ENVIRONMENTAL MANAGEMENT GROUP
Technical report

ISSN 1174 3077

HAWKE'S BAY
REGIONAL COUNCIL

SAFEGUARDING YOUR ENVIRONMENT + KAITIAKI TUKU IHO

Stream Ecological Valuations

Selected sites within the Napier and Heretaunga Catchments

May 2010
EMT 10/19
HBRC Plan Number 4201

159 Dalton Street + Private Bag 6006 + Napier
Telephone (06) 835 9200
Fax (06) 835 3601
Regional Freephone (06) 0800 108 838
SAFEGUARDING YOUR ENVIRONMENT + KAITIAKI TUKU IHO

Environmental Management Group
Technical Report

Environmental Science

Stream Ecological Valuations From Selected Reaches Within the Napier and Heretaunga Catchments

---

Prepared by:
Brett Stansfield

Reviewed by:
Adam Uytendaal & Sandy Haidekker

Approved:
Darryl Lew, Group Manager – Environmental Management

4 May 2010
EMT 10/19
HBRC Plan Number 4201

EXECUTIVE SUMMARY

The Stream Ecological Valuation (SEV) is a method which facilitates the examination of integrity of stream ecological functions at a given site (‘the study reach’) and provides a framework for the application of numerical values to describe the level of impairment of ecological functions operating at a study reach.

The SEV method was developed by Auckland Regional Council and a team of experts from the National Institute of Water and Atmospheric Research (NIWA) and Landcare Research for the purpose of not only assessing ecological value but also gaining an understanding of environmental compensation for stream reaches that may be affected by urban development.

This report provides a summary of stream ecological valuations conducted at two sites on Saltwater Creek in the Napier catchment and a further ten sites on tributaries of the Clive River.

The Saltwater Creek sites scored poorly indicating that restoration measures made to the stream may not improve ecological health significantly owing to the highly modified nature of the stream. Alternatively, most tributaries of the Clive River catchment scored moderately well indicating significant improvement in ecological performance could be made with appropriate restoration measures. The exceptions to this were Karitewhenua Stream at Napier Rd and Louisa Stream which were in a more degraded state.

Examples of hypothesised improvements to ecological performance are provided for the Karitewhenua Stream and Louisa Stream given applied restoration measures to demonstrate what ecological benefits could be made with restoration.

The Ruahapia Stream was analysed by two agencies (HBRC and MWH Ltd) on two different stream reaches at different times of the year. Despite the spatial and temporal differences in application of the SEV method, the final scores attained by both agencies were very similar. This indicates that the SEV method is a very robust tool for assessing ecological performance of a stream and is not unduly biased by stream reach, location, time of year of assessment or investigation error.

The SEV assessments made to date form an important component of the Karamu Resource Investigations Study and provide an important baseline upon which future comparisons of ecological performance can be made.

It is recommended that the stream ecological valuation continue to be used for assessments of small (1^{st}-3^{rd} order) streams throughout the Hawke’s Bay Region. Further SEV assessments are recommended within the Clive River catchment in the Tomoana Drain, Mallory Drain, Awahou Stream, Southland Drain, Mahora Drain, Tekahika Stream and Karamu Stream at St. Georges Rd.

Contents

1.0 INTRODUCTION

The Hawke's Bay Regional Council commissioned MWH Ltd to undertake a number of stream ecological valuations within the Napier and Karamu Stream catchments to enhance our understanding of aquatic ecosystems.

The current report provides further stream ecological valuation assessments within these catchments that were not commissioned to MWH. In doing so it fills gaps in knowledge of tributaries that previously have not been assessed using the stream ecological valuation methodology.

The Stream Ecological Valuation (SEV) methodology was first developed by an expert panel in 2006 (ARC 2006) and later edited in January 2008 (ARC 2008) and it is this methodology that this report adheres to.

The SEV is a method which facilitates the examination of integrity of stream ecological functions at a given site ('the study reach') and provides a framework for the application of numerical values to describe the level of impairment of ecological functions operating at a study reach. The advantage of using a functional approach (rather than a structural approach) is that the SEV scores returned from sites of different character can be directly compared.

Once SEV values have been determined for a study reach the SEV calculator can be used to predict for given enhancement actions at the study reach, what the likely improvements in ecological performance would be. This provides a useful tool for strategic planning and prioritisation of ecological enhancement activities.

The specific objectives of this study were to:

1. Undertake a baseline survey of selected sites using the SEV method.
2. Provide a summary report containing survey methods, SEV results, identify key issues for each waterway and identify and outline opportunities for cost-effective improvement in SEV values to return an improvement in ecological condition.

This report presents a summary of the results from SEV analysis of 12 study reaches, 2 of which are located in the Napier catchment (Saltwater Creek) and 10 are located in the Clive catchment (Muddy Creek, Mangarau Stream (2), Herehere Stream, Karitewhenua Stream (2), Irongate Stream, Te Waikaha Stream, Ruahapia Stream, Louisa Stream (refer to Figure 14 & 18). The potential for ecological enhancement of study reaches is considered within the SEV framework only for those site reaches that provide the most cost effective enhancement options. On that basis, stream reaches identified as having good enhancement potential according to the SEV method, are the focus of the enhancement scenario section of this report.

It should be noted that the SEV method only provides an ecological assessment of instream values and does not provide an holisitic assessment of nearby terrestrial ecology values, therefore the findings of this report constitute only part of the total consideration required if ecological values of urban and rural streams within the region are to be considered fully. The results are split according to the catchments (Napier and Clive).

1.0 BACKGROUND

1.1 River Environment Classification of Saltwater Creek

The River Environment Classification or REC (Snelder, 2004) for Saltwater Creek is provided in Table 1 below.

Table 1 : REC classification of Saltwater Creek

REC Category	Saltwater Ck REC Classification	Description of Classification
Climate	Warm-dry	Warm and dry climate.
Source-of-flow	Low-elevation	Very marked seasonal flow patterns: high in winter, low in summer. Low sediment supply. Stable low-gradient, entrenched channels with low flow velocity and silty-sand substrates. Flood velocities are low due to low channel slope.
Geology	Alluvium	Rainfall infiltration is high which tends to reduce flood frequency. There tends to be a high degree of surface water and groundwater infiltration. Base flows may be sustained by seepage or springs or may reduce in the downstream direction as water flows into the groundwater system. Water chemistry reflects the nature of the parent material.
Land-cover category	Urban	Flood peaks are very 'peaky' and recessions return quickly to base flow. Base flows are very low. High concentration of many contaminants. High suspended sediment load during development and typically low afterward. Fine substrates (silts and muds) relative to natural land-cover categories.
Network position	Low-order	Headwater streams (stream order 1 and 2) with little upstream storage. Fluxes of water and water borne constituent (e.g. sediment) move rapidly through with little attenuation.
Valley-landform	Low-gradient	Low-gradient channels.

1.1.1 Catchment Land Use

Saltwater Creek is positioned in the lower reaches of the Napier Catchment (See figure 14 on p 29). The Catchment has a total area of approximately 400 ha[1]. Of that area, 30 - 40% is in residential land use. The remaining area is in rural land use. It has been estimated that 30% of the catchment is impervious cover.

[1] Area of catchment measured above the point of convergence with the Karamu Stream / Clive River.

1.1.2 Saltwater Creek Study Reach Description

Two study reaches were investigated on Saltwater Creek, one at Tamatea Drive and one further upstream opposite Lancaster Street. For both reaches the stream is characterised by being heavily engineered for flooding purposes. The stream lacks any riffle or pool habitats and sinuosity is sparse. The stream bed is predominantly muds and silts which is blanketed by aquatic macrophyte growth. Riparian shading is minimal with only sparsely planted native and exotic trees. For both sites a study reach of 100m was investigated upstream of the NZMG coordinates. The reference details for the Saltwater Creek reaches are presented in Table 2 below.

Table 2 : Reference details of Saltwater CreekSEV reach

Stream Name	Site Location	Bottom of SEV Reach (Easting/Northing)
Saltwater Ck @ Tamatea Drive	Upstream of Tamatea Drive Bridge	E2842807 N6181950
Saltwater Ck @ Lancaster St	Across from Lancaster St Intersection	E2841850 N6180977

1.1.3 Saltwater Creek General Character

The land surrounding Saltwater Creek is predominantly urban at Tamatea Drive however at the Lancaster Street site, the land use is mostly recreational park on the true left bank and urban on the true right. Wide (3m) mown grass verges adjoin the stream with either flat to gentle (< 10˚) slope. Occasional trees are present within the riparian zone (exotic and native at Tamatea Drive, exotic only at Lancaster Street). A fenced paddock is located on the upper portion of the true left bank however stock have no access to the stream.

The stream channel is entrenched within the surrounding plain to a depth of 2-3 meters. Bank slumping is occasional.

Saltwater Creek has an average wetted width of 7.5 metres at Tamatea Drive and 4.5 m at Lancaster Street, and an average depth of 0.33m and 0.27m respectively.

Figure 1: Typical character of Saltwater Creek @ Tamatea Drive study reach, December 2009

Figure 2: Typical character of Saltwater Creek @ Lancaster St study reach, December 2009

1.2 Ruahapia Stream Overview

1.2.1 River Environment Classification of the Ruahapia Stream

The NIWA River Environment Classification (REC) description of the Saltwater Creek is provided in Table 3 below.

Table 3 : REC classification of the Ruahapia Stream

REC Category	Ruahapia Stream REC Classification	Description of Classification
Climate	Warm-dry	Warm and dry climate.
Source-of-flow	Low-elevation	Very marked seasonal flow patterns: high in winter, low in summer. Low sediment supply. Stable low-gradient, entrenched channels with low flow velocity and silty-sand substrates. Flood velocities are low due to low channel slope.
Geology	Alluvium	Rainfall infiltration is high which tends to reduce flood frequency. There tends to be a high degree of surface water and groundwater infiltration. Base flows may be sustained by seepage or springs or may reduce in the downstream direction as water flows into the groundwater system. Water chemistry reflects the nature of the parent material.
Land-cover category	Urban	Flood peaks are very 'peaky' and recessions return quickly to base flow. Base flows are very low. High concentrations of many contaminants. High suspended sediment load during development and typically low afterward. Fine substrates (silts and mud) relative to natural Land-Cover categories..
Network position	Low-order and Middle-order	Low-order: Headwater streams (Stream Order 1 and 2) with little upstream storage. Fluxes of water and water borne constituent (e.g. sediment) move rapidly through with little attenuation. Middle-order: Tributaries (Stream Orders 3 to 4).
Valley-landform	Low-gradient	Low-gradient channels.

1.2.2 Catchment Land Use

The Ruahapia Stream is positioned in the lower reaches of the Karamu Catchment (See Figure 18). The Ruahapia Catchment has a total area of approximately 191 ha[2]. Of that area 45% is covered in industrial land use and 40% is in residential land use. The remaining 15% is in rural

[2] Area of catchment above the point of confluence with the Karamu Stream.

land use. Given the land use and catchment area, approximately 80% of the catchment is covered in impervious surface.

1.2.3 Ruahapia SEV Study Reach Description

One SEV study reach has been established on the Ruahapia Stream titled “Ruahapia @ Showgrounds.” The study reach is 100m in length and the top of the study reach is about 150m downstream of the show grounds area. The reference details for the Ruahapia SEV reach is presented in Table 4 below.

Table 4 : Reference details of Ruahapia 1 SEV reaches

Reach Name	Location Description	Top of SEV Reach (Easting/Northing)
Ruahapia	Downstream of Showgrounds	E2841627 N6168096

1.2.4 Ruahapia General Character

The land surrounding the Ruahapia study reach is rural on the true right bank and park on the true left bank. Riparian vegetation is predominantly rank pasture with occasional exotic trees. Emergent macrophytes and sedges are common along the stream margins and occasional submerged macrophytes are also evident. The substrate is predominantly muds and silts with occasional large and small woody debris. Stock have free access to the stream. The stream channel is entrenched within the surrounding plain to a depth of 2-3 metres. Bank slumping is common.

The Ruahapia study reach has an average wetted width of 2.4 m and an average depth of 0.08 m.

Figure 3: Typical character of the Ruahapia SEV study reach, January 2010

1.3 Karitewhenua Stream Overview

1.3.1 River Environment Classification of the Karitewhenua Stream

The NIWA River Environment Classification (REC) of the Karitewhenua Stream is provided in Table 5 below.

