APPENDIX FIVE

Central/Lower Waikato Project Assessments

Contents

CLW 1 Priority: high	Water quality improvement in the Aka Aka catchment	BCR value
Relevant unit goal(s)	Wetlands are protected, enhanced, created and able to perform their water purification role. The mauri/life supporting capacity of freshwater is protected and restored for aquatic species.	
Name of feature	Waterways and wetlands within the Aka Aka sub-catchment	
Brief description of feature	One of the most north-western catchments in the Waikato River catchment, the Aka Aka catchment covers 6915ha north of the river near Port Waikato. The catchment is predominately pastoral (85%) but retains approximately 8% indigenous vegetation cover. The main waterway in the catchment is the Aka Aka Stream. This enters the Waikato River east of Otaua. Catchment waterways are highly modified and channelised and are managed as part of the Aka Aka/Otaua drainage scheme. Catchment land use is predominantly dairy farming. In recent years wetland protection and enhancement works have been undertaken in this catchment by local iwi and landowners. The key aim of this has been to improve whitebait spawning habitat. The Aka Aka and lower Waikato River area is very significant to Waikato-Tainui and the river marae. The lower Waikato River, Aka Aka and the river islands sustained the tangata whenua for centuries with īnanga (whitebait), tuna (eel), pātiki (flounder), kāeo and many more mahinga kai species. It was also an important area for trade and travel. There are many existing and historic pā sites within the area. Modelling undertaken in 2016 indicates that the Aka Aka catchment is a high priority for actions that assist in nitrogen and *E.coli* reduction.	
Desired state to achieve Vision & Strategy	- A sub-catchