Natural Character component score breakdown for each of the eight assessment sites. An average score has been calculated to identify the Natural Character Value of each assessment site. These scores each fit somewhere on the NCV continuum (Table 1), between 'Very Low' and 'Very High', which is given in the final column.*

NCV Assessment Site	Bio total (out of 20)	Geo total (out of 20)	Ame total (out of 10)	Total (out of 50)	Avg. Score (out of 5)	Total Natural Character Value
K1 - Silverstream Reserve	14.00	17.00	7.00	38.00	3.80	High
K2 - Butchers Road Bridge	13.00	13.00	7.00	33.00	3.30	Moderate
K3 - Kaiapoi town centre (above bridge)	13.00	9.00	6.00	28.00	2.80	Moderate
K4 - Kaiapoi town centre (below bridge)	10.00	5.00	4.00	19.00	1.90	Low
O1 - Top of Okuku River (Pinchgut Track)	18.00	18.00	8.00	44.00	4.40	High
O2 - Okuku Farm (first braid)	14.00	17.00	7.00	38.00	3.80	High
O3 - Karetu River confluence	15.00	12.00	7.00	34.00	3.40	Moderate
O4 - Birch Hill Road Bridge	10.00	11.00	6.00	27.00	2.70	Moderate

5.1 KAIAPOI CATCHMENT

Kaiapoi Site 1 - Silverstream Reserve

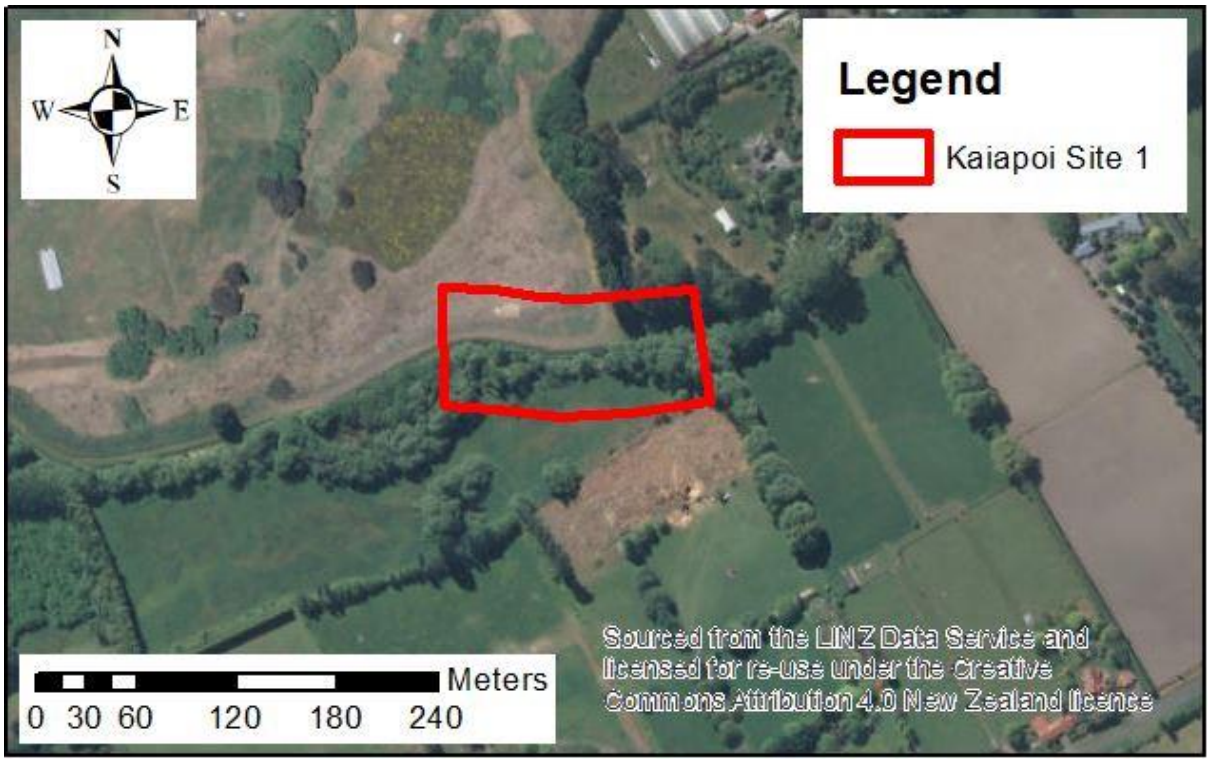

Figure 1a: *Aerial image showing the outline of the Kaiapoi Site 1 assessment area (red), in the southeastern corner of the Silverstream reserve, within a rurally dominated environment.*

Figure 1b: *Photo taken at Kaiapoi Site 1, looking upstream. River here has been able to act naturally eroding its banks with a high variation in riverbed characteristics and no fine sediments. Poor vegetation cover due to the nearby park and pasture however high vegetative habitat variation was present. This site experiences moderate road noise with pastures nearby bringing rural smells while mahinga kai support was high.*

Table 3: *Showing Kaiapoi Site 1 as overall having a 'High' Natural Character Value.*

≤ 1.4 = Very Low	**1.5 - 2.4 = Low**	**2.5 - 3.4 = Moderate**	**3.5 - 4.4 = High**	**≥ 4.5 = Very High**
Very Low natural character value due to very high anthropogenic influence	Low natural character value due to high anthropogenic influence	Moderate natural character value due to moderate anthropogenic influence	High natural character value due to low anthropogenic influence	Very High natural character value due to very low anthropogenic influence

Kaiapoi Site 2 - Downstream of Butchers Road Bridge

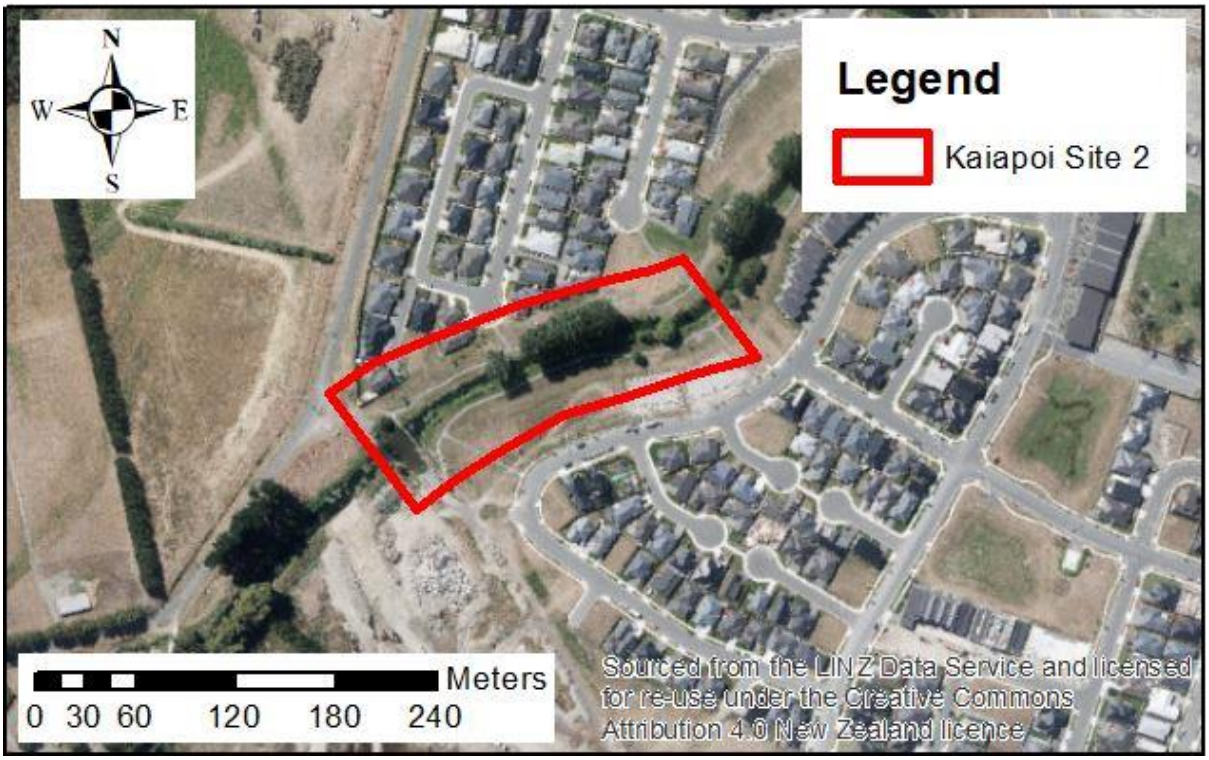

Figure 2a: *Aerial image showing the outline of the Kaiapoi Site 2 assessment area (red), located immediately downstream of Butchers Road bridge and between two new housing developments (not yet built in this image).*

Figure 2b: *Photo taken at Kaiapoi Site 2, looking downstream. River here has high variation in bed characteristics with a moderate ability to erode its banks however restricted by stabilising vegetation. Biological habitat here has moderate variation however is very sporadic with little ability to foster ecosystem services. Natural experiential value here was moderate due to nearby road noise and presence of development.*

Table 4: Showing Kaiapoi Site 2 as overall having a 'Moderate' Natural Character Value.