Table 5: REC Classification of Karitewhenua Stream

REC Category	Karitewhenua Stream REC Classification	Description of Classification
Climate	Warm-dry	Warm and dry climate.
Source-of-flow	Low-elevation	Very marked seasonal flow patterns: high in winter, low in summer. Low sediment supply. Stable low-gradient, entrenched channels with low flow velocity and silty-sand substrates. Flood velocities are low due to low channel slope.

REC Category	Karitewhenua Stream REC Classification	Description of Classification
Geology	Alluvium	Rainfall infiltration is high which tends to reduce flood frequency. There tends to be a high degree of surface water and groundwater infiltration. Base flows may be sustained by seepage or springs or may reduce in the downstream direction as water flows into the groundwater system. Water chemistry reflects the nature of the parent material.
Land-cover category	Pastoral	Flood peaks tend to be higher and recede faster. Low flows are generally more extreme relative to catchments with natural land cover. Nutrient concentrations are high relative to natural land cover categories. Erosion rates tend to be high, resulting in low water clarity and fine substrates (silt and mud) compared to natural land cover
Network position	Low-order	Headwater streams (stream order 1 and 2) with little upstream storage. Fluxes of water and water borne constituent (e.g. sediment) move rapidly through with little attenuation.
Valley-landform	Low-gradient	Low-gradient channels.

1.3.2 Catchment Land Use

Karitewhenua Stream is predominantly in pastoral land use. The remaining area is in urban land use. It has been estimated that 11% of the catchment is impervious cover.

1.3.3 Karitewhenua Stream Study Reach Description

Two study reaches were investigated on Karitewhenua Stream, one at Napier Rd and one further upstream above Te Mata Rd. The two study reaches are very different with respect to the immediate surrounding land use. The Napier Rd site has historically been grazed however more recently has been subject to a regional council enhancement programme with regular plantings of native shrubs at the Karamu Stream confluence. The stream is quite open and is surrounded by long pasture grasses. Alternatively the Te Mata Rd site is within a reserve that was established by the Havelock North Community. The site is very well shaded by high density plantings of native and occasional exotic trees. The study reach at the Napier Rd site extends approximately 50m upstream of the NZMG reference. The study reach of the Te Mata Rd site extends approximately 100m above the NZMG reference. The reference details for the Karitewhenua Stream reaches are presented in

Table 6: Reference details of Ruahapia Stream
overleaf.

Table 6: Reference details of Ruahapia Stream

Stream Name	Site Location	Bottom of SEV Reach (Easting/Northing)
Karitewhenua Stream @ Napier Rd	Downstream of Napier Rd	E2843200 N6164300
Karitewhenua Stream @ Te Mata Rd	Upstream of Te Mata Rd	E2844567 N6163109

1.3.4 Karitewhenua General Character

The land surrounding the Karitewhenua Stream is predominantly pastoral however the study reaches fall within an urban landscape. The upper reaches of the stream (Te Mata Rd) are ephemeral and it was noted that stream flow ceased somewhere between 10th December 2009 and 22nd December 2009 and remained dry through to the present (April 8th 2010). The substrate within the stream is predominantly small to large gravels. The Napier Rd site has a mean wetted width of 4.8 m and mean depth of 0.15m while the Te Mata Rd site has a mean width of 0.58m and mean depth of 0.04m.

Figure 4: Typical character of the Karitewhenua Stream SEV study reach at Napier Rd, January 2010

Figure 5: Typical character of the Karitewhenua Stream SEV study reach at Te Mata Rd, January 2010 in a dry state

1.4 Mangarau Stream Overview

1.4.1 River Environment Classification of the Mangarau Stream

The NIWA River Environment Classification (REC) of the Mangarau Stream is provided in Table 7 below.

Table 7: REC of Mangarau Stream

REC Category	Mangarau Stream REC Classification	Description of Classification
Climate	Warm-dry	Warm and dry climate.
Source-of-flow	Low-elevation	Very marked seasonal flow patterns: high in winter, low in summer. Low sediment supply. Stable low-gradient, entrenched channels with low flow velocity and silty-sand substrates. Flood velocities are low due to low channel slope.
Geology	Hard Sedimentary	Infiltration of rainfall is variable. Where geology is fractured, infiltration is high, resulting in infrequent floods but sustained base flow. Low natural nutrient concentration. Low suspended sediment. Relatively coarse substrate (cobble, gravel, sands) depending on local morphology.
Land-cover category	Pastoral	Flood peaks tend to be higher and recede faster. Low flows are generally more extreme relative to catchments with natural land cover. Nutrient concentrations are high relative to natural land cover categories. Erosion rates tend to be high, resulting in low water clarity and fine substrates (silt and mud) compared to natural land cover
Network position	Low-order	Headwater streams (stream order 1 and 2) with little upstream storage. Fluxes of water and water borne constituent (e.g. sediment) move rapidly through with little attenuation.
Valley-landform	Low-gradient	Low-gradient channels.

1.4.2 Catchment Land Use

The Mangarau Stream is predominantly in pastoral land use. The remaining area is in urban land use. The catchment has a surface area of 8.0 ha at Kierunga Rd and it has been estimated that less than 1 % is impervious cover at this site. The Te Aute Rd site has a catchment area of 9.7ha and has an estimated impervious cover of 5%.

1.4.3 Mangarau Stream Study Reach Description

The downstream site at Te Aute Rd is predominantly orchard land in the lower section of the study reach which becomes urban towards the upper reach. The shading regime is therefore quite similar to that experienced at the Kierunga Rd site, i.e. quite open in the lower reach while being quite shaded in the upper reaches.

The upstream site at Kierunga has a park adjoining the true right bank while the true left bank is in urban land use. The site is well shaded in the upper reaches owing to high banks of between 3 – 5 m and an abundance of trees while in the lower reaches the stream is more open. As a result of the shading gradient, aquatic macrophytes are predominant in the lower reach whereas they are less prevalent in the upper reach.

One thing noted by staff was that emergent aquatic macrophytes do provide shading to the stream yet this is something not considered by the SEV methodology. It is possible that future assessments may need to take this into consideration.

For both Mangarau Stream sites a study reach of 150m length was chosen to give a good representative assessment of the stream. The reference details for the Mangarau Stream reaches are presented in **Error! Reference source not found.** 8 below.

Table 8: Reference details of Mangarau Stream sites

Stream Name	Site Location	Bottom of SEV Reach (Easting/Northing)
Mangarau Stream @ Te Aute Rd	Downstream of Te Aute Rd	E2842192 N6163233
Mangarau Stream @ Kierunga Rd	Adjoining the park towards the end of Kierunga Rd	E2843288 N6162028

1.4.4 Mangarau Stream General Character

The land surrounding the Mangarau Stream is predominantly pastoral however the study reaches fall within an urban landscape. Like the Karitewhenua and Herehere streams, the Mangarau Stream is a cobble / gravel stream system with occasional occurrence of runs, riffles and pools. The stream is well entrenched within a flood plain of between 3 – 5 metres in height. The Te Aute Rd site has a mean wetted width of 2.6m and a mean depth of 0.23 m while the Kierunga Rd site has a mean wetted width of 2.0m and a mean depth of 0.20 m.

Figure 6: Typical character of the Mangarau Stream SEV study reach at Te Aute Rd, January 2010

Figure 7: Typical character of the Mangarau Stream SEV study reach at Kierunga Rd, January 2010

1.5 Herehere Stream Overview

1.5.1 River Environment Classification of the Herehere Stream

The NIWA River Environment Classification (REC) of the Herehere Stream is provided in Table 9 below.

Table 9: REC of the Herehere Stream

REC Category	Herehere Stream REC Classification	Description of Classification
Climate	Warm-dry	Warm and dry climate.
Source-of-flow	Low-elevation	Very marked seasonal flow patterns: high in winter, low in summer. Low sediment supply. Stable low-gradient, entrenched channels with low flow velocity and silty-sand substrates. Flood velocities are low due to low channel slope.
Geology	Hard Sedimentary	Infiltration of rainfall is variable. Where geology is fractured, infiltration is high, resulting in infrequent floods but sustained base flow. Low natural nutrient concentration. Low suspended sediment. Relatively coarse substrate (cobble, gravel, sands) depending on local morphology.
Land-cover category	Pastoral	Flood peaks tend to be higher and recede faster. Low flows are generally more extreme relative to catchments with natural land cover. Nutrient concentrations are high relative to natural land cover categories. Erosion rates tend to be high, resulting in low water clarity and fine substrates (silt and mud) compared to natural land cover
Network position	Middle-order	Tributaries (Stream order 3 and 4)
Valley-landform	Low-gradient	Low-gradient channels.

1.5.2 Catchment Land Use

The Herehrere Stream has a catchment area of 945 Ha and is predominantly in pastoral land use. The true left bank of the stream adjoins an orchard while the true right bank adjoins a residential back drop. It has been estimated that approximately 3.0 % of the catchment is impervious cover.

1.5.3 Herehere Stream Study Reach Description

The Herehere Stream study reach is within a predominantly urban and orchard environment. The stream channel is deeply entrenched and has long rank grasses and occasional native and exotic trees shading the stream. Emergent aquatic macrophytes are abundant, particularly water celery, water cress and munky musk.

A study reach of 100m length was chosen to give a good representative assessment of the stream. The reference details for the Herehere Stream reaches are presented in **Error! Reference source not found.** 10 below.

Table 10: Reference details of the Herehere Stream SEV reach

Stream Name	Site Location	Bottom of SEV Reach (Easting/Northing)
Herehere Stream	Access downstream of Te Aute Rd	E2841599 N6163117

1.5.4 Herehere Stream General Character

The land surrounding the Herehere Stream is predominantly pastoral or horticultural. The true left bank of the stream is within the influence of an orchard while the true right bank adjoins an urban landscape. Like the Karitewhenua and Herehere streams, the Herehere Stream is a cobble / gravel stream. While areas of sediment deposition are evident, the stream bank is very firm to walk on. The stream is well entrenched within the flood plain with stream sides of 3-5m height. The stream has a mean wetted width of 2.2 m and a mean depth of 0.16 m.

Figure 8: Typical character of the Herehere Stream SEV study reach at Te Aute Rd, January 2010

1.6 Irongate Stream Overview

1.6.1 River Environment Classification of the Irongate Stream

The NIWA River Environment Classification (REC) of the Irongate Stream is provided in Table 11 below.

Table11 REC of Irongate Stream

REC Category	Irongate Stream REC Classification	Description of Classification
Climate	Warm-dry	Warm and dry climate.
Source-of-flow	Low-elevation	Very marked seasonal flow patterns: high in winter, low in summer. Low sediment supply. Stable low-gradient, entrenched channels with low flow velocity and silty-sand substrates. Flood velocities are low due to low channel slope.
Geology	Alluvial	Rainfall infiltration is high which tends to reduce flood frequency. There tends to be a high degree of surface water and ground water interaction. Base flows may be sustained by seepage or springs or may reduce in the downstream direction as water flows into the groundwater system. Water chemistry reflects the nature of the parent material. Note that the source information on catchment geology, the LRI, does not discriminate the parent material for alluvium. This makes the geochemistry of the Alluvium category variable.
Land-cover category	Pastoral	Flood peaks tend to be higher and recede faster. Low flows are generally more extreme relative to catchments with natural land cover. Nutrient concentrations are high relative to natural land cover categories. Erosion rates tend to be high, resulting in low water clarity and fine substrates (silt and mud) compared to natural land cover
Network position	Middle-order	Tributaries (Stream order 3 and 4)
Valley-landform	Low-gradient	Low-gradient channels.

1.6.2 Catchment Land Use

The Irongate Stream is predominantly in pastoral land use and has a catchment area of 2141 Ha. The true left bank is within reach of urban influence of the suburb of Flaxmere while the true right bank is within a rural/ horticultural environment. Fennel pond weed and elodea are the dominant submerged aquatic macrophytes while the dominant marginal species is water celery. Other marginal species include beggars tick, swamp willow weed, and water cress. Duckweed and Azolla are present along the margins.

It has been estimated that less than 1 % of the catchment is impervious cover.

1.6.3 Irongate Stream Study Reach Description

The Irongate Stream study reach is within a predominantly pastoral environment. Riparian shading is sparse with the majority of the stream banks comprising sedges and long grasses with a scattering of trees and thin understorey. The stream has a moderate amount of modification however bends, riffles and pools are present.

A study reach of 150m length was chosen to give a good representative assessment of the stream. The reference details for the Irongate Stream reach are presented in Table 12 below.