≤ 1.4 = Very Low	**1.5 - 2.4 = Low**	**2.5 - 3.4 = Moderate**	**3.5 - 4.4 = High**	**≥ 4.5 = Very High**
Very low natural character value due to very high anthropogenic influence	Low natural character value due to high anthropogenic influence	Moderate natural character value due to moderate anthropogenic influence	High natural character value due to low anthropogenic influence	Very high natural character value due to very low anthropogenic influence

Kaiapoi Site 3 - Kaiapoi town centre (above bridge)

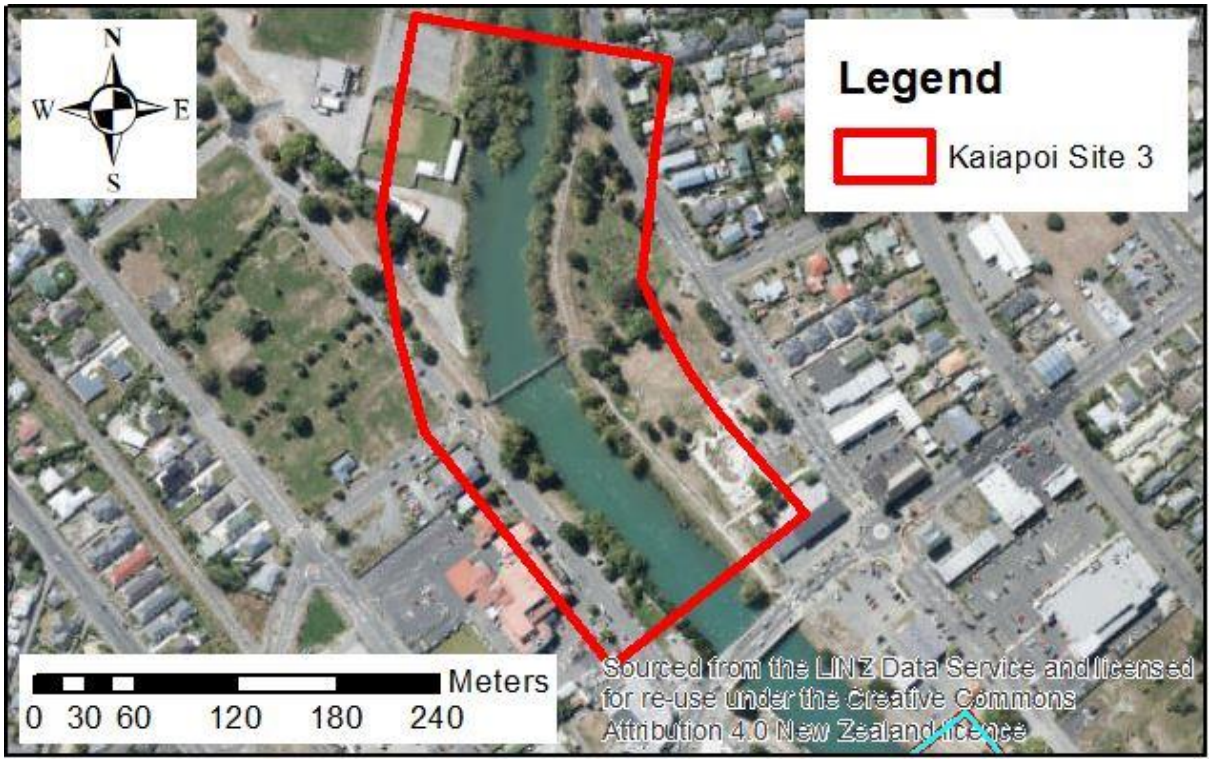

Figure 3a: *Aerial image showing the outline of the Kaiapoi Site 3 assessment area (red), located upstream of the Williams Road vehicle bridge. Very urban environment with a dominance of buildings, roads and parks.*

Figure 3b: *Photo taken at Kaiapoi Site 3, looking upstream. River here is confined by stop banks and some sections have concrete banks. Very little variation in riverbed characteristics with a prominence of fine sediments. Biological habitat here has moderate variation, however, is very sporadic and does not foster many ecosystem services. Natural experiential value is moderate as vehicle noise and poor due to water clarity. Mahinga kai support here was also low.*

Table 5: *Showing Kaiapoi Site 3 as overall having a 'Moderate' Natural Character Value.*

≤ 1.4 = Very Low	**1.5 - 2.4 = Low**	**2.5 - 3.4 = Moderate**	**3.5 - 4.4 = High**	**≥ 4.5 = Very High**
Very low natural character value due to very high anthropogenic influence	Low natural character value due to high anthropogenic influence	Moderate natural character value due to moderate anthropogenic influence	High natural character value due to low anthropogenic influence	Very high natural character value due to very low anthropogenic influence

Kaiapoi Site 4 - Kaiapoi town centre (including and below bridge)

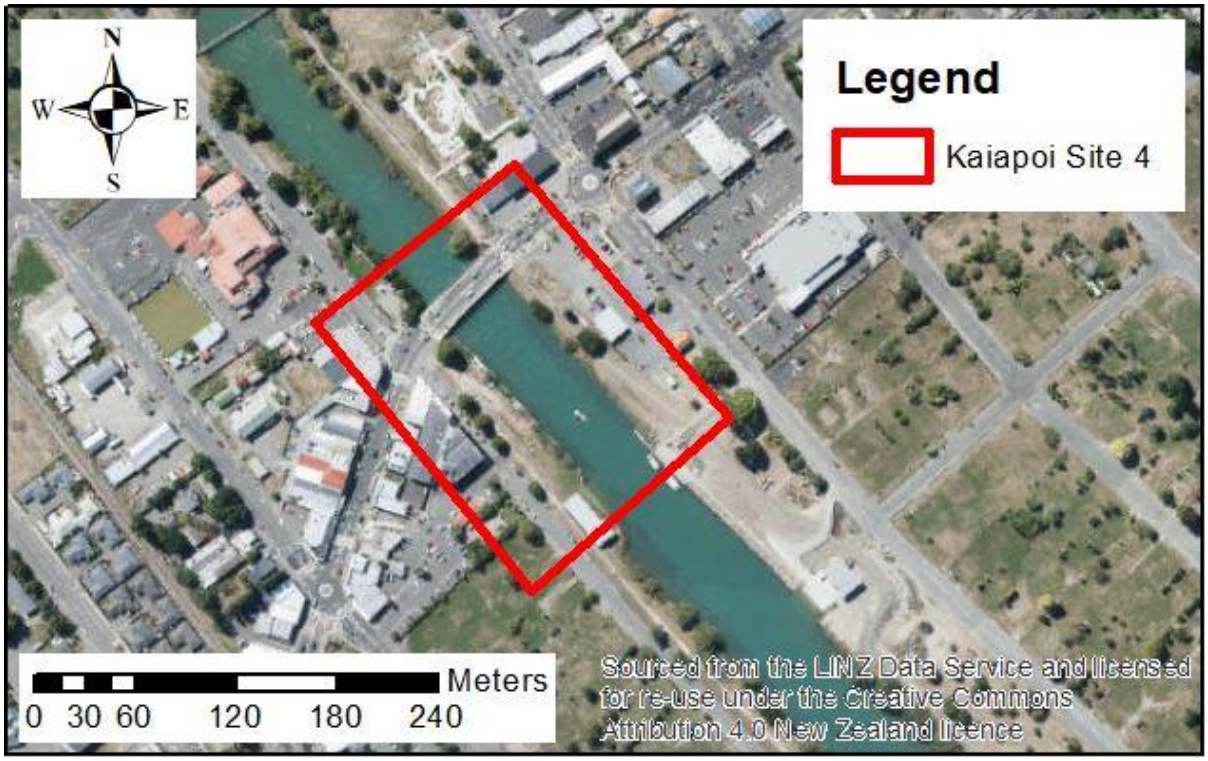

Figure 4a: *Aerial image showing the outline of the Kaiapoi Site 4 assessment area (red), which includes the Williams Road vehicle bridge. Very urban environment with a dominance of urban surfaces and structures.*

Figure 4b: *Photo taken at Kaiapoi Site 4, looking upstream. The river has been modified by urban structures including concrete banks jetties and a bridge which all inhibit natural river processes. Biological habitat is almost non-existent apart from mown grass and few large trees. Natural experiential value here is low due to the road noise, poor water clarity and few natural characteristics. Mahinga kai support here is also low.*

Table 6: *Showing Kaiapoi Site 4 as overall having a 'Low' Natural Character Value.*

≤ 1.4 = Very Low	1.5 - 2.4 = Low	2.5 - 3.4 = Moderate	3.5 - 4.4 = High	≥ 4.5 = Very High
Very low natural character value due to very high anthropogenic influence	Low natural character value due to high anthropogenic influence	Moderate natural character value due to moderate anthropogenic influence	High natural character value due to low anthropogenic influence	Very high natural character value due to very low anthropogenic influence

5.2 OKUKU CATCHMENT

Okuku Site 1 - Foothills at the start of the Pinchgut Track

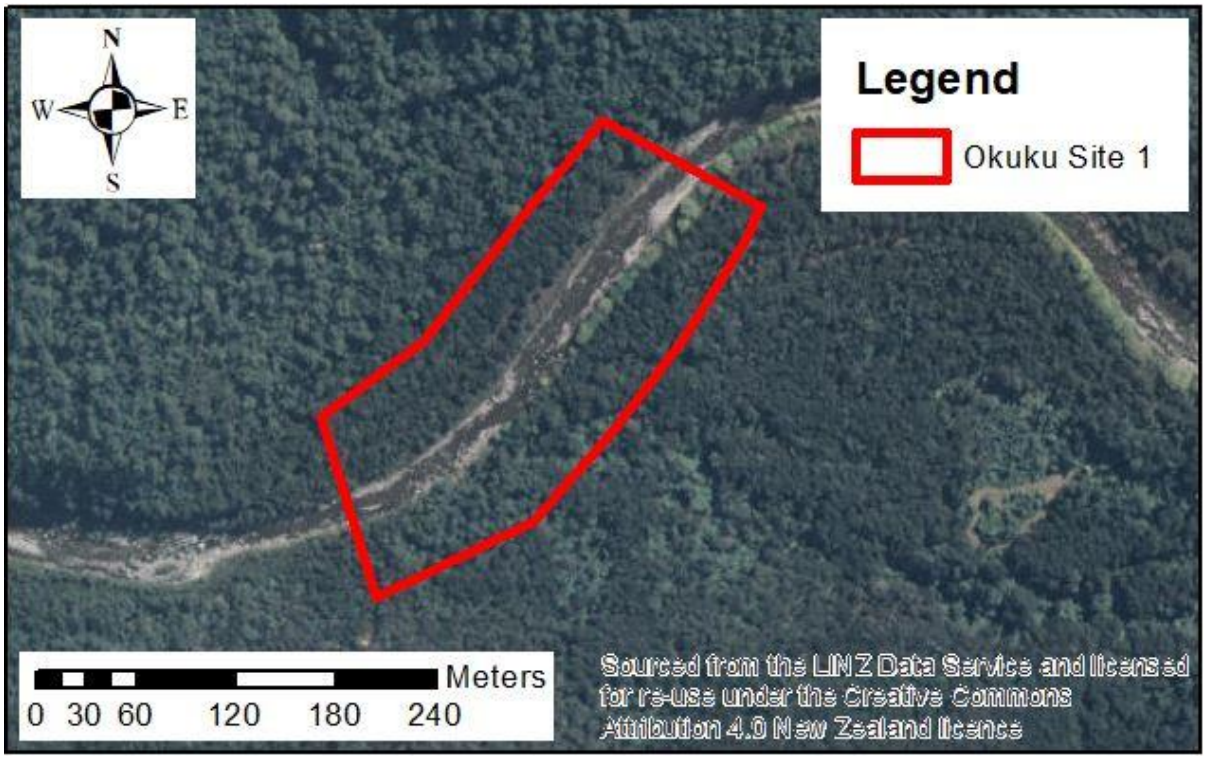

Figure 5a: *Aerial image showing the outline of the Okuku Site 1 assessment area (red), located near the start of Pinchgut Track. Highly naturally dominated environment with complete vegetation cover.*

Figure 5b: *Photo taken at Okuku Site 1, looking upstream. The river here can carry out its natural processes and has high variation in bed characteristics with no fine sediments. Biological habitat has high variation and coverage fostering a range of ecosystem services; however, presence of gorse and willow is detrimental. Natural experiential value is high and mahinga kai support is also high.*

Table 7: *Showing Okuku Site 1 as overall having 'High' Natural Character Value.*

≤ 1.4 = Very Low	**1.5 - 2.4 = Low**	**2.5 - 3.4 = Moderate**	**3.5 - 4.4 = High**	**≥ 4.5 = Very High**
Very low natural character value due to very high anthropogenic influence	Low natural character value due to high anthropogenic influence	Moderate natural character value due to moderate anthropogenic influence	High natural character value due to low anthropogenic influence	Very high natural character value due to very low anthropogenic influence

Okuku Site 2 - Okuku Farm (first braid)

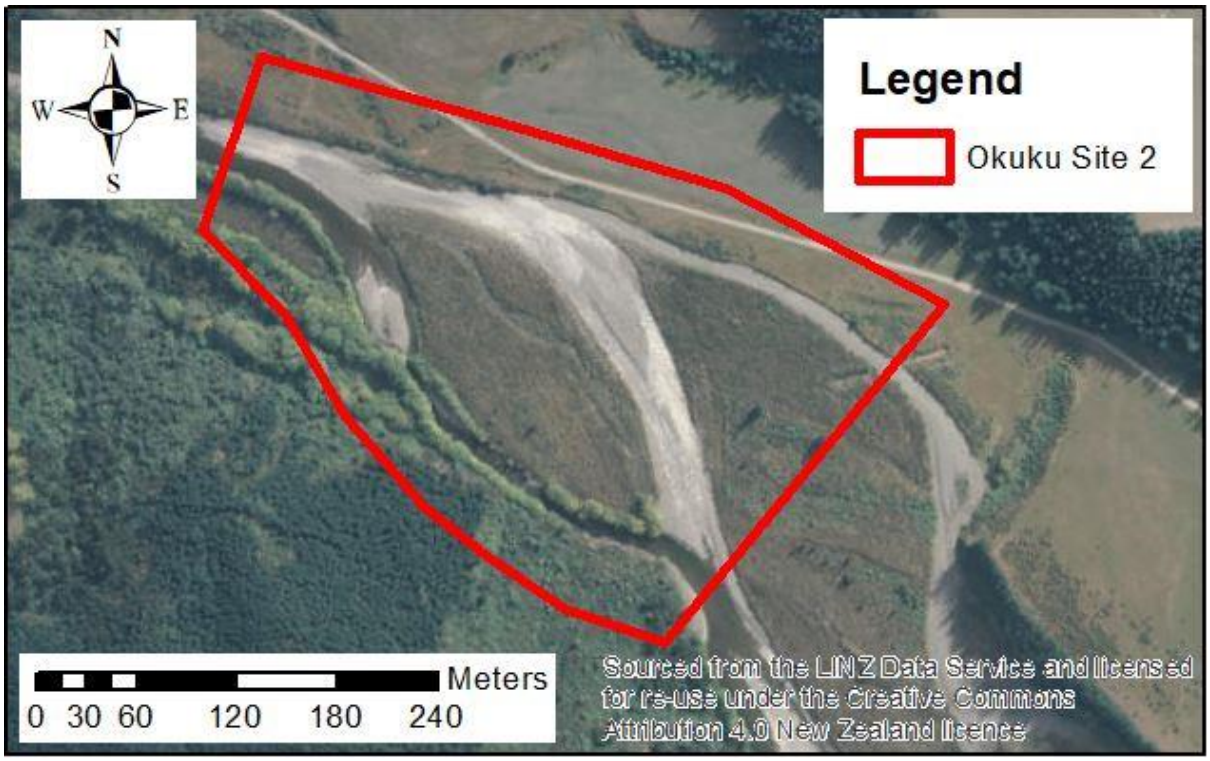

Figure 6a: *Aerial image showing the outline of the Okuku Site 2 assessment area (red), located 2 km downstream from Okuku Site 1. Plantation is present to the south and pasture is present to the north.*

Figure 6b: *Photo taken at Okuku Site 2, looking upstream. The river here has high variability in bed characteristics with no fine sediment. Biological habitat has high variation however is dominated by gorse and willows. Natural experiential value here is moderate due to the presence of pastures and dominance of gorse.*

Table 8: *Showing Okuku Site 2 as overall having 'High' Natural Character Value.*

≤ 1.4 = Very Low	**1.5 - 2.4 = Low**	**2.5 - 3.4 = Moderate**	**3.5 - 4.4 = High**	**≥ 4.5 = Very High**
Very low natural character value due to very high anthropogenic influence	Low natural character value due to high anthropogenic influence	Moderate natural character value due to moderate anthropogenic influence	High natural character value due to low anthropogenic influence	Very high natural character value due to very low anthropogenic influence

Okuku Site 3 – Immediately downstream from the Okuku/Karetu River confluence

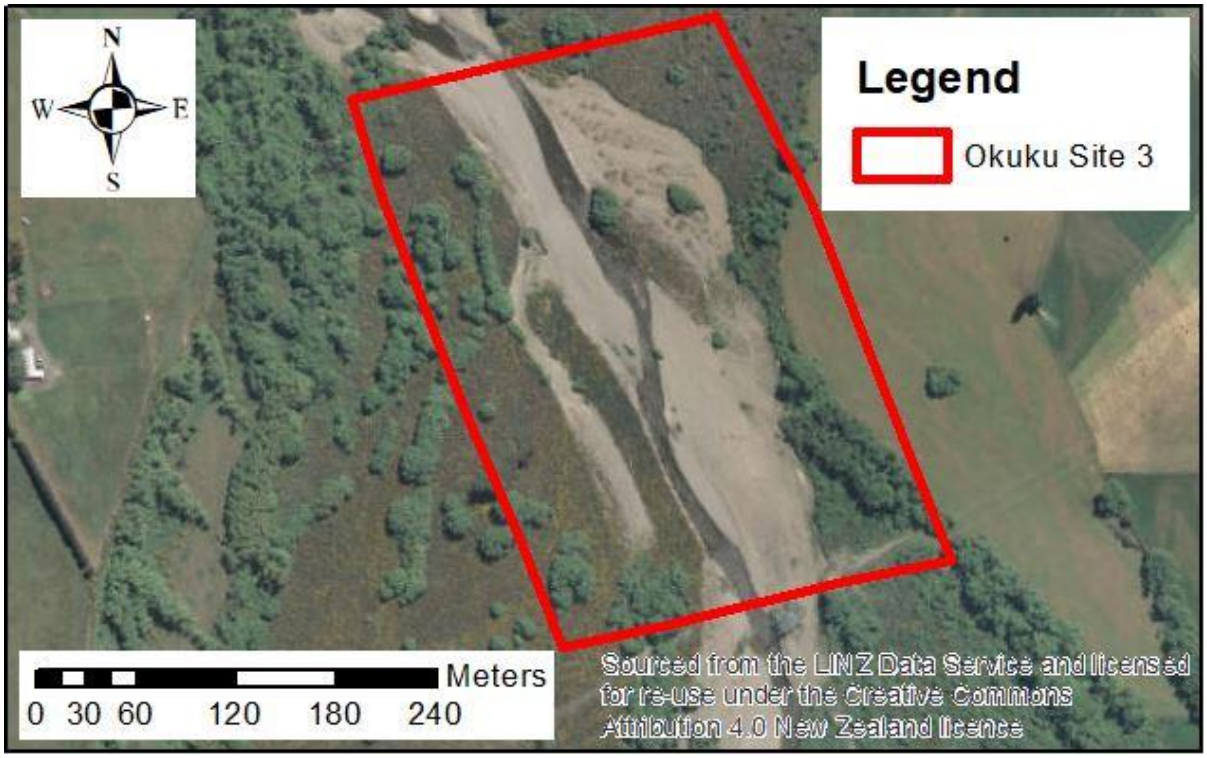

Figure 7a: *Aerial image showing the outline of the Okuku Site 3 assessment area (red), located immediately downstream of the Okuku and Karetu Rivers confluence. Agricultural encroachment is present.*