Table 12: Reference details of Irongate Stream

Stream Name	Site Location	Bottom of SEV Reach (Easting/Northing)
Irongate Stream @ Portsmouth Rd	Access via an orchard on the southern side of Portsmouth Rd.	E2834778 N6167727

1.6.4 Irongate Stream General Character

The land surrounding the Irongate Stream is predominantly pastoral or horticultural however the true left of the stream is within the urban influence of the suburb of Flaxmere. Like the Karitewhenua and Herehere streams, the Irongate Stream is a cobble / gravel stream however years of sediment inputs from surrounding land uses and stream bank erosion have resulted in the stream bed being blanketed with a layer of sediment resulting in a boggy nature to the streambed. The stream is well entrenched within the flood plain with stream sides of 2-3 m height. The stream has a mean wetted width of 3.9m and a mean depth of 0.24 m.

Figure 9: Typical character of the Irongate Stream SEV study reach at Te Aute Rd January 2010

1.7 Louisa Stream Overview

1.7.1 River Environment Classification of the Louisa Stream

River Environment Classification of the Louisa Stream is presented in
Table13: REC of Louisa Stream

Table13: REC of Louisa Stream

REC Category	Louisa Stream REC Classification	Description of Classification
Climate	Warm-dry	Warm and dry climate.
Source-of-flow	Low-elevation	Very marked seasonal flow patterns: high in winter, low in summer. Low sediment supply. Stable low-gradient, entrenched channels with low flow velocity and silty-sand substrates. Flood velocities are low due to low channel slope.
Geology	Hard Sedimentary	Infiltration of rainfall is variable. Where geology is fractured, infiltration is high, resulting in infrequent floods but sustained base flow. Low natural nutrient concentration. Low suspended sediment. Relatively coarse substrate (cobble, gravel, sands) depending on local morphology.
Land-cover category	Pastoral	Flood peaks tend to be higher and recede faster. Low flows are generally more extreme relative to catchments with natural land cover. Nutrient concentrations are high relative to natural land cover categories. Erosion rates tend to be high, resulting in low water clarity and fine substrates (silt and mud) compared to natural land cover
Network position	Middle-order	Tributaries (Stream order 3 and 4)
Valley-landform	Low-gradient	Low-gradient channels.

1.7.2 Catchment Land Use

The Louisa Stream has a catchment area of 3477 Ha and is predominantly in pastoral land use . It has been estimated that less than 1 % of the catchment is impervious cover.

1.7.3 Louisa Stream Study Reach Description

The Louisa Stream study reach is within a predominantly pastoral environment. Riparian shading is sparse in the lower portion of the reach but increases significantly in the upper portion of the reach.

A study reach of 150m length was chosen to give a good representative assessment of the stream. The reference details for the Louisa Stream reaches are presented in **Error! Reference source not found.** 14 below.

Table14: Reference details of the Louisa Stream SEV reach

Stream Name	Site Location	Bottom of SEV Reach (Easting/Northing)
Louisa Stream @ Te Aute Rd	Access via Te Aute Rd	E2840900 N6162500

1.7.4 Louisa Stream General Character

The land surrounding the Louisa Stream is predominantly pastoral or horticultural. Like the Karitewhenua and Herehere streams, the Irongate Stream is a cobble / gravel stream however years of sediment inputs from surrounding land uses and stream bank erosion have resulted in the streambed being blanketed with a thick layer of sediment resulting in a boggy nature to the streambed. The stream is well entrenched within the flood plain with stream sides of 2-3 m height. The stream has a mean wetted width of 3.5m and a mean depth of 0.55 m. The stream is dominated by submerged aquatic macrophytes such as Lagrosiphon, Canadian pond weed and crinkly pond weed. The stream is fairly uniform in shape with no presence of riffles or pools. Areas of stream bank erosion are evident within the reach, particularly on the true right bank.

Figure 10: Typical character of the Louisa Stream SEV study reach at Te Aute Rd, January 2010

1.8 Te Waikaha Stream Overview

1.8.1 River Environment Classification of the Te Waikaha Stream

The NIWA River Environment Classification (REC) of the Mangarau Stream is provided in Table 7 below.

Table 15: REC of Te Waikaha Stream

REC Category	Te Waikaha Stream REC Classification	Description of Classification
Climate	Warm-dry	Warm and dry climate.
Source-of-flow	Low-elevation	Very marked seasonal flow patterns: high in winter, low in summer. Low sediment supply. Stable low-gradient, entrenched channels with low flow velocity and silty-sand substrates. Flood velocities are low due to low channel slope.

REC Category	Te Waikaha Stream REC Classification	Description of Classification
Geology	Hard Sedimentary	Infiltration of rainfall is variable. Where geology is fractured, infiltration is high, resulting in infrequent floods but sustained base flow. Low natural nutrient concentration. Low suspended sediment. Relatively coarse substrate (cobble, gravel, sands) depending on local morphology.
Land-cover category	Pastoral	Flood peaks tend to be higher and recede faster. Low flows are generally more extreme relative to catchments with natural land cover. Nutrient concentrations are high relative to natural land cover categories. Erosion rates tend to be high, resulting in low water clarity and fine substrates (silt and mud) compared to natural land cover
Network position	Middle-order	Tributaries (Stream order 3 and 4)
Valley-landform	Low-gradient	Low-gradient channels.

1.8.2 Catchment Land Use

The Te Waikaha Stream is predominantly in pastoral land use and has a catchment area of 524 Ha. The true left bank of the stream adjoins cropping that entails the ploughing of soil while the true right bank is pastoral farming. It has been estimated that less than 0.1 % of the catchment at this site is impervious cover at this site

1.8.3 Te Waikaha Stream Study Reach Description

The Te Waikaha Stream study reach is within a predominantly pastoral environment. The stream channel is deeply entrenched and has long rank grasses and occasional native and exotic trees shading the stream.

A study reach of 100m length was chosen to give a good representative assessment of the stream. The reference details for the Te Waikaha Stream reach are presented in Table 16 below.

Table 16: Reference details of Te Waikaha Stream SEV reach

Stream Name	Site Location	Bottom of SEV Reach (Easting/Northing)
Te Waikaha Stream	Access approximately 500m south of Mutiny Rd/Middle Rd intersection	E2836016 N6156110

1.8.4 Te Waikaha Stream General Character

The land surrounding the Te Waikaha Stream is predominantly pastoral or horticultural. The true left bank of the stream is within the influence of intensive cropping while the true right bank adjoins pastoral farming. Like the Karitewhenua and Herehere streams, the Irongate Stream is a cobble / gravel stream, while areas of sediment deposition are evident, the stream bank is very firm to walk on and a lot of stable substrate is present (stones, wood, branches). The stream is well entrenched within the flood plain with stream sides of 3-5m height. The stream has a mean wetted width of 1.8 m and a mean depth of 0.47 m.

Figure 11: Typical character of the Te Waikaha Stream SEV study reach at Te Aute Rd, January 2010

1.9 Muddy Creek Stream Overview

River Environment Classification of the Muddy Creek

Table 17: REC of Muddy Creek

REC Category	Muddy Ck REC Classification	Description of Classification
Climate	Warm-dry	Warm and dry climate.
Source-of-flow	Low-elevation	Very marked seasonal flow patterns: high in winter, low in summer. Low sediment supply. Stable low-gradient, entrenched channels with low flow velocity and silty-sand substrates. Flood velocities are low due to low channel slope.

REC Category	Muddy Ck REC Classification	Description of Classification
Geology	Alluvial	Rainfall infiltration is high which tends to reduce flood frequency. There tends to be a high degree of surface water and ground water interaction. Base flows may be sustained by seepage or springs or may reduce in the downstream direction as water flows into the groundwater system. Water
		chemistry reflects the nature of the parent material. Note that the source information on catchment geology, the LRI, does not discriminate the parent material for alluvium. This makes the geochemistry of the Alluvium category variable.
Land-cover category	Pastoral	Flood peaks tend to be higher and recede faster. Low flows are generally more extreme relative to catchments with natural land cover. Nutrient concentrations are high relative to natural land cover categories. Erosion rates tend to be high, resulting in low water clarity and fine substrates (silt and mud) compared to natural land cover
Network position	Low-order	Tributaries (Stream order 1 and 2)
Valley-landform	Low-gradient	Low-gradient channels.

1.9.1 Catchment Land Use

Muddy Creek is predominantly in orchard land use and has a catchment area of 1056 Ha. The true left bank of the stream adjoins a residential area of Clive while the true right bank adjoins an orchard. It has been estimated that <1% of the catchment is impervious cover at this site

1.9.2 Muddy Creek Study Reach Description

The Muddy Creek study reach is within a predominantly pastoral and orchard environment. The stream channel is deeply entrenched and has long rank grasses and exotic trees shading the stream from the true left bank. Water celery is abundant in places as is water cress, creeping bent, swamp willow weed, purua grass and mercer grass at the margins. The dominant submerged species is hornwort with egeria and curled pondweed also abundant. Fennel leaved pondweed and elodea are less common. The surface of the stream is covered with floating duck weed.

A study reach of 150m length was chosen to give a good representative assessment of the stream. The reference details for the Muddy Creek reach is presented in Table 18 below.

Table18: Reference details of Muddy Creek SEV reach

Stream Name	Site Location	Bottom of SEV Reach (Easting/Northing)
Muddy Creek	Access upstream of Mill Rd	E2846200 N6172100

1.9.3 Muddy Creek General Character

The land surrounding the Herehere Stream is predominantly pastoral or horticultural. The stream is well entrenched with stream banks between 1 – 2 m in height. The stream bottom is very muddy with silts and sand being the most predominant substrate. There is an absence of riffles or pools, with the stream being engineered as a run with few bends for flooding purposes. The stream has a mean wetted width of 5 m and a mean depth of 0.44 m.

Figure 12: Typical character of the Muddy Creek SEV study reach at Mill Rd. January 2009

2.0 METHODS

2.1 The SEV Method

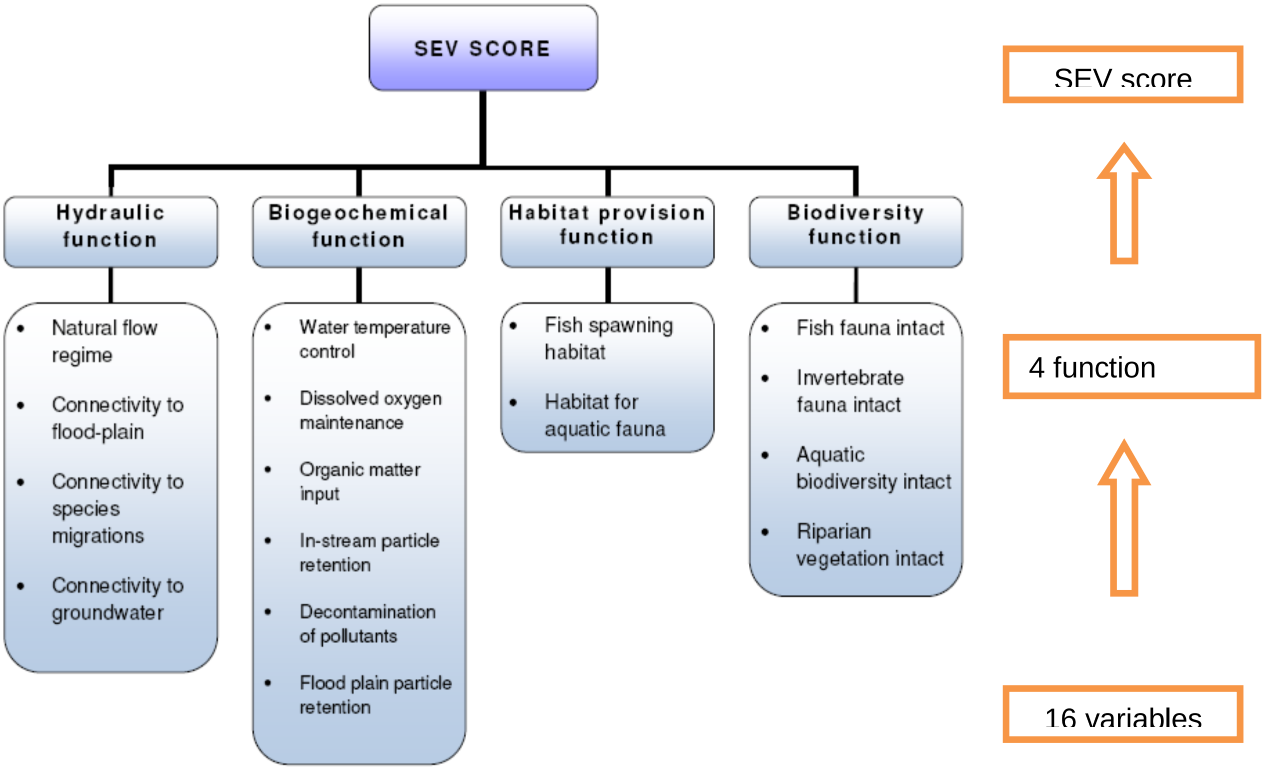
The SEV method was developed to provide a method of assigning values to stream ecology attributes and calculating the required amount of restoration to off-set loss of ecological value at an impact site.