Figure 7b: *Photo taken at Okuku Site 3, looking downstream. The river here has moderate variability in bed characteristics with little fine sediment. Biological habitat has moderate variation and coverage, however, is dominated by willows. Natural experiential value here is high and Mahinga kai support is moderate.*

Table 9: *Showing Okuku Site 3 as overall having 'High' Natural Character Value.*

≤ 1.4 = Very Low	**1.5 - 2.4 = Low**	**2.5 - 3.4 = Moderate**	**3.5 - 4.4 = High**	**≥ 4.5 = Very High**
Very low natural character value due to very high anthropogenic influence	Low natural character value due to high anthropogenic influence	Moderate natural character value due to moderate anthropogenic influence	High natural character value due to low anthropogenic influence	Very high natural character value due to very low anthropogenic influence

Okuku Site 4 - Birch Hill Road Bridge

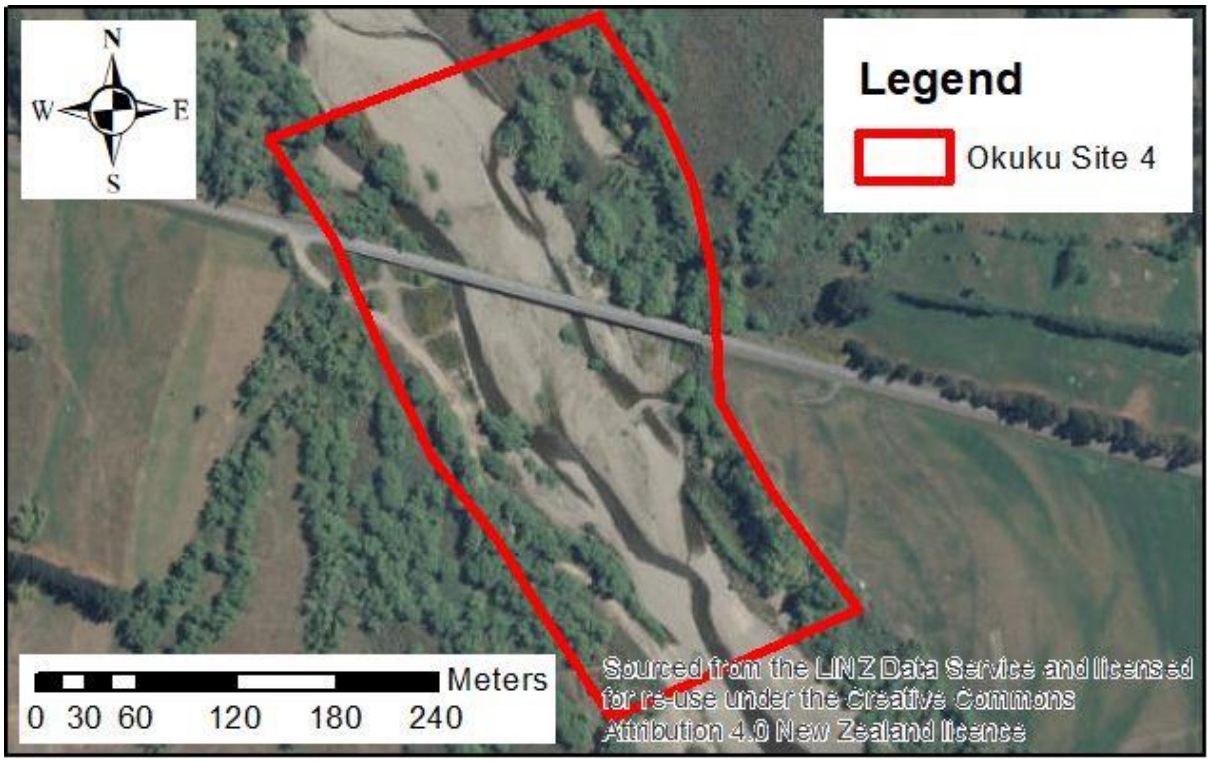

Figure 8a: *Aerial image showing the outline of the Okuku Site 4 assessment area (red), including the Birch Hill Road vehicle bridge. Very high influence from agricultural encroachment.*

Figure 8b: *Photo taken at Okuku Site 4, looking downstream. The river here has moderate variability in bed characteristics with little fine sediment. Biological habitat has moderate variation and coverage however is dominated by willows on its banks. Natural experiential value here is moderate due to the presence of the bridge, vehicle noise and Mahinga kai support was also moderate.*

Table 10: *Showing Okuku Site 4 as overall having 'Moderate' Natural Character Value.*

≤ 1.4 = Very Low	**1.5 - 2.4 = Low**	**2.5 - 3.4 = Moderate**	**3.5 - 4.4 = High**	**≥ 4.5 = Very High**
Very low natural character value due to very high anthropogenic influence	Low natural character value due to high anthropogenic influence	Moderate natural character value due to moderate anthropogenic influence	High natural character value due to low anthropogenic influence	Very high natural character value due to very low anthropogenic influence

5.3 LIMITATIONS OF RESULT

Although great lengths were gone to with this NC Framework and Criteria to ensure the scores elected for each index were accurate and reproducible, there were still limitations. One of these is regarding field observations, as it is possible that when assessing a site, it was in a unusual or extreme state, meaning the scores elected are likely not representative of the sites general state. The brief data collection period also means that the overall NCV at each site assessed is the only representative of its environmental characteristics present on the day of assessment.

The historical comparison index was also a somewhat grey area - as the score was only as reliable as the secondary data it was inferred from (Canterbury Maps and Black Maps). Some assessment sites did not have pre-1950s imagery, meaning a recent image had to be used to assess anthropogenic modifications over time. The results here are also limited due to the absence of three determined NCV indices which were unable to be incorporated into this framework, elaborated in the discussion.

6.0 DISCUSSION

6.1 RESULTS ANALYSIS

One observation noted from the results was that upstream sites corresponded with higher natural character, whereas downstream sites were consistent with lower natural character values. This correspondence is likely due to the increasing presence of anthropogenic modification in downstream sites.

The lowest biological scores were at the two sites with bridges present (K4 and O4). These scores were influenced by bridges which have a detrimental impact on connectivity. As stated

in a report by (NIWA, 2004), biological connectivity is lost due to anthropogenic influences. This can result in some species no longer moving through a specific area, reducing the biodiversity of an entire catchment. Restoring areas deficient in biological connectivity can see species recolonize an area after anthropogenic influence, though ongoing influences prevent optimum environmental biodiversity replenishment (NIWA, 2004).

Okuku River at the start of the Pinchgut track (O1) was the highest scoring site for biology, this may have been due to the lack of urban influences such as no houses or towns nearby. Profound effects on biodiversity are associated with urban areas and light and noise pollution (Newport, Shorthouse, & Manning, 2014). The high biological score may also have been due to the extensive presence of indigenous forest surrounding the river. The mobility of organisms is predominantly attributed to connectivity where vegetation corridors are well established with high biological diversity and coverage (Estreguil et al., 2016).

The lowest scoring site within the geomorphological attribute were the Kaiapoi town sites (K3, K4) and the lowest site on the Okuku near the Ashley River confluence (O4) which are all far from their source. This may be due to the anthropogenic influence of engineering stop banks to control rivers and prevent flooding. Which in turn alter the natural geomorphological processes, disrupt flow of sediment, causing riverbed and bank erosion downstream (Poeppl, Keesstra and Hein, 2015). Conversely, the best geomorphological conditions were the sites on each river nearest to their source (O1, K1).

The Kaiapoi town site had the lowest amenity value (K4). While the site had jetties and walkways which gave a good amenity feel from a human perspective, these are human-made values not natural character values. As the framework is assessing natural character it is

important to note experiential values are determined by natural characteristics and experiences as outlined in the criteria in **Appendix E**. As mentioned by Maplesden (2000) there is a difference between human-made amenity values and natural character values. It is stated amenity values are related to nature and culture in relation to natural character which aligns with this assessment. Amenity values should be regarded as natural, not human-made.

Other sites still scored reasonably high regarding amenity value. The Silverstream site (K1,) while nestled within an agriculturally predominated landscape, has had extensive native planting and stream rehabilitation. This shows humans can have a positive influence on the amenity values of rivers as stated in a report by NIWA (2004), as riparian buffer zones are an effective manager of fine sediments, nutrients and biodiversity. The Butchers Road site (K2) has Carex and tree plantings along the river's edge as stated by (Anderson et al., 2019) vegetation communities enhance habitats for fish and birds, therefore, contribute to greater mahinga kai values and develop connections between people and rivers.

The Okuku farm site (O2) had a mix of both agricultural land and established native forest. This may have struck the right balance of human influence and natural, allowing the river to be suitable for mahinga kai and provide a good experiential value (Anderson et al., 2019). revise the balance between anthropogenic influence and natural environments and effects that may be experienced through environment alteration. As people directly experience alteration, their needs should still be satisfied by recreational and gathering use whilst respecting natural values (Anderson et al., 2019). Karetu River confluence (O3) again shows you can have good amenity value within a farming landscape.

6.2 EFFECTIVENESS OF THE FRAMEWORK

When compared to previous frameworks, this framework provides a more flexible and comprehensive tool to assess natural character. The framework created uses ten indices to assess any river systems, irrespective of its characteristics or type. The greater number of indices in this reports framework allow the user to evaluate a river system in greater depth than the Boffa Miskell and Duncan Gray frameworks, who use four and eight indices, respectively (Boffa Miskell, 2018; Gray, 2018). In addition, Gray's framework is exclusively applied to braided rivers (Gray, 2018).

The method of dividing into two teams and assessing both the river systems separately, was unique to our framework. Use of this method ensured the consistency and reproducibility of our results. No previous framework (found during this project) has described using a means to verify its reproducibility (Boffa Miskell, 2018; Gray, 2018).

The framework by Boffa Miskell uses large scale assessment areas to average the natural character of the river system, comparatively the framework used in this report employs a smaller scale of assessment (Boffa Miskell, 2018). Assessing with this smaller scale has the advantage of recognising the discrepancies in natural character that are expressed on a very small spatial scale. In contrast, the larger assessment areas of the Boffa Miskell framework makes it susceptible to overlooking smaller scale natural character changes.

It can be confirmed that the framework and criteria created and applied in this report has served its purpose as described by our research aim.

6.3 LIMITATIONS

This framework has a high dependence on field observations which are limited to the users' visual range. Visual obstacles are a frequent occurrence during field work and often impair the users' visual range and consequently what can be assessed. Managing abnormalities in the conditions of the river systems was also an issue. A river being assessed with abnormalities in its condition could provide an inaccurate representation its usual state. An abnormality could consist of a flood event, stock movements or interference which disrupt the water body. This could skew any natural character assessment results gathered and thus, give a misrepresentation of the river system. Therefore, natural character assessments need to be conducted during a river system's standard conditions.

Attributes such as water quality and fauna were omitted from our framework. Water quality and fauna are both essential to components of the ecosystems occupying river systems. River ecosystems change according to the water quality. This is demonstrated by algae, which flourishes in conditions where water quality is poor. In addition, these algae can be toxic to existing flora and fauna (Collins & Weber, 1978). Fauna also influences river ecosystems, as invasive species can threaten present ecosystems. While water quality is vital to the health of a river system, there is insufficient data to evaluate its natural character and an inadequate timeframe to conduct water quality measurements. Likewise, with fauna, the insufficient data and impracticality of conducting measurements prevented us from assessing it. Both these measurements are also subject to frequent changes which render it difficult to attribute significant meaning to them from a short timeframe.

This framework was tasked with the assessment of sections of the Okuku and Kaiapoi rivers. Hence, the method used to assess these rivers was not intended for the assessment of the river

in its entirety. Given the boundaries of our assessment task, the results in this report cannot be used as a measure the overall natural character for the Okuku and Kaiapoi rivers.

6.4 FUTURE RECOMMENDATIONS

There are also recommendations for the future employment of this framework. If the framework is to be continued by Waimakariri District Council, then further mana whenua engagement is recommended. Due to time constraints, interaction with mana whenua was limited. Contact was established, and references were made to the Iwi Management Plan (IMP). Information from the IMP was found to be useful and was subsequently integrated into the mahinga kai assessment. Hence, if this natural character framework is deemed suitable for its intended purpose, then further engagement with mana whenua is recommended.

The methods by which this natural character framework is assessed on could be improved. The means of observing the sites could be improved by using a more adaptable method of observation. Utilising drones for observation would enable an adjustable perspective that can compensate for visual obstacles. Investigating methods of fauna data collection would also be prudent for future improvements. Due to the importance of fauna to river ecosystems it should be incorporated into the natural character framework.

7.0 CONCLUSION

In this community research project, a Natural Character Framework and Criteria were created in order to assess meandering and braided rivers in the Waimakariri District. 'Natural Character Value' is a broad term that has numerous contributing attributes; in previous assessments, many of these have been overlooked. In this report, the Natural Character Framework and Criteria produced takes these oversights into account, leading to more accurate and reproducible results from a range of environments.

The main finding of this assessment is that the Natural Character Value of a river decreases from a river's source towards its mouth. This was identified to be directly related to the increase in anthropogenic modifications, which makes sense as this makes up the definition of Natural Character Value. It is, however, essential to consider there are exceptions to this as structures, such as dams and bridges, can lead to local scale variations in Natural Character Value.

Should this framework and criteria be further developed or utilised by the Waimakariri District Council, the excluded indices must be incorporated - as well as Maori world views. Further engagement with mana whenua is also necessary to improve mahinga kai indices.

The results identified that none of the sections of the river assessed had 'Very High' Natural Character Values, this could help inform the Council of where to prioritise restoration. For example, Okuku Site 1 had significant issues with gorse bush - even though it is remote, distant from developed land. This Natural Character assessment toolset thus allows the sections of the rivers to be assessed, identifying their failings, which will require restorative action.

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APPENDIX:

APPENDIX A:

Table A1: Appendix A consists of the final score value. It also consists of the upper and lower brackets for each scoring level.

≤ 1.4 = Very Low	**1.5 - 2.4 = Low**	**2.5 - 3.4 = Moderate**	**3.5 - 4.4 = High**	**≥ 4.5 = Very High**
Very low natural character value due to very high anthropogenic influence	Low natural character value due to high anthropogenic influence	Moderate natural character value due to moderate anthropogenic influence	High natural character value due to low anthropogenic influence	Very high natural character value due to very low anthropogenic influence

APPENDIX B:

Table B1: Showcases all totals, averages and modes for each site, as well as a grand total and average attaining to the final score.

	B total	B Avg.	G total	G Avg.	A total	A Avg.	Mode	Total	Average
K1	14.00	3.50	17.00	4.25	7.00	3.50	3, 4	38.00	3.75
K2	13.00	3.25	13.00	3.25	7.00	3.00	4	33.00	3.17
K3	13.00	3.25	9.00	2.25	6.00	3.00	3	28.00	2.83
K4	10.00	2.50	5.00	1.25	4.00	2.00	1, 2	19.00	1.92

O1	18.00	4.50	18.00	4.50	8.00	4.00	5	44.00	4.33
O2	14.00	3.50	17.00	4.25	7.00	3.50	4	38.00	3.75
O3	15.00	3.75	12.00	3.00	7.00	3.50	4	34.00	3.42
O4	10.00	2.50	11.00	2.75	6.00	3.00	3	27.00	2.75

Table B2: Showcases average and overall scores for each river, giving a final score.

	B Avg.	G Avg.	A Avg.	Avg. Score	Final Value
Kaiapoi River	3.13	2.75	3.00	2.96	Moderate
Okuku River	3.56	3.63	3.50	3.56	High

Table B3: Showcases final scores and values for each location.

	Total (Out of 50)	**Final Average Score**	**Final value**
K1 – Silverstream	38.00	3.80	High
K2 – Butchers Road/ edge of Kaiapoi town centre	33.00	3.30	Moderate

K3 – Kaiapoi town centre (above bridge)	28.00	2.80	Moderate
K4 – Kaiapoi town centre (below bridge)	19.00	1.90	Low
O1 – Top of Okuku River (Pinchgut Track)	44.00	4.40	High
O2 – Okuku Farm (split braid)	38.00	3.80	High
03 – Karetu River confluence	34.00	3.40	Moderate
O4 – Mouth of river (below Birch Hill Road bridge)	27.00	2.70	Moderate

Appendix C:

This Natural Character Criteria is to be used in conjunction with the Natural Character Framework to aid the user in assessing the natural character of a river. This is a summary of the components of the criteria and framework.

1. **Biology**

1.1. Connectivity

1.1.1. Streamwise

'Streamwise' is the connectivity of the water down the active channel only. Culverts or weirs give a lower score, and footbridges or nothing give a higher score, as the former is interrupting the flow and movement of aquatic organisms, and the latter is not.

1.1.2. Lateral

Similar to 'Streamwise', but instead includes the active river, its margins and broader context. Includes flora and fauna connectivity – so concrete banks have no connectivity, whereas natural banks with extensive vegetation (up to 50 m) will have excellent connectedness.

1.2. Diversity

1.2.1. Flora variation

'Flora variation' typically promotes ecosystem processes. This index is an assessment of the variety of habitats, rather than flora coverage. Higher variation gives a higher score as it fosters a range of ecosystem services and raises natural character.

1.2.2. Detrimental impact of invasive flora species

A visual assessment of the (harmful) impact flora can have on the environment, e.g. willows being used for bank reinforcement (lower score). Some species (e.g. introduced to modify rivers) have suffocating effects on the natural environment, others having positive effects.

2. Geomorphology

2.1. Channel morphology

2.1.1. Riverbed

The natural or anthropogenically altered state of a river channel is being measured. Natural riverbeds tend to show signs on the surface, such as rapids or choppy water. The amount of variation in water surface is used as an indicator of riverbed morphology.

2.1.2. Fine sediment prominence

Typically, fine sediments likely originate from nearby anthropogenic land use and can have a suffocating effect on habitat. Water clarity can give an assumption, e.g. very poor water clarity is assumed to have high fine sediment amounts and therefore, would score lower.