In this study the SEV method is applied as a valuation tool for establishment of a baseline state, against which future change can be measured against.

2.1.1 SEV Structure

The SEV score is generated by collection of data relating to 16 variable scores. Those variable scores contribute to one or more function group scores. The SEV score is the average of those four function group scores.

Figure 13: SEV general structure



2.1.2 Function Group Definitions

The four function groups relate to the ecological function qualities overleaf (see Table 19).

Table 19 : Explanation of function group definitions

Function Group Title	Function has Reference to these Matters
Hydraulic functions	Processes associated with water storage, movement and transport
Biogeochemical functions	Related to the processing of minerals, particulates and water chemistry
Habitat provision functions	Types, amounts and quality of habitats that the stream reach provides for flora and fauna
Biotic provision functions	The occurrence of diverse populations of indigenous native plants and animals that would normally be associated with the stream reach

2.2 Study Site Selection Methods

The SEV study reaches were located according to stream and surrounding land use characteristics. Aerial photographs, topographical maps and the National Institute of Water and Atmosphere's (NIWA) River Environment Classification (REC) were used to derive preliminary locations for study reaches. Those locations were then investigated in the field to confirm representativeness of the surrounding environment and site access.

2.3 Application of the SEV Method

The standard SEV method (Rowe *et al*, 2008) was adhered to. Most study reaches were 100-150 metres in total length, with ten transects used to assess the stream. This arrangement aligned with the transect design required for the fish survey, as outlined below.

2.3.1 Field Surveys

(a) Fish fauna survey

If fish data was available for a site from the New Zealand Freshwater Fish Database within the previous 4 years, it was not surveyed a second time. The assumption being made was the previous survey results adequately described the fish community for the current study. For those sites that needed surveying owing to the data being too old or absent (Louisa, Mangarau, Herehere, Irongate and Karitewhenua Streams), light spotting and efishing was used.

All fish surveys were undertaken in general accordance with the Draft Standardised Fish Sampling Protocols for New Zealand Wadable Streams (Bruno, 2009).

All study reaches were night spotlighted. One 30W Lightforce spotlight was used per person.

Electric fishing was not used at some of the reaches owing to the high conductance of these waters (Irongate, Louisa) and in some cases the streams being too deep to safely survey them in this manner.

(b) Macroinvertebrate survey

Macroinvertebrate surveys were undertaken in accordance with the MfE (2001) Protocols C1 and C2 for Sampling Macroinvertebrates in Wadeable Streams.

Saltwater Creek, Muddy Creek, Ruahpia Stream, Irongate Stream and Louisa Stream were surveyed according to the soft-bottomed semi-quantitative protocol “C2”. The Te Waikaha Stream, Karitewhenua Stream, Herehere Stream and Mangarau Stream were surveyed according to the hard-bottomed semi-quantitative protocol “C1”.

A macroinvertebrate kick-net with 0.5mm mesh aperture was used for sample collection. Samples were preserved with c. 70 % ethanol: 30%: water solution in the field and shipped to Landcare Research (Auckland) for taxonomic analysis.

2.3.2 Desktop Analyses

(a) Reference site rationale

In the context of the SEV method, a reference site should be un-impacted by development or other human disturbance. A reference stream should be of a similar stream order, underlying geology, gradient and substrate type, and should have an intact native forest riparian zone. Such conditions represent the original or ‘best case’ scenario for a given test site.

Due to the highly modified nature of riparian conditions associated with lowland streams within the Heretaunga Plains and Napier Catchment, no pristine reference site is available for inclusion in the SEV calculations. The National Institute of Water and Air (NIWA) have provided an opinion that Auckland reference stream data can be applied to streams in Hawke’s Bay[3]. On that basis, specific reference values for each variable score have been developed with consideration of (1) the test score returned from field analysis; (2) NIWA endorsed reference scores for a Papakura Stream; and (3) experience gathered from application of the SEV method at other sites within the Hawke’s Bay Region (Forbes, 2009).

It is known that during pre-Polynesian times (i.e. more than 800yrs BP) Hawke’s Bay was covered in woody vegetation (Fromont and Walls, 1988). Charred wood fragments have been found at locations across the Heretaunga Plains (Grant, 1996), suggesting that the area would once have supported a tall native forest community. On this basis it is assumed that before human settlement the surveyed streams would have benefited from a riparian zone with full native forest cover. This assumption has consequently been adopted in the compilation of the reference SEV data.

(b) Specific reference score details

With regard to reference macroinvertebrate scores, it is potentially problematic to determine accurately what macroinvertebrate community structure would have been present in reference conditions. On that basis macroinvertebrate data from the Auckland reference site, Papakura Stream has been adopted across all sites.

Reference scores for the variables Vtrans and Vretain were calculated using the average of three Auckland reference score results.

Given the absence of fish fauna records for reference sites, Index of Biotic Integrity (‘IBI’) scores of 59 (“excellent”) were applied to all reference sites.

Hypothesised reference scores, along with measured test scores, are enclosed in Appendix A of this report.

(c) Various desktop techniques

Delineation and measurement of catchment boundaries and the proportion of the catchment above each study reach in impervious cover were calculated using GIS (ArcGIS 9.3) and the river environment classification layer.

---

[3] This confirmation has been provided in the letter dated 22nd May 2008 from Stephanie Parkyn (NIWA) to Graham Sevicke-Jones (HBRC).

Fish survey data was input into the IBI calculator (Index of Biotic Integrity, Joy & Death 2004) to generate IBI scores. Those scores were imported into the SEV calculator.

SEV scores were calculated using Version 9 of the SEV spreadsheet calculator.

2.4 Limitations

2.4.1 Reference Scores

No actual reference site is available on the Heretaunga Plains or Napier Catchment for the SEV study. On that basis previously developed reference data for Auckland and Hawke's Bay, and from the author's experience and opinion were relied upon to compile representative reference scores.

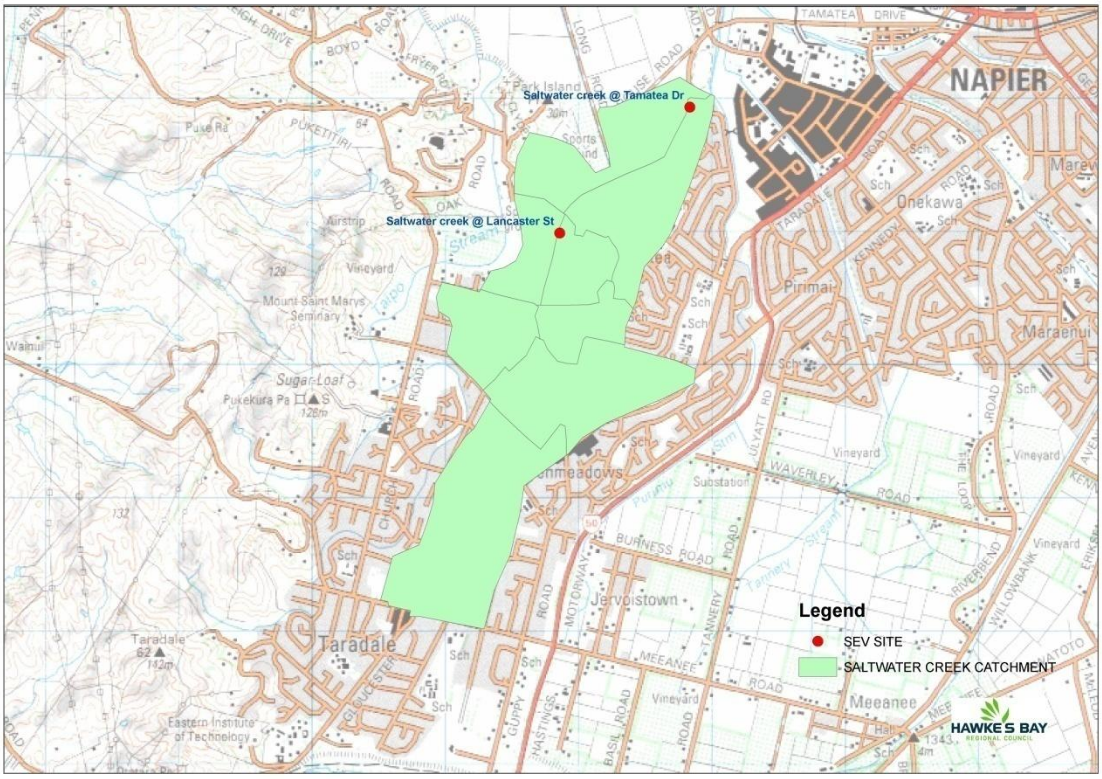
The Karitewhenua Stream at Te Mata Rd is an intermittent stream, therefore caution should be exercised when comparing the SEV of this site to other sites. The stream could not be surveyed for fish owing to it being dry on the day of fish surveys.

3.0 RESULTS - NAPIER

3.1 Overview of SEV Scores

Figure 14 below outlines the locations of the sites in the Saltwater Creek Catchment.

Figure 14: SEV sites for the Saltwater Creek study reaches



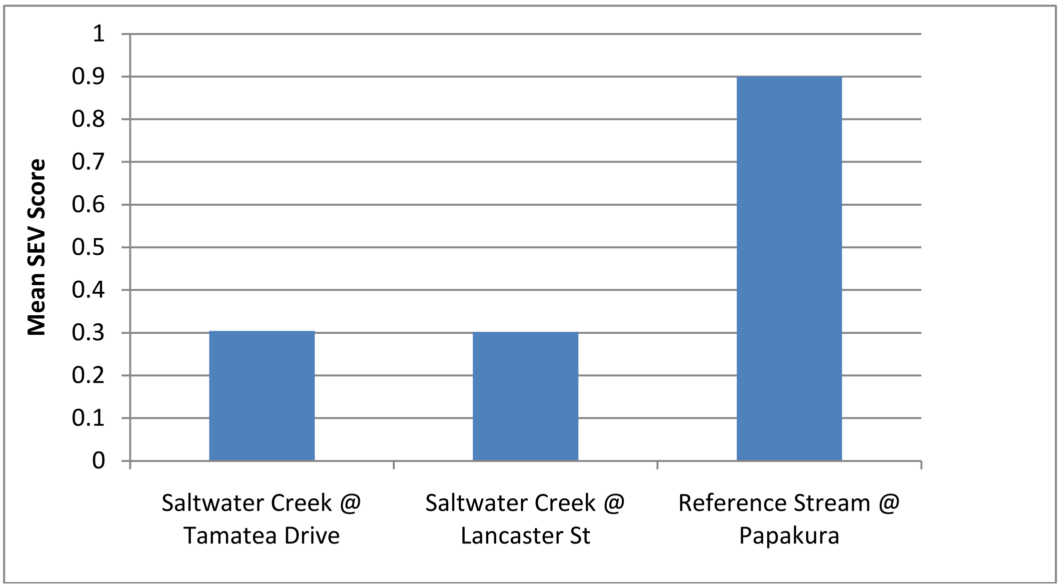


Figure 15: SEV scores for the Saltwater Creek study reaches

Test scores returned from SEV analysis of the representative reaches of Saltwater Creek are presented in Figure 15 above. Low SEV scores were returned for both study reaches and were significantly lower to the reference score attained from the Papakura Stream.

3.2 Macroinvertebrate Communities

Macroinvertebrate community index (MCI) scores all returned low results. It is possible that scores returned from Saltwater Creek may reflect the heavily modified nature of the stream and catchment as well as the effects of pump stations and tidal influences in the lower reaches. Certainly a lack of significant shading and limited stable habitat for macroinvertebrate colonisation was noted during field visits.

Table 20 : Macroinvertebrate Index Results for the Saltwater Creek study reaches

Macroinvertebrate Index by Study Reach			
Site Reach	Mean MCI	Mean EPT	Mean Richness
Saltwater Creek @ Tamatea Drive	74	0	16
Saltwater Creek @ Lancaster St	70	0	11
Reference Stream @ Papakura	101	16	26

3.3 Fish Communities

The fish survey results for Saltwater Creek is presented in below.

Table 21: Fish survey results for Saltwater Creek

Scientific Name	Common Name	Tamatea Drive	Lancaster St
Anguilla spp.	Unidentified Eel	✓	✓
Carassius auratus	Goldfish	✓	
Gambusia affinis	Mosquito Fish	✓	✓

Index of Biotic Integrity scores for Saltwater Creek are presented in Figure 16 below.

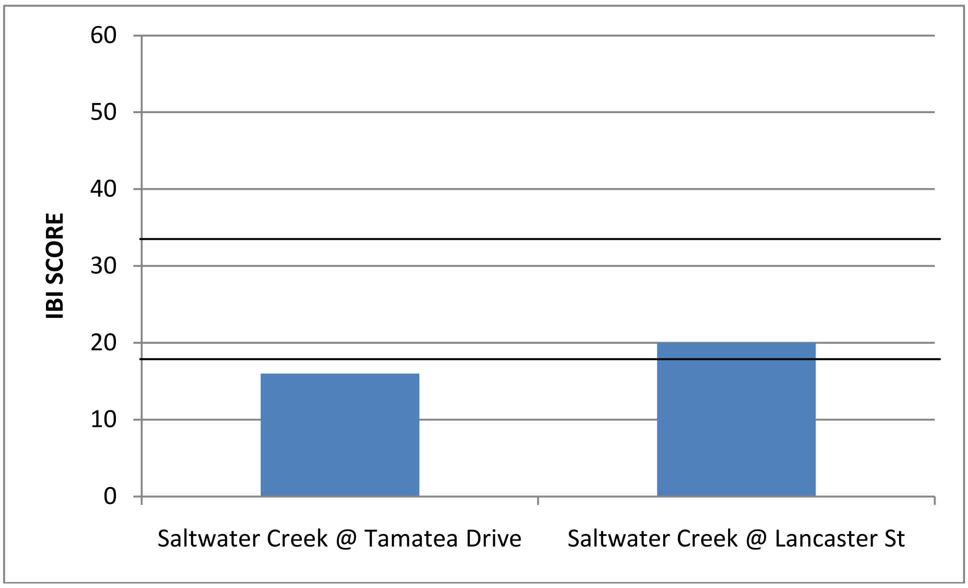


Figure 16: IBI scores for Saltwater Creek study reaches. Note threshold lines represent very poor (<18) and poor (<32) categories

3.4 Function Scores

(a) Saltwater Creek (SEV : Test = 0.304,0.302, Reference = 0.900)

Saltwater Creek returned moderate hydraulic function and biogeochemical function scores. The overall SEV scores were reduced by the poor habitat and biodiversity variable scores. In particular the low roughness, lack of shading, lack of sinuosity and homogenous substrate (silt) lowered the habitat provision function while the impaired fish and macroinvertebrate community structures, and highly degraded riparian condition contributed to the poor biodiversity function score

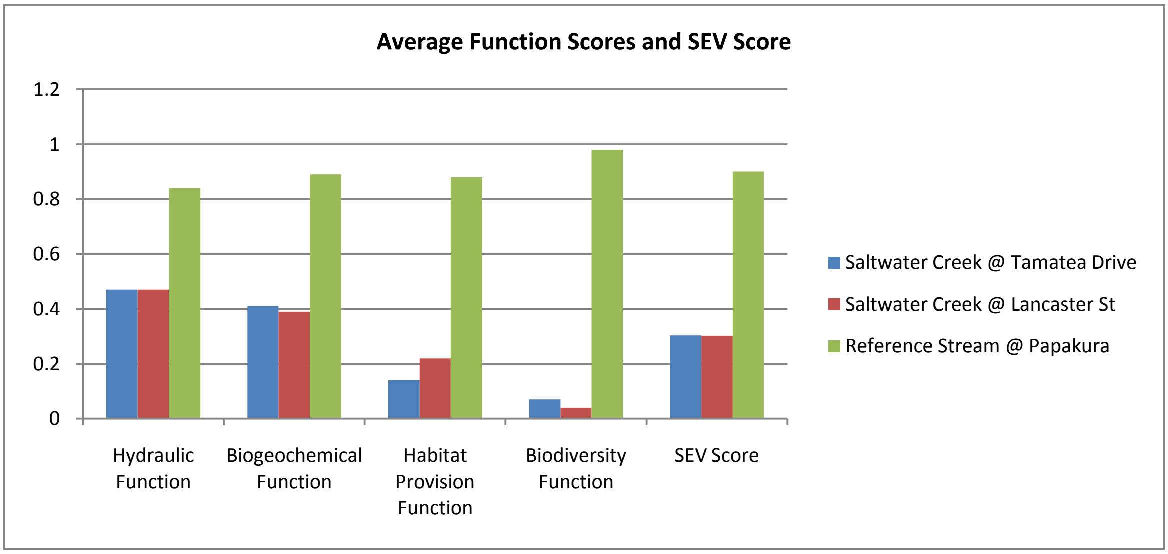


Figure 17: Average function scores and overall SEV score for the Ruahapia Stream study reach

4.0 RESULTS – HASTINGS/CLIVE

The Hastings and Clive urban streams have been grouped together and include the Te Waikaha, Mangarau, Herehere, Karitewhenua Streams Muddy Creek Irongate and Ruahapia Streams. They are all tributaries of the Clive River.

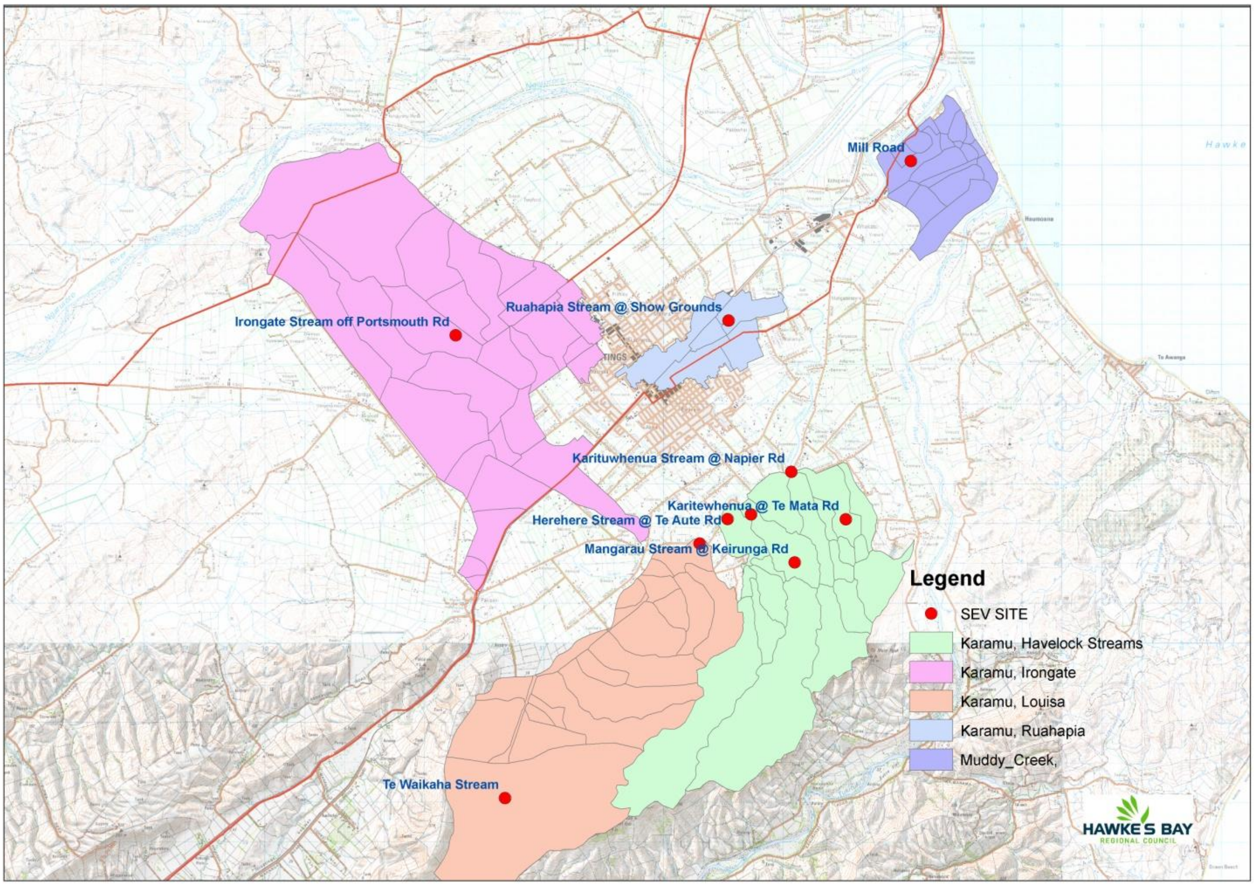


Figure 18: Sites within the Karamu Stream Catchment.

Test scores returned from SEV analysis of the representative reaches are presented in Figure 19 below. Sites scored moderately well with most sites falling within the maximum enhancement potential band of 0.4-0.8. The Louisa Stream and Kariewhenaua Stream at Napier Rd were the only sites to fall below the 0.4 mean SEV threshold (both scoring 0.398). Mangarau Stream @ Kierunga Rd had the highest mean SEV score of 0.558 followed by the Te Waikaha Stream with a mean SEV score of 0.499.

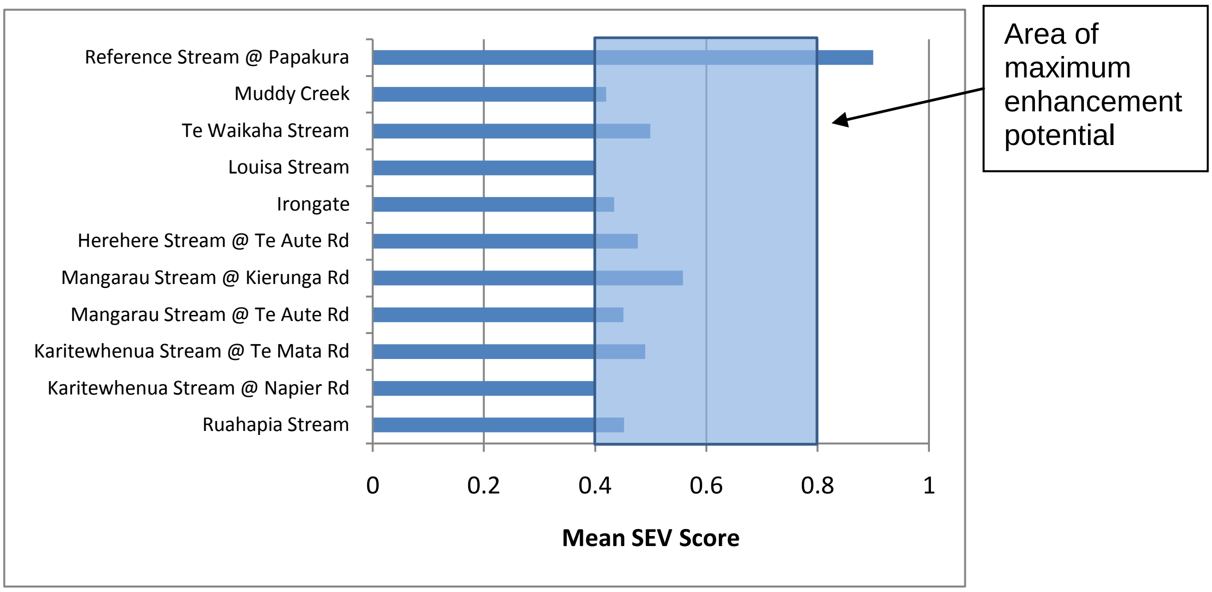


Figure 19: Mean SEV scores for the Karamu Stream Catchment

4.1 Macroinvertebrte Communities

With the exception of the Te Waikaha Stream, most sites scored poorly for MCI and EPT. Most sites had a total taxa richness that was close to the reference value of 26 at Papakura Stream. This would indicate that more pollution tolerant taxa and less sensitive taxa were present at the Havelock/Clive streams than the reference stream.