2.2. Natural processes

2.2.1. Erosion/ sediment transport

Riverbed/ bank modifications can heavily impact a river's natural ability to erode, migrate and transport sediment. Anthropogenic modifications (e.g. channelising with concrete banks (Very Low score) or willows, or nothing (Very High score)) often prevent natural processes from taking place.

2.3. River condition

2.3.1. Historical comparison

Rivers are ever-changing over time. Comparisons were made using historical imagery, to past and present versions of the river. Specifically looking at anthropogenic modifications, higher levels of modifications results in a lower natural character value, and therefore a lower score.

3. **Amenity Values**

3.1. Mahinga kai

3.1.1. Iwi Management Plan

Mahinga kai is the value of natural resources in an environment that sustains life. Four key attributes that indicate mahinga kai values are water clarity, habitat flow variability, the sufficiency of accessibility and native species. These contribute to cultural stream health and access to clean, healthy kai.

3.2. Experiential

'Experiential' focuses on the pleasant natural states of a river. As this index can be subjective, it was very carefully measured. For example, prominent bird noises scored higher compared to vehicle noises. Examples from the environment were taken, rather than the assessors' interpretation or feelings.

Appendix D:

Appendix D consists of the Natural Character Framework created to aid the user in assessing the natural character of a river. This is the score sheet used to present the final scores given to each index. These final scores are given in the field as well as at university (online), as stated.
This framework is given in the report, but is presented here as well.

Attribute	Component	Indices	Data Sources	Score (1-5)
Biology	Connectivity	Streamwise	Field observations	
		Lateral	Field observations	
	Diversity	Flora variation	Field observations	
		Detrimental impact of flora	Field observations	
Geomorphology	Channel Morphology	River bed	Field observations	

		Fine Sediment Prominence	Field observations	
	Natural processes	Erosion/ Sediment transport	Field observations	
	River condition	Historical comparisons	Black maps, historical imagery	
Amenity values	Mahinga Kai values		Iwi Management Plan	
	Experiential		Field observations	

Appendix E:

This Natural Character Criteria is to be used in conjunction with the Natural Character Framework to aid the user in assessing the natural character of a river.

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Natural Character Framework Criteria

This criterion is to be used in conjunction with the Natural Character Framework to aid the user in assessing the natural character of a river.

Assessments should be done on days with no extreme influences (i.e. floods, storms), where river conditions are most typical. In the case that an index is unable to be assessed at a specific river system its weighting should be subtracted from the final Natural Character Value.

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Attribute	Component	Indices	Criteria	Examples

Biology	Connectivity	Streamwise	Streamwise connectivity focuses on the ability of aquatic organisms to move up and down a river channel naturally. Anthropogenic modifications to a river's bed or flow that affect the natural ease of passage of organisms will reduce streamwise connectivity, as well as constraining, restricting and reducing natural flows. Active river channels which are unobstructed and flow naturally will score highly. In contrast, a highly anthropogenically modified system with various barriers and structures in the stream will score poorly. This streamwise assessment is focused on the river's active channel and does not include structures beyond the edge of the active river channel - as this is covered in lateral connectivity. Anthropogenic modifications that reduce streamwise connectivity and modify river flow include but are not limited to: dams, culverts, bridges, weirs, jetties.	1 = Very poor connectedness, excessive presence of anthropogenic modifications which greatly restricts biological passage and detrimentally alters natural flow. i.e. culverts. 2 = Poor connectedness, high presence of modifications that have high effects on the biological passage and natural flow. i.e. weirs. 3 = Fair connectedness, some modifications are present and have moderate effects on the biological passage and natural flow. i.e. motor vehicle bridges. 4 = Good connectedness, few modifications are present and minimally affect biological passage and natural flow. i.e. footbridge and jetties. 5 = Excellent connectedness, absence of modifications that restrict biological passage and natural flow.

		Lateral	Lateral connectivity focuses on the ability of organisms to transition between the active river, its margin and broader context. This transition into the terrestrial environment is especially crucial for adult freshwater macroinvertebrates that are the foundation of many food chains. A well-connected, unmodified river system with high coverage will score highly due to its natural ease of biological passage - this includes a high coverage of vegetation. In contrast, a river confined by marginal barriers would score poorly. If vegetation is absent/ has low coverage or has been anthropogenically degraded, the site will score poorly. Modified surfaces close to river channels will also have detrimental effects on ecosystem health due to contaminant runoff. This assessment must consider lateral barriers restricting biological passage and the context ~50 m beyond the edge of a river bed. Anthropogenic modifications that reduce lateral connectivity include but are not limited to: concrete channel confinements, stopbanks, agricultural encroachment, urban development, grass buffers, parks, roads, jetties, fences and paths.	1 = Very poor connectedness, excessive presence of anthropogenic modifications which excessively restricts biological passage, i.e. channel confined by concrete with no riparian vegetation, dominated by urban development. 2 = Poor connectedness, presence of modifications that highly restrict biological passage. i.e. mown stopbank, parks, roads and agricultural encroachment. 3 = Fair connectedness, some modifications are present and moderately restrict biological passage. i.e. Grass buffers, fences, paths with some vegetation. 4 = Good connectedness, few modifications are present and minimally affect biological passage. i.e. Riparian plantings, although anthropogenically built, do foster ecosystem services. 5 = Excellent connectedness, absence of modifications that restrict biological passage from the river channel to its context. i.e. unaltered river system.

	Diversity	Flora variation	A reduction in flora biodiversity can alter ecosystem processes. This index is a visual assessment of the variation in vegetative habitat on the riparian margin (however, in meandering rivers, the flora species in the river bed should also be considered) to identify if few habitats dominate, or if it is a diverse range of flora habitats. A habitat is an environment produced by the presence of flora that fosters environmental processes. Coupled with the life-supporting capacity of ecosystems in which organisms live. For example, a flora habitat can be defined as an assemblage of flora, such as grasses, small shrubs, and trees. Flora variation is an assessment of the different flora habitats present, as opposed to the coverage of flora present. For example, an environment may have multiple flora habitats and pockets present but low coverage, therefore, it would score highly. Conversely, a river system with minor variation in flora habitat would score low. Note: Consider what makes up the natural vegetative habitats. i.e. alpine areas may naturally have low vegetative habitat variation, such as a dominance of hunangāmoho (tussocks).	1 = No variation/dominance of a single vegetative habitat. i.e. exclusively short grasses such as a mown bank. 2 = Low variation/dominance of few vegetative habitats. i.e. grassy bank up to the river's edge with only small trees. 3 = Moderate variation in vegetative habitats. i.e. short grasses, long grasses, with some small bushes. 4 = High variation in vegetative habitats. i.e. short grasses, long grasses, bushes, and small trees. Could be similar to riparian planting. 5 = Very high/ natural variation of vegetative habitats. i.e. environment in its natural state. With numerous vegetative habitat types which will foster a range of ecosystem service. Extra: in a meandering river, the river bed would also have high flora habitat variation.

		Detrimental impact of flora	Flora that thrives in an environment but is detrimental to the existing ecosystem and natural character. This index is a visual assessment of the (likely negative) impact flora have within the environment. Detrimental flora species: Dominance of willows and poplars affecting flow rates, Old Man's Beard suffocating the surrounding flora, kohi (gorse) and kuiki (boxthorn), competing with non-invasives and fixing nitrogen to soils, parakipere (blackberry) smothering soils prevents seedling growth, tohetaka (dandelion) and kohukohu (chickweed) crowding out desirable plants. Note: Having only indigenous/ native plantings does not necessarily mean a higher score - the flora could still be detrimental. This assessment is more about the harmful impact flora has on natural river processes. A high presence of low impact flora does not necessarily indicate a highly detrimental impact.	1 = Very high detrimental impacts of flora. An environment which is severely negatively impacted by the predominance of damaging flora. 2 = High detrimental impact of flora. An environment largely impacted by damaging flora due to the high presence of adverse flora. 3 = Moderate detrimental impact of flora. An environment moderately impacted by damaging flora due to the moderate presence of adverse flora. 4 = Low detrimental impacts of flora. An environment with little impact from damaging flora, due to the low presence of adverse flora. 5 = No detrimental impact from flora. Potentially dominated by non-invasive/ natural species.

Geomorphology	Channel Morphology	River bed	Naturally, rivers exhibit irregular riverbeds. As a result, they tend to display uneven water surfaces. A flatter river bed would show a smoother water surface; in contrast, an uneven riverbed would show a rough water surface. However, a natural river system would show both smoother and uneven water surfaces; due to variations in river bed characteristics. A river surface with low variation would represent a low variation in river bed characteristics, thus would score lower. In contrast, a highly variable river surface would represent a higher variation in bed characteristics - scoring higher. Anthropogenic modifications that reduce river bed variation include but are not limited to: gravel extraction, channelising, river flow regulation, anthropogenic changes to runoff and anthropogenic modifications to watersheds.	1 = Water surface is flat and has no variation. High amounts of anthropogenic modifications or processes nearby affecting the river channel and bed. e.g. a river could be artificially straight with no variation, meaning the river bed is flatter - showing a calmer water surface. 2 = Minor or little variation in the water surface, mostly smooth due to minor bed variation. A high presence of anthropogenic modifications nearby, highly likely affecting river channels and bed. 3 = Moderate variation in the water surface. Presence of anthropogenic modifications nearby, moderately affecting the river channel and bed. 4 = High amounts of variation of the water surface, little anthropogenic modifications nearby potentially affecting the river channel or bed. 5 = Very high variation in characteristics of the water surface, e.g. eddies, riffles and roughness. No nearby anthropogenic modifications.