Macroinvertebrate Index by study Reach			
Site Reach	Mean MCI	Mean EPT	Mean Richness
Ruahapia Stream	67	0	20
Karitewhenua Stream @ Napier Rd	74.8	0	22
Karitewhenua Stream @ Te Mata Rd	80	1	23
Mangarau Stream @ Te Aute Rd	63.8	2	21
Mangarau Stream @ Kierunga Rd	83.3	8	30
Herehere Stream @ Te Aute Rd	66.4	3	22
Irongate	66	3	20
Louisa Stream	90	4	22
Te Waikaha Stream	105.8	8	24
Muddy Creek	73.3	2	21
Reference Stream @ Papakura	101	16	26

Table 22: Macroinvertebrate Index Results for the Hastings/Clive study reaches

4.2 Fish Communities

The fish survey results for the stream reaches are provided in Table 23 overleaf. To avoid clutter two Tables have been created. Note, fish could not be surveyed in the Mangarau Stream @ Te Aute Rd owing to the stream being dry at the time.

Scientific Name	Common Name	Ruahapia Stream	Karitewhenua @ Napier Rd	Mangarau @ Kierunga Rd	Herehere @ Te Aute Rd
Anguilla dieffenbachii	Longfin eel		✓	✓	✓
Anguilla australis	Shortfin Eel	✓	✓	✓	
Galxias maculatus	Inanga	✓	✓		✓
Retropinna retropinna	Common Smelt				
Gobiomorphus cotidianus	Common Bully			✓	✓
Paranephrops planifrons	Koura			✓	✓
Gobiomorphus basalis	Crans bully			✓	✓
Carassius auratus	Goldfish		✓		
Gambusia affinis	Mosquito Fish	✓	✓		

Scientific Name	Common Name	Irongate Stream	Louisa Stream	Te Waikaha Stream	Muddy Creek
Anguilla dieffenbachii	Longfin eel		✓	✓	
Anguilla australis	Shortfin Eel	✓			✓
Galxias maculatus	Inanga		✓		✓
Retropinna retropinna	Common Smelt		✓		✓
Gobiomorphus cotidianus	Common Bully		✓		✓
Paranephrops planifrons	Koura			✓	✓
Gobiomorphus basalis	Crans bully				
Gobiomorphus	Upland Bully			✓	
Aldrichetta forsteri	Yellow eyed Mullet				✓
Carassius auratus	Goldfish		✓		✓
Gambusia affinis	Mosquito Fish		✓		✓

Table 23 : Fish survey presence data from Hastings/Clive Study reaches

Index of Biotic Integrity scores for Hastings/Clive reaches are presented in Figure 24 below.

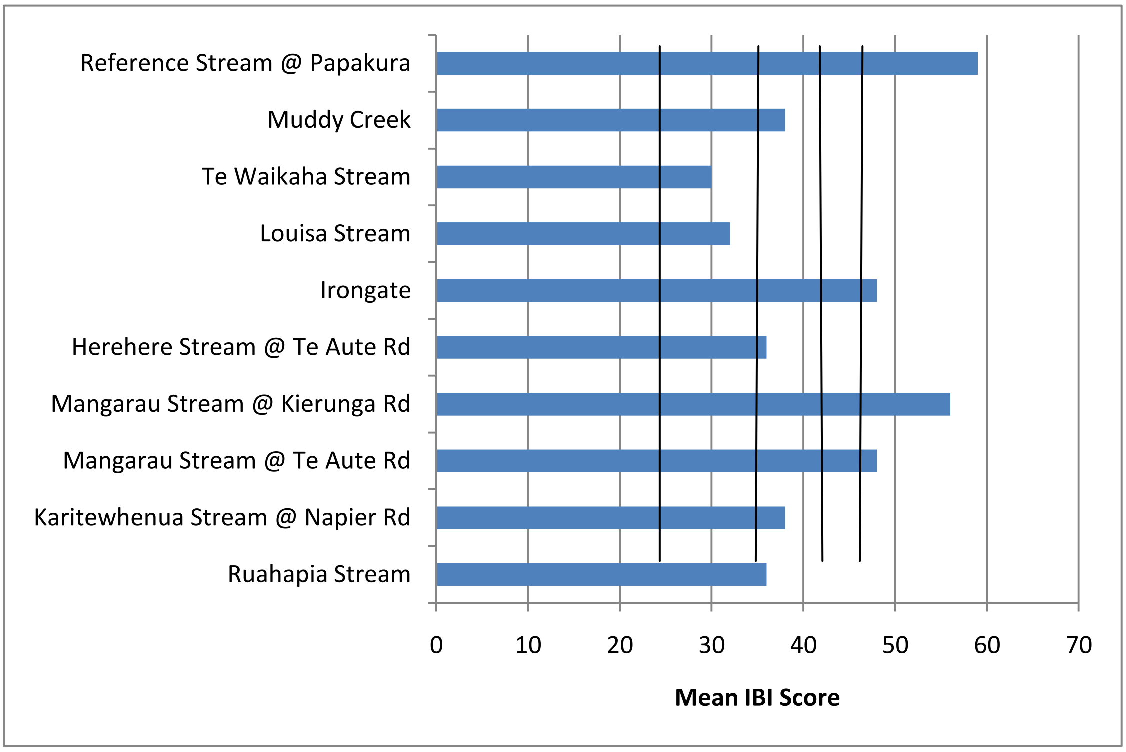


Figure 20: IBI scores for Karamu Stream tributary study reaches

Note the threshold lines represent very poor (<18), poor (<32), moderate <36, good (<44) and excellent (>44) categories. No fish survey was undertaken for Karitewhenua Stream at Te Mata Rd as there was no flow at the time.

4.3 Function Scores

Function scores of the study reaches of Hastings/Clive are presented overleaf.

The Karitewhenua Stream sites and Ruahapia Stream scored particularly low for the biodiversity function. This is primarily due to these sites having the lowest EPT scores of the group (see Table 22)as well as the presence of pest fish (see Table 23) and the Karitewhenua Stream at Te Mata Rd having poor galaxiid spawning habitat. This is because this site is well shaded, therefore there is almost no marginal grasses growing on the stream margins which are normally used by galaxiids for spawning. Alternatively Mangarau Stream at Kierunga Rd scored the highest in terms of the biodiversity variable. The stream site had the best fish fauna as indicated by the fish IBI score (see Figure 20). The Mangarau Stream also had a comparatively high EPT score and had the highest taxa richness of the group (see Table 22).

Habitat provision scored low at three sites namely Louisa Stream, Irongate Stream Ruahapia Stream and Muddy Creek. These are the soft bottomed streams of the group therefore the habitat provision score was dragged down by having a homogenous silty substrate. The remaining sites are hard bottomed gravel/cobble streams so they have a higher habitat provision function score.

The biogeochemical function scores are also driven largely by the substrate of the stream bed therefore the gravel / cobble systems score higher because they have a greater connection with groundwater than do soft bottomed streams.

The Mangarau Stream @ Te Aute Rd has a low hydraulic function owing to it having a retaining wall immediately adjacent to the stream edge. This reduces the connectivity to the floodplain. Karitewhenua Steam at Napier Rd scores low in hydraulic function because a major fish barrier is located upstream of this point (located on the corner of Brookvale Rd and Woodlands Drive) which reduces the value of the variable associated with connectivity for species migrations. All other sites score moderately well on hydraulic function. (See Figure 21).

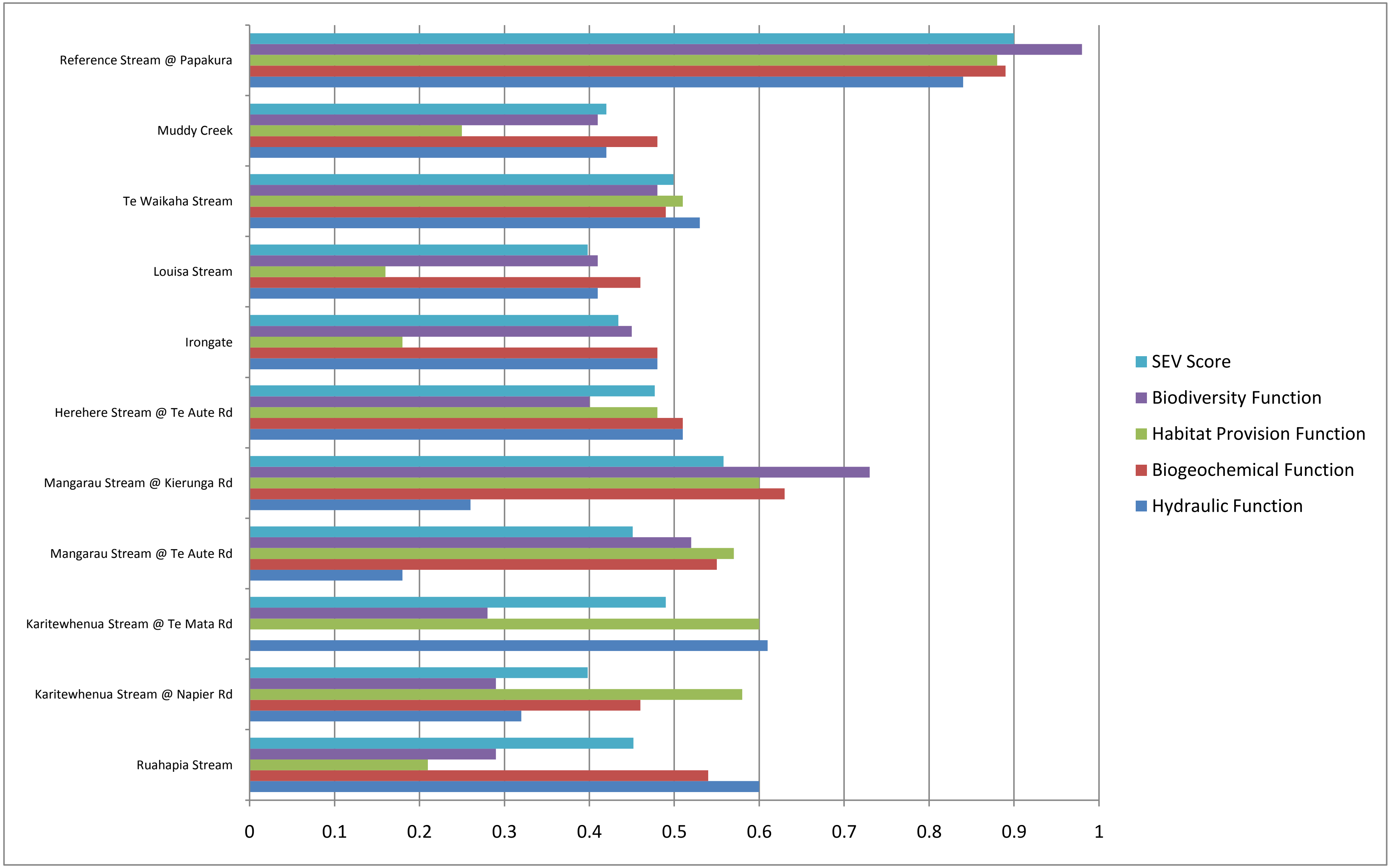


Figure 20: Average function scores and overall SEV score for the karamu stream tributaries

Figure 21: Fish barrier on the corner of Brookvale Rd and Woodlands Drive. The streams base flow has been piped and concreted over.

5.0 RUAHAPIA STREAM CASE STUDY

5.1 Comparison of two independent SEV assessments on the Ruahapia Stream

This section examines some results of two independent SEV assessments conducted on the Ruahapia Stream on two different reaches. On August 10th 2009 MWH consultants undertook a SEV survey of the Ruahapia Stream. This was followed up with a fish monitoring survey on August 31st 2008. The MWH assessments were undertaken a short distance (150m) below Bennett Rd. On 25th January 2010 an SEV survey was conducted on the Ruahapia Stream by the Hawke's Bay Regional Council, the results of which have already been reported in this report. A fish survey was not conducted for this reach because it had recently been surveyed as part of Council's State of the Environment monitoring programme, so records were extracted from the New Zealand Freshwater Fish Database. The reach surveyed by Council was located just above Elwood Rd in Hastings.

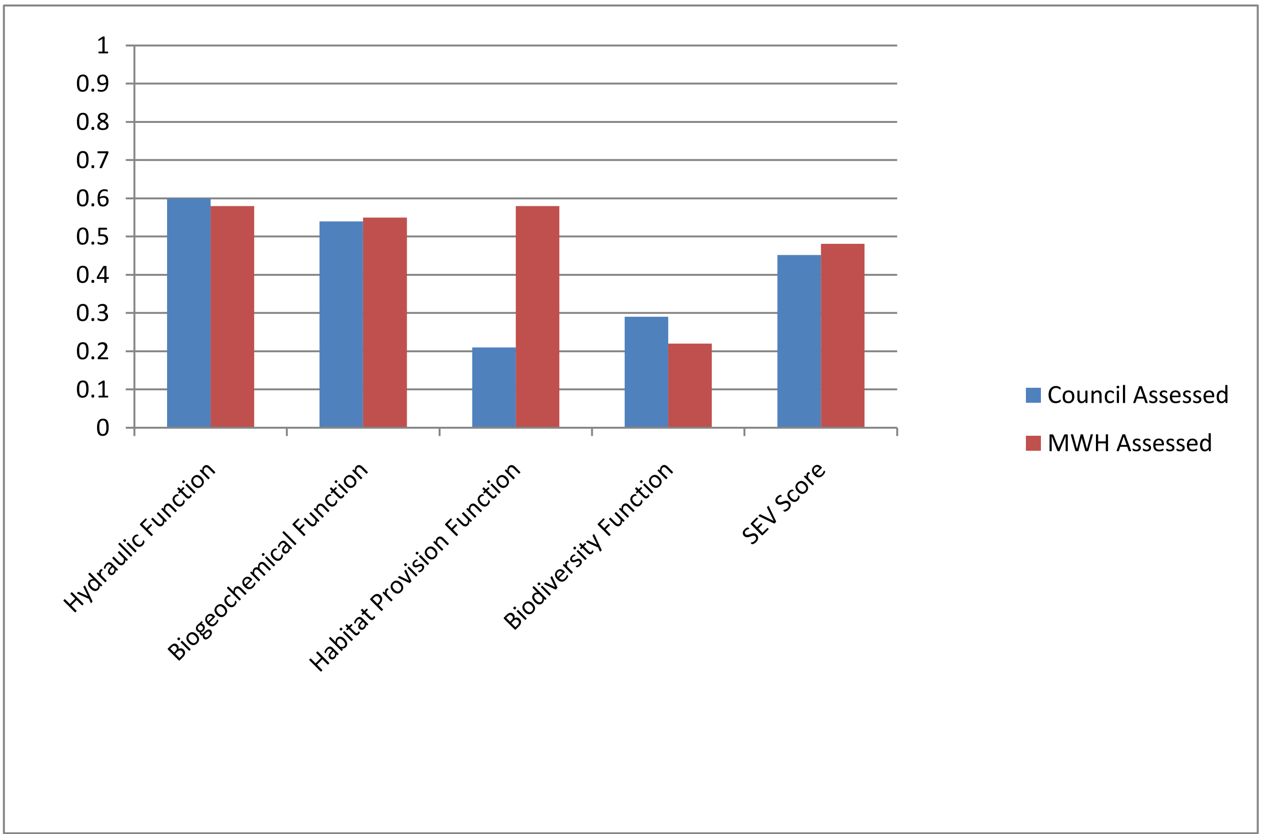


Figure 22: Council vs MWH SEV survey comparisons for the Ruahpia Stream

Figure 23 shows that the Council SEV and MWH SEV assessments returned very similar results. For hydraulic function Council gave the Ruahapia Stream score of 0.6 while MWH gave the Ruahapia Stream a score of 0.58. For the biogeochemical function, Council gave the Ruahapia Stream a score of 0.54 while MWH gave the Ruahapia Stream a score of 0.55. Larger differences were shown for the habitat provision function in which Council gave the Ruahapia Stream a score of 0.21 while MWH gave a score of 0.58. This difference is expected as the two agencies were measuring physical habitat in two different locations. For biodiversity function, the Council gave the Ruahapia Stream a score of 0.29 while MWH gave a score of 0.22. The over all SEV score given by both agencies was very similar with a Council SEV score of 0.45 and MWH an SEV score of 0.48. This inidicates that the SEV methodology is quite a robust tool that is not unduly influenced by the surveyor or the reach of a given stream.

6.0 DISCUSSION

6.1 Interpretation of SEV Baseline Results

6.1.1 Saltwater Creek

Saltwater Creek is a highly modified stream that has little diversity of habitat and an aquatic fauna representative of poor habitat quality. The stream lacks any natural sinuosity and water levels are maintained by a pump downstream of the Tamatea Rd site. The stream bed is highly silted and bank to bank aquatic macrophyte and periphyton growths are common throughout the year. The pump station towards Ahuriri Estuary is likely to act as a potential barrier to fish pass as well as a barrier to sediment transport out of the stream. The Lancaster St site has less silt build up than the Tamatea Drive site further downstream, and the firmness of the bed indicates cobbles and or gravels are likely to be present beneath the silt layer. Grasses are mown to the waters edge and stream bank erosion areas are evident particularly at the Tamatea Rd site. The mown grasses are likely to reduce any shading capacity or sediment filtering capacity of the riparian margins.

Fish spawning habitat is sparse as the overall morphology of the stream has been heavily engineered to the point that there are few shallow margins that contain long grasses or emergent macrophytes for galaxiids (white bait) to spawn in. Furthermore the absence of gravels or cobbles means there is no habitat available for other fish species such as common bullies to spawn amongst. Clean gravels and cobbles are needed for many smaller native fish to use as habitat to escape predation and to provide resting areas. This type of habitat is not available in Saltwater Creek so the resulting fish diversity is low and the hardier pest fish (Gambuisa and Goldfish) are present. Although eels were found in Saltwater Creek, the density appeared to be low. A lack of undercut banks which are often used by eels could be partly why the density of eels is low.

Due to the poor habitat Saltwater Creek provides, the diversity of the fish and invertebrate fauna is low. Sensitive orders of macroinvertebrates (ephemeroptera, plecopteran and trichopteran) are absent and the resulting macroinvertebrate community index indicates severely polluted water. Sensitive macroinvertebrates require clean gravel cobble substrate with good groundwater connection and a diversity of habitat (runs, riffles, pools) that are not provided by Saltwater Creek. The bank to bank aquatic macrophyte and periphyton growths combined with the slow flowing nature of the creek are likely to create large swings in diurnal dissolved oxygen, pH and temperature which would stress any sensitive macroinvertebrates.

The biogeochemical function scores low at both sites owing to the homogenous silt /mud stream bed offering little connectivity for groundwater to feed into the stream. Riparian plantings are in place however the trees are well back from the stream and it will be many years before they provide adequate shade to maintain cool water temperatures. Many of the trees are deciduous which will provide a large organic load to the stream during the autumn months. Biodiversity value is likely to remain low within and surrounding this stream owing to the relatively uniform instream and riparian habitat. Both sites release toxic hydrogen sulphide gas when you walk across it. This is a sign that the stream bed is anoxic.

6.1.2 Relative Enhancement Potential

With regard to ecological functions operating within the stream environment, the enhancement options listed in Table 24 overleaf are those which present the best opportunity to improve the performance of aquatic ecological functions. Clearly a large amount of work would be required to improve the ecological performance of Saltwater Creek as most of the relevant enhancement actions would need to occur at a catchment scale.

Table 24: Key options for improvement of function performance of urban stream ecosystems

Ecological function	Relevant enhancement actions
Natural Flow Regime	Minimise imperviousness, piping channelization. Increase sinuosity of stream. Introduce run riffle and pool habitat.
Connectivity to floodplain	Avoid concrete channels or confining retaining walls
Connectivity to fish migrations	Remove artificial barriers
Connectivity to groundwater	Maintain natural bed material, reduce sediment inputs, consider groundwater agumentation via a bore.
Aquatic biodiversity intact	In addition to the above measures, increase native riparian margin cover, provide undercut banks, provide shallow ledges or wetland margins.
Water temperature control	Increase riparian shading to 80%
Dissolved oxygen maintenance	In addition to the above, reduce organic waste input at source
Organic (leaf and wood) input	Increase evergreen vegetation over stream.
Instream particle retention	Increase instream roughness (eg. Woody debris and cobbles).
Decontamination of pollutants	Increase supply of leaf litter and stable substrate.
Flood plain particle retention	Increase flood plain vegetation thickness, provide wetland margins
Fish spawning habitat	Maintain stony bed and damp marginal grasses
Habitat for aquatic fauna	In addition to the above, increase habitat diversity and native riparian vegetation.
Riparian vegetation intact	Maintain indigenous vegetation
Fish fauna intact	Likely to improve due to the above measures
Invertebrate fauna intact	

Adapted from S. Moore

The SEV method (Rowe et al 2008) was developed to provide a scientific framework for calculating environmental compensation. That is, for a given loss of ecological functions at one stream site, the SEV method provides a rationale for the calculation of the type and amount of restoration required to achieve ‘no net loss’ of ecological performance at an enhancement site.

The SEV method provides a scale from 0.0 to 1.0 along which the potential ecological performance gains for enhancement actions can vary. As presented below, when the SEV score at a given site is between 0.0 to 0.4, enhancement of ecological performance may be limited by extraneous factors such as large areas of impervious surface in the catchment upstream of the site, changing the natural flow regime and impacting habitat and water quality.

At the upper end of the SEV enhancement potential scale, if a test site SEV score is ≥ 0.8 the site ecological functioning is near reference conditions and provides only little potential for enhancement of ecological performance.

Where a test site SEV score is between 0.4 and 0.8, the potential for enhancement of ecological performance is greatest. The method suggests that the greatest gains in ecological performance would be achieved from enhancement efforts spent at study reaches with SEV scores ranging between 0.4 and 0.8.

Test site SEV score

Low potential				Greatest Enhancement Potential				Low Potential	
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9

Figure 24: Potential SEV scores

The overall SEV value of Saltwater Creek is 0.3 (0.302 for Lancaster St, 0.304 for Tamatea Drive) which falls short of the 0.4 to 0.8 range that indicates maximum enhancement potential.

6.1.3 Hastings/Clive Study Reaches

Most sites scored moderately well in terms of the ecological functions of the SEV score so the discussion which follows focuses on those sites for which a particular function was suboptimal or scored highly.

Three sites scored poorly for the hydraulic function namely Karitewhenua Stream at Napier Rd (0.32), and Mangarau Stream at Te Aute Rd and Kierunga Rd (0.18 and 0.26 respectively). The hydraulic function of Karitewhenua Stream at Napier Rd is low due to the stream showing little sinuosity, and the existence of a known fish barrier upstream. The Mangarau Stream at Te Aute Rd scores poorly due to it having a retaining wall on the true left bank and a steep confined floodplain while the Mangarau Stream at Kierunga Rd also scores low due to the steep floodplain.

The hydraulic function of the soft bottomed streams (Ruahapia, Louisa and Muddy Creek) scored moderately well which was surprising. Although these sites had poor connectivity to groundwater (owing to the soft bottom substrate), they had good connectivity for species migrations and good connectivity to the floodplain with few signs of streambank erosion (except the Louisa).

Karitewhenua Stream at Te Mata Rd had the highest score for hydraulic function (0.61). This site is located within a community reserve which has been extensively planted in native and occasional exotic vegetation. The stream has good sinuosity and a good frequency of runs riffles and pools and also has a good floodplain width. There are no signs of erosion within the reach and the channel is largely unmodified.

Most sites scored well in terms of the biogeochemical function as the reaches demonstrated good riparian margins to provide adequate water temperature control, organic matter input and floodplain particle retention.

Four sites scored poorly in terms of the habitat provision function namely, Ruahapia Stream, Irongate Stream, Louisa Stream and Muddy Creek (0.21,0.18,0.16 and 0.25 respectively). These are all soft bottomed streams so they do not provide any gravels or small cobbles for spawning and resting for species of bully (common, crans and upland). The muddy or silty nature of the stream bed is also likely to be less suitable for sensitive macroinvertebrate taxa that need a stable substrate to either feed from (e.g. the net spinning *Aoteapsyche* caddisfly), graze from (eg. mayflies and stoneflies) or filter feed (eg. some mayflies and diptera). Ryder (1989) has demonstrated that mayflies and stoneflies prefer to graze from unsilted periphyton meaning that food quality for these orders of insects is likely to be of poor quality in these streams. To add to that the silty nature makes the habitat unsuitable (due to a low oxygen content) for macroinvertebrates that inhabit the interstitial spaces of gravels and cobbles (mostly mayflies, stoneflies and caddisflies). The variable dod (dissolved oxygen demand) scores lower in soft bottomed streams owing to the lack of reoxygenation by groundwater and the entrapment of organic matter within the silt matrix.