		Fine Sediment Prominence	This index is a visual assessment of the channel to determine the presence of fine sediment within the riverbed. Fine sediments likely originate from nearby anthropogenic land use and can have a suffocating effect on biological habitat. This effect is evident throughout all types of rivers, from meandering to braided rivers. Particularly anthropogenically modified braided rivers. A riverbed observed to have a substantial presence of fine sediment will get a lower score. Comparatively, a river bed with a lower presence of fine sediment will get a higher score. Note: a river with consistently low clarity would be assumed to have fine sediments on its bed.	1 = Very high amounts of fine sediment present on the river bed. The river channel is highly suffocated and has a substantial presence of fine sediments. Highly likely to have very poor water clarity. 2 = High amounts of fine sediment present. High suffocation from fine sediments. Likely to have low water clarity. 3 = Moderate amounts of fine sediment present. Partial impact/ suffocation of fine sediment. 4 = Low amounts of fine sediment present. Low detrimental impact/ suffocation of fine sediment. Likely to have high water clarity. 5 = Very low amounts of fine sediment present with very low detrimental impact. Very likely to have high water clarity.

	Natural processes	Erosion/ Sediment transport	River bed/ bank modifications can heavily impact a river's natural ability to erode, migrate and transport sediment. These are essential processes for sustaining the morphology of a river and its ecosystems. Anthropogenic modifications to a river's bed or banks often prevent natural river processes from taking place. A river system which has not experienced bed or bank modification will score highly. Comparatively, a highly modified river bank or bed that restricts natural processes would score poorly. Anthropogenic modifications to a river bed or banks which restrict natural processes include but are not limited to concrete banks/ beds, riparian planting, groynes and rock gabions.	1 = Very poor capability to carry out natural processes, i.e. concrete stopbank or heavily channelised. 2 = Poor capability to carry out natural processes, i.e. groynes or rock gabions. 3 = Moderate capability to carry out natural processes. This could be dense riparian plantings, e.g. wirou (willows) and papara (poplars). 4 = High capability to carry out natural processes. This could be minor riparian plantings, e.g. harakeke (flaxes) and pūrei (carex). 5 = Very high capability to carry out natural processes. No anthropogenic modifications with a high ability to migrate and transport sediment.

	River Condition	Historical comparison	Historic comparisons show how rivers have changed over time, either naturally or due to anthropogenic influence. Using Black Maps, this assessment will compare a river's previous condition with its current (likely more modified) state. The level of anthropogenic modification identified between sources will determine its river condition values. A water body that reveals significant anthropogenic change between data periods will have a low score allocation. Comparatively, a water body with minimal anthropogenic change will have a high score allocation. Note: rivers naturally migrate over time - not automatically resulting in a lower score. Results may be constricted by the accessibility and availability of data and its ability to identify anthropogenic modifications. Note: Another anthropogenic modification which will be assessed but not extensively measured is water extraction. We will record the presence of water extraction happening by online resource consents. If it is happening, this will slightly lower the natural character value.	1 = Very high level of anthropogenic modifications since early imagining and past data, e.g. intensive structural development and extensive river encroachment. 2 = High anthropogenic modification, e.g. significant structural development and river encroachment. 3 = Moderate anthropogenic modification, e.g. moderate structure development, moderate encroachment to the river. 4 = Low anthropogenic modification, e.g. minor structure development or minor encroachment to the river. 5 = Very low anthropogenic modification, e.g. no structural development and no encroachment to the river.

Amenity values	Mahinga Kai values		Mahinga kai is the value of natural resources in an environment that sustains life. These resources must be sustainably managed, through kaitiakitanga, for future generations to continue traditional food collection. A river system that supports mahinga kai resources represents a high natural character, and also supports the traditional practices of producing and protecting resources. These practices are the foundation of Ngāi Tahu values and should be maintained in order to sustain and nourish for the future. Four key attributes that indicate mahinga kai values are water clarity, habitat flow variability, the sufficiency of accessibility and native species. These contribute to cultural stream health and access to clean, healthy kai, therefore, represent a high natural character. An environment with a high mahinga kai score would include: high water clarity (no pollution evident), high habitat flow variability (current and depth are highly variable, establishing different flow-related habitats), high accessibility (able to sufficiently gather with no restrictions), high variability in native species (complete cover of vegetation, margins unmodified).	1 = Very low mahinga kai value. e.g. appears highly polluted, no current, no accessibility, little to no vegetation cover and highly modified margins. 2 = Low mahinga kai value. e.g. appears polluted, little variation in current and depth, low accessibility, little vegetation cover and significant modification to margins. 3 = Moderate mahinga kai value. e.g. moderate pollution, partial variation in current and depth, sufficient accessibility, moderate vegetation cover and moderate modification to bank. 4 = High mahinga kai value. e.g. low pollution, good variation in current and depth, good accessibility, high cover of vegetation and little bank modification. 5 = Very high mahinga kai value. e.g. no pollution evident, current and depth varies, no restrictions to accessibility, complete cover of vegetation and no bank modification.

	Experiential		The relationship humans have with the environment and how they interact with it determines experiential values. Values include what can be heard, seen and smelt. If an environment has a positive impact on an individual's well-being, the specified environment has a general positive impact in terms of experiential value. The direct experience of an environment determines how a person values that environment. An environment with high aesthetic values would broadly include natural characteristics and appearances. Plantings, water clarity and general condition of the environment contribute to experiential values. Experiences will differ individually; in general, we should assess commonalities between the natural environment. An urban environment may have built an aesthetically pleasing structure; however, be it the environment has an urban influence that may be aesthetically pleasing, we seek to assess natural experiential value in this assessment.	1 = Very poor natural experiential value. The environment may have an unappealing smell such as effluent, vehicle fumes or industrial emissions, the general noise of vehicles, loud unnatural noise, no greenery. Likely anthropogenically dominated. 2 = Poor natural experiential value. The environment may have an unpleasant smell; dominant noise may be vehicles, little greenery. 3 = Moderate natural experiential value. The environment may have dust, a slight smell of effluent, some noise from vehicles, moderate levels of greenery. 4 = High natural experiential value. Dominant noise is birds and natural processes, predominant areas of greenery. Low anthropogenic noises, smells. 5 = Very high natural experiential value. The naturally scented environment may be dominantly green, high aesthetics, the sound of nature, high well-being - no anthropogenic hindrance.

Appendix F:

Appendix E consists of the Natural Character Notes Framework created to aid the user in assessing the natural character of a river. This is the score sheet used to present the scoring and thought process behind the final scores given to each index. These notes are written in the field as well as at university (online), as stated. This framework is given in the report, but is presented here as well.

A	C	Indices	Data Sources	Score	Notes/ Explanation:
B	C	Streamwise	Field observations		
		Lateral	Field observations		
	D	Flora variation	Field observations		
		Detrimental impact of flora	Field observations		
G	CM	River bed	Field observations		
		Fine Sediment Prominence	Field observations		
	NP	Erosion/ Sediment transport	Field observations		
	RC	Historical comparisons	Black maps, historical imagery		
A	MK		Iwi Management Plan		

	E		Field observations		

Appendix G:

Appendix F consists of the Natural Character Notes Framework in-field results from assessing the natural character of a river. This is the score sheet used to present the notes of scoring and thought process behind the final scores given to each index. These notes are written in the field as well as at university (online), as stated. These framework notes are given in the report, but are presented here as well.

K1 - Silverstream

A	C	Indices	Data Sources	Score	Notes/ Explanation:
B	C	Streamwise	Field observations	4	Mostly clear, no bridges etc. Presence of concrete blocks (x2) brought it down to 4.
		Lateral	Field observations	3	Riverbank itself has good habitat, but it is then straight to grass paddocks on both sides.
	D	Flora variation	Field observations	4	As above, very high variation on immediate banks, but none thereafter. Mainly just lawn grass everywhere but banks.
		Detrimental impact of flora	Field observations	3	There are weeds suffocating river, as well as willows, old mans beard & gorse. This means good habitat variation but lower stream health.
G	C M	River bed	Field observations	5	Riffles, eddies and strong flow. Visible raise & lowering of sediment/bed. Large variation in sediment (for a meandering).
		Fine Sediment Prominence	Field observations	5	Large variation in sediment, for a meandering. Stirring up bed didn't turn stream muddy, little fine sediment. etc
	N P	Erosion/ Sediment transport	Field observations	3	Highly channelised with vegetation. Poplars & willows major bank support. the river can't erode well, the banks are reinforced.
	R C	Historical comparisons	Black maps, historical imagery	4	Lots of agricultural encroachment and vegetation change (19th century)
A	M K		Iwi Management Plan	4	Good water clarity. Good current & variable depth & variation in habitat at & in the stream. Sufficient accessibility - native species had good variability but moderate modification.
	E		Field observations	3	There is decent bird noise. However, also road noise close by, as well as buildings. Landscape development, pasture, fences etc.