The Louisa Stream also scored low in terms of the roughness of the surrounding riparian vegetation. The thickness of vegetation on the floodplain will influence the amount of runoff material retained by it. Field observations found the true right bank of the Louisa Stream to be heavily eroded and the stream bank tops also lacked any vegetation in the lower section of the reach.

The highest score for habitat provision was achieved at the Karitewhenua Stream at Te Mata Rd (0.6). The stream channel is largely unmodified, has a good frequency of runs riffles and pools and is located in a community reserve that has predominantly been planted in native tree and flax species. The stream is stony bottomed and it’s natural morphology provides good habitat for most instream taxa while the riparian margins provide extensive habitat for surrounding riparian fauna and flora.

Three sites scored poorly in terms of the biodiversity function namely Ruahapia Stream, Karitewhenua @ Napier Rd and Karitewhenua @ Te Aute Rd (0.29,0.29,and 0.28 respectively). This is primarily due to these sites having the lowest EPT scores of the group (see Table 22) as well as the presence of pest fish (see Table 23) and the Karitewhenua Stream at Te Mata Rd having poor galaxiid spawning habitat. This is because this site is well shaded, therefore there is almost no marginal grasses growing on the stream margins which are normally used for galaxiid spawning. Alternatively Mangarau Stream at Kierunga Rd scored the highest in terms of the biodiversity variable (0.73). The stream site had the best fish fauna as indicated by the fish IBI score (see figure 20). The Mangarau Stream also had a comparatively high EPT score and had the highest taxa richness of the group (see Table 22).

6.1.4 Relative Enhancement Potential

Most sites in the Hastings/Clive area showed a final SEV score within the 0.4-0.8 bracket indicating that they have good enhancement potential. The exceptions were Karitewhenua at Napier Rd and the Louisa Stream. The discussion that follows focuses on these two sites and what effect a particular action may have on raising the SEV score above 0.4.

As indicated earlier, the Karitewhenua Stream at Napier Rd scores poorly in the hydraulic function owing to a known fish barrier upstream. Table 25 overleaf demonstrates what would happen to the overall ecological performance of the stream if the fish barrier was removed.

Table 25: Example of potential improvements in ecological performance of the Karitewhenua Stream at Napier Rd if the known fish barrier was removed.

Enhancement Action	Assumed Outcome	Functions Affected	SEV Outcome Pre enhancement	SEV Outcome Post enhancement
Remove barrier located on Brookvale Rd	Allow for species migrations to occur further upstream	Connectivity for species migrations	0.0	1.0
		Hydraulic Function Mean Score	0.32	0.57
		Overall SEV Score	0.398	0.460

Table 25 shows that by removing the known fish barrier at Brookvale Rd, the connectivity for species migrations score improves thereby improving the hydraulic function mean score. As a result of this the SEV score improves from 0.398 to 0.46 bringing the Karitewhenua Stream into the SEV range of providing the greatest enhancement potential.

The Louisa Stream scores particularly low in terms of two variables, namely dissolved oxygen demand and roughness. The dissolved oxygen demand in soft bottomed streams is higher owing to a lower connectivity to groundwater and the entrapment of organic matter within the silt matrix. Table 26 below demonstrates what would happen to the overall ecological performance of the stream if the substrate was changed to a more gravel/cobble system.

Table 26: Example of potential improvements in ecological performance of the Louisa Stream if the streambed substrate was replaced with gravels and cobbles.

Enhancement Action	Assumed Outcome	Functions Affected	SEV Outcome Pre enhancement	SEV Outcome Post enhancement
Replace muddy substrate with gravels and cobbles	Allow for better water exchange between surface and groundwater	Vdod (dissolved oxygen demand)	0.00	1.0
		Biogeochemical Score	0.46	0.62
		Vwaterqual (water quality)	0.00	0.84
		Habitat provision Score	0.16	0.27
		SEV Score	0.398	0.473

Table 26 shows that if the muddy substrate was replaced with gravels and cobbles, the dissolved oxygen demand of the substrate (Vdod) would reduce thereby improving the overall biogeochemical score. Furthermore water quality would improve as would habitat provision resulting in an improved SEV score.

Clearly replacing the substrate of the Louisa Stream at a catchment scale is not feasible as it would be prohibitively expensive and the process of removing the muds and silts could be ecologically damaging.

In the scenario that follows (Table 27) we examine what improvement in ecological function that could arise if the roughness of the riparian margins were improved.

Table 27 Example of potential improvements in ecological performance of the Louisa Stream if the floodplain roughness was increased.

Enhancement Action	Assumed Outcome	Functions Affected	SEV Outcome Pre enhancement	SEV Outcome Post enhancement
Increase the thickness of riparian vegetation particularly on the true right bank	Allow for improved filtering of runoff contaminants prior to them entering the stream	Vrough	0.31	0.76
		Floodplain retention score	0.37	0.52
		Biogeochemical Score	0.46	0.48
		SEV Score	0.398	0.407

Table 27 shows that by increasing the floodplain roughness (by planting thicker riparian vegetation) the roughness increases resulting in an increased floodplain retention and biogeochemical score. As a result of this the SEV score improves from 0.398 to 0.407.

7.0 CONCLUSIONS

The stream ecological valuation has proven to be a useful tool for assessing ecosystem function of the reaches surveyed. The results for Saltwater Creek indicate that it’s stream function is severely impaired. The final SEV scores indicate that the stream’s potential for improving ecological function through restoration efforts are low. Having said that this should not discount the stream from restoration as other values (cultural and amenity) may improve significantly with different restoration methods. For example putting in a pervious cycle way alongside the stream may do nothing to improve ecological health, however amenity value could increase significantly by this action.

Most streams within the Karamu Catchment (Hastings/Clive) have great potential for enhancement of ecological functions of the streams. The results from the Karitewhenua Stream at Te Mata Rd need to be treated with caution as it is an intermittent stream. The SEV assumes perennial flow and as such is perhaps a less informative tool for intermittent streams.

Council is currently working with NIWA to enhance the SEV methodology to include intermittent streams so that comparisons with streams reaches like the Karitewhenua Stream at Te Mata Rd may become more meaningful.

8.0 RECOMMENDATIONS

It is recommended that the stream ecological valuation continue to be used for assessments of small (1^{st}-3^{rd} order) streams throughout the Hawke's Bay Region. Further SEV assessments are recommended within the Karamu Stream Catchment in the Tomoana Drain, Mallory Drain, Awahou Stream, Soutland Drain, Mahora Drain Tekahika Stream and Karamu Stream at St. Georges Rd.

Literature Cited

Bruno, D. (2009) Standardised Fish Sampling Protocols for New Zealand Wadeable Streams

Forbes, A. (2009) Stream Ecological Valuation: Napier Urban Streams. MWH New Zealand Limited

Fromont, M., & Walls, G.(1988) The Lowlands of Hawke's Bay: Protected Natural Areas Programme Stage One Survey – Maungaharuru, Heretaunga & Eastern Hawke's Bay Ecological Districts. Napier: Department of Conservation.

Grant, P. (1996) Hawke's Bay Forests of Yesterday. Havelock North : Patrick Grant

Joy, M., & Death, R. (2004) Application of the Index of Biotic Integrity to new Zealand Freshwater Fish Communities. *Environmental Management, 34, 415-428*

Rowe, D., Quinn, J., Parkyn, S., Collier, K., Hatton, C., Joy, M., Maxted, J. & Moore, S. (2006) Stream Ecological Valuation (SEV): a method for scoring the ecological performance of Auckland streams and for quantifying mitigation. Prepared for Auckland Regional Council. NIWA Client Report: HAM 2006-084, June 2006.

Rowe, D., Quinn, J., Parkyn, S., Collier, K., Hatton, C., Joy, M., Maxted, J. & Moore, S. (2008) Stream Ecological Valuation (SEV): a method for scoring the ecological performance of Auckland streams and for quantifying environmental compensation. Prepared for Auckland Regional Council. 2nd Edition

Ryder, G. I., (1989) Experimental studies on the effects of fine sediment on lotic invertebrates. PHD Thesis University of Otago, Dunedin

Snelder, T., Biggs, B. & Weatherhead, M.(2004) New Zealand River Environment Classification User Guide. Published by the Ministry for the Environment PO Box 10-362, Wellington, New Zealand.

Stark, J.D., Boothroyd, I.K.G., Harding, J.S., Maxted, J.R., Scarsbrook, M.R.,(2001) Protocols for sampling macroinvertebrates in wadeable streams. Prepared for the Ministry for the Environment. Sustainable Management Fund Contract No. 5103. November 2001

APPENDIX 1: REFERENCE SEV SCORES

						Mean values for
			Hays Stream	Hays Stream	Symmonds Stream	reference sites
Function categor	**Function**	**Variable (code)**	7.00	9.00	23.00	
		Vbed	0.94	0.93	0.93	0.93
		Verosn	1.00	1.00	1.00	1.00
		Vimper	0.70	1.00	1.00	0.90
Hydraulic	**NFR**	=	0.68	0.97	0.97	0.87
		Vfpwidth	0.40	0.40	1.00	0.60
		Vfreq	0.40	0.40	0.80	0.53
Hydraulic	**CFP**	=	0.40	0.40	0.90	0.57
		Vbarr	1.00	1.00	1.00	1.00
		Vcatch	1.00	1.00	1.00	1.00
Hydraulic	**CSM**	=	1.00	1.00	1.00	1.00
		Vhypo	0.94	0.93	0.93	0.93
Hydraulic	**CGW**	=	0.94	0.93	0.93	0.93
	Hydraulic function mean score		0.75	0.82	0.95	0.84
		Vshade	0.93	0.84	0.85	0.87
		Vdepth	0.80	0.70	0.70	0.73
		Vveloc	0.70	0.80	1.00	0.83
		Vlength	1.00	1.00	1.00	1.00
biogeochemical	**WTC**	=	0.88	0.84	0.88	0.86
		Vdod	1.00	1.00	1.00	1.00
biogeochemical	**DOM**	=	1.00	1.00	1.00	1.00
		Vcanop	0.83	0.78	0.88	0.83
		Vdecid	0.00	0.00	0.00	0.00
biogeochemical	**OMI**	=	0.83	0.78	0.88	0.83
		Vtrans	1.00	1.00	1.00	1.00
		Vretain	1.00	1.00	0.93	0.98
biogeochemical	**IPR**	=	1.00	1.00	0.93	0.98
		Vsurf	1.00	0.86	1.00	0.95
biogeochemical	**DOP**	=	1.00	0.86	1.00	0.95
		Vfpwidth	0.40	0.40	1.00	0.60
		Vrough	0.87	0.84	0.87	0.86
		Vfreq	0.40	0.80	0.80	0.67

biogeochemical	**DOP**	**=**	1.00	0.86	1.00	0.95
		Vfpwidth	0.40	0.40	1.00	0.60
		Vrough	0.87	0.84	0.87	0.86
		Vfreq	0.40	0.80	0.80	0.67
biogeochemical	**FPR**	**=**	0.56	0.68	0.89	0.71
Biogeochemical function mean score			0.88	0.86	0.93	0.89
		Vgalspwn	1.00	1.00	1.00	1.00
		Vgalqual	0.75	0.25	0.75	0.58
		Vgobspwn	1.00	1.00	1.00	1.00
habitat provision	**FSH**	**=**	0.88	0.63	0.88	0.79
		Vphyshab	1.00	1.00	1.00	1.00
		Vwatqual	0.97	0.92	0.93	0.94
		Vimper	0.70	1.00	1.00	0.90
habitat provision	**HAF**	**=**	0.92	0.98	0.98	0.96
Habitat provision function mean score			0.90	0.80	0.93	0.88
		Vfish	0.95	0.95	0.95	0.95
Biodiversity	**FFI**	**=**	0.95	0.95	0.95	0.95
		Vmci	1.00	1.00	1.00	1.00
		Vept	1.00	1.00	1.00	1.00
Biodiversity	**IFI**	**=**	1.00	1.00	1.00	1.00
		Vvert	0.95	0.95	0.95	0.95
		Vinvert	1.00	1.00	1.00	1.00
Biodiversity	**ABI**	**=**	0.98	0.98	0.98	0.98
		Vripcond	1.00	1.00	1.00	1.00
		Vripconn	1.00	1.00	1.00	1.00
		Vripar	1.00	1.00	1.00	1.00
Biodiversity	**RVI**	**=**	1.00	1.00	1.00	1.00
Biodiversity function mean score			0.98	0.98	0.98	0.98
Sum of scores (maximum			14.00	13.98	15.15	14.38
Overall mean SEV score (			0.88	0.87	0.95	0.90