K2 - Butchers Road / edge of Kaiapoi town

A	C	Indices	Data Sources	Score	Notes/ Explanation:
B	C	Streamwise	Field observations	4	Small, minimal impact from footbridge. Small piping present in stream. Would score 5 if not for these.
		Lateral	Field observations	2	A lot of riparian plantings along the bank. However, past the bank, only grass present until houses. Poor connectivity
	D	Flora variation	Field observations	4	In stream vegetation is very good, out of stream, however, is not a 5. There are good habitats, but not enough.
		Detrimental impact of flora	Field observations	3	Trees present on stopbank. However, grass coverage and plantings are good.
G	C M	River bed	Field observations	4	Variation in river surface. Eddies, turbulence, however, pipes causing build up of sediment.
		Fine Sediment Prominence	Field observations	4	Good coverage by pebbles. Not much variation in rocks, so is a 4. Will be a layer of fine sediment underneath.
	N P	Erosion/ Sediment transport	Field observations	3	Willows to stop erosion, on outward bend. There are still spots to erode between roots etc.
	R C	Historical comparisons	Black maps, historical imagery	2	Several groundwater extraction sites. There is a point where extensive vehicle activity has taken The nature and structure of the river seems to change - braided place to meandering
A	M K		Iwi Management Plan	4	Good water clarity. Let down by influence of pipes. Good flow habitat variability, slight variability in depth Good accessibility. Highly modified Margins
	E		Field observations	3	Main road nearby reduces value. Houses are quite close. River itself scores highly. Many plantings, trout, clear water, birds, ducks etc.

K3 - Kaiapoi Town Centre - above bridge

A	C	Indices	Data Sources	Score	Notes/ Explanation:
B	C	Streamwise	Field observations	4	Only a footbridge with minimal in-stream disruption. Channelising with grass banks & small area of concrete.
		Lateral	Field observations	2	Grass banks to waters edge, fair connectedness. Footpaths on banks (concrete). Urban parks immediately after (i.e. mainly grass, mown).
	D	Flora variation	Field observations	4	Many different variations of flora. Raparian plantings for biodiversity. Parks on either side with aesthetic plantings. Grasses, flaxes, bushes, trees.
		Detrimental impact of flora	Field observations	3	Not quite a 5. Flora is planted to channelise (willows). However, many raparian plantings raise score.
G	C M	River bed	Field observations	2	Few small eddies. River surface is very flat + slow moving. Highly likely flat river bed. Willow roots affecting river bed (willows in middle of river)
		Fine Sediment Prominence	Field observations	1	Very dirty, poor water quality with no unsual situations (e.g. in flood). Can see grass covered with fine sediment at waters edge.
	N P	Erosion/ Sediment transport	Field observations	3	Moderate capability. Footbridge has concrete reinforcements for banks. Heavily channelised w stopbanks & willows.
	R C	Historical comparisons	Black maps, historical imagery	3	Surface water extraction point. Large urban confinements (19th century).
A	M K		Iwi Management Plan	3	The area is relatively polluted. Has low flow habitat variability. there is little to moderate amount of vegetation (and native plantings) Can gather, but not well, at waters edge.
	E		Field observations	3	Mostly bird noises. However, roads on other side of stopbank, with car park. Town centre is right there. Bird + ducks present. Has pollution.

KH - Kaiapoi Town Centre - Vehicle Bridge

A	C	Indices	Data Sources	Score	Notes/ Explanation:
B	C	Streamwise	Field observations	3	Heavy channelising. Road bridge at top of section. Little interferance except jetties, channelising and bridge.
		Lateral	Field observations	1	Concrete stopbanks. Then immediate shops etc. Grass banks on one side after concrete, then immediate road + shops.
	D	Flora variation	Field observations	2	Little to no flora. What is there is mainly few grasses in planter boxes, grasses on one bank with few planted large trees.
		Detrimental impact of flora	Field observations	4	Small introduced grasses smother near stream habitat. Mainly trees on other side for bank reinforcement. Little to no vegetation.
G	C M	River bed	Field observations	1	River surface very flat. Little to no flow movement. Highly likely flat river bed.
		Fine Sediment Prominence	Field observations	1	Very dirty / poor clarity. Not in unusual situation (e.g. flooding). Grey water, grass on bank is stained with fine sediment.
	N P	Erosion/ Sediment transport	Field observations	1	Concrete banks - vertical on each side. One side has grass/ dirt stopbank after concrete. No ability to erode due to extensive concrete.
	R C	Historical comparisons	Black maps, historical imagery	2	Multiple shallow ground water extraction points (19th century). Heavy urban confinements - stopbanks.
A	M K		Iwi Management Plan	2	Very little native species (except few plant boxes of grasses). No/little flow & high pollution braught value down. Good space to gather, eg. high accessibility & seating.
	E		Field observations	2	Road bridge with extensive traffic noise and smell. Very partial greenery, but can hear birds in few trees across river.

01 - top of Okuku, Pinchgut Track

A	C	Indices	Data Sources	Score	Notes/ Explanation:
B	C	Streamwise	Field observations	5	Absolutely no bridges or man-made structures.
		Lateral	Field observations	5	Dense bush, varying heights of canopy
	D	Flora variation	Field observations	5	High variation in flora, and in native flora plus grasses & willows
		Detrimental impact of flora	Field observations	3	Gorse alongside both sides. Willow saplings along one side
G	C M	River bed	Field observations	5	Heaps of variation in river bed. Riffles, rapids. Slow areas, fast areas. Lots of habitat.
		Fine Sediment Prominence	Field observations	5	Low amounts of fine sediment
	N P	Erosion/ Sediment transport	Field observations	3	Presence of willow, although doesn't seem purposely planted, will be having some impact on natural ability to erode
	R C	Historical comparisons	Black maps, historical imagery	5	Increase in natural vegetation, gorged river carved out a lot of sediment. Some stabalising plants but negligible effect (1960's)
A	M K		Iwi Management Plan	4	No pollution and good flow habitat variability. Many native species harder to gather but still accessible (i.e. due to driving times).
	E		Field observations	4	Pasture in distance. Plantation forestry in distance and presence of gorse brings down experience of it being totally untouched.

02 - Okuku Farm - split braid

A	C	Indices	Data Sources	Score	Notes/ Explanation:
B	C	Streamwise	Field observations	5	No bridges or anthropogenic influences
		Lateral	Field observations	4	One side of river a 5 - vegetation other side dirt road & pasture - 3. Score of 4 - met in middle
	D	Flora variation	Field observations	4	An area of nature bush, plantation forestry, gorse, willow one side of river, gorse + pine
		Detrimental impact of flora	Field observations	1	Dense gorse either side of split channel, other channel willow
G	C M	River bed	Field observations	5	eddies, riffles, white water
		Fine Sediment Prominence	Field observations	5	very low amounts of fine sediment
	N P	Erosion/ Sediment transport	Field observations	4	Erosion & ability to move on one side - lots of willows on other - so knock it back to a 4
	R C	Historical comparisons	Black maps, historical imagery	3	moderate agriculture encroachment, some ability to erode banks / migrate. Surface water extraction site.
A	M K		Iwi Management Plan	4	Compared to other site, better access but fewer native species. No pollution & good river flow habitat.
	E		Field observations	3	Dirt track with odd vehicle, heavy gorse, willow, forestry and farming take away from natural character.

03 - Middle

A	C	Indices	Data Sources	Score	Notes/ Explanation:
B	C	Streamwise	Field observations	5	No bridges or structures of any kind - no anthropogenic influence
		Lateral	Field observations	4	Good vegetation - although has been planted somewhat - some human influence. Slight influence, such as gravel track.
	D	Flora variation	Field observations	4	More variation of habits, grasses, tussocks, trees.
		Detrimental impact of flora	Field observations	2	Inability for river to move due to dense understorey along margins of river. High influence of gorse & blackberry.
G	C M	River bed	Field observations	4	High variation in river surface, including riffles
		Fine Sediment Prominence	Field observations	3	Fine sediment prominent on bars, ability to join active channels.
	N P	Erosion/ Sediment transport	Field observations	3	Moderate ability to erode due to density of vegetation, such as willows & poplars.
	R C	Historical comparisons	Black maps, historical imagery	2	Severe agricultural encroachment High presence of stabilising plantations (1960's)
A	M K		Iwi Management Plan	3	Similar to Ot. Good water clarity & flow. Moderate accessability to gather, and limited native species outweighed by invasives.
	E		Field observations	4	Scores lower due to gravel road & gorse. Natural sounds

04 - Bridge & downstream

A	C	Indices	Data Sources	Score	Notes/ Explanation:
B	C	Streamwise	Field observations	2	Motor vehicle bridge with multiple support columns interfering with the active channel
		Lateral	Field observations	3	Willows supporting banks - although do connect (connectivity). 50m tree buffer (even though antropogenically planted).
	D	Flora variation	Field observations	3	Multiple flora habitats present including small pockets of grasses, willow, broom, gorse
		Detrimental impact of flora	Field observations	2	Understory of river margins littered with blackberry & gorse. Poplar & willow dominant on margins. Middle of river channel covered with broom, for a lower score, more coverage would be present.
G	C M	River bed	Field observations	4	High variation in water surface, including riffles & flat surfaces. Scores lower due to influence of bridge.
		Fine Sediment Prominence	Field observations	3	Fine sediment prominent on gravel bars, active channel has larger boulders. Due to ability of river to move, this affects movement of fine sediment in the active channel.
	N P	Erosion/ Sediment transport	Field observations	3	Due to willows & poplars, moderate ability to erode & transport sediment, presence of bridge. Clear cutting into bank.
	R C	Historical comparisons	Black maps, historical imagery	1	Significant agriculture encroachment (from 500m to 200m wide) Water extraction site Bridge (1960's)
A	M K		Iwi Management Plan	3	Beside road & bridge, ability to gather. Good flow and water clarity. Much of vegetation wasn't native, however. this brought down score.
	E		Field observations	3	Motor vehicle bridge creates dust and noise, especially dust is present from modified gravel road. However, still greenery & bird noise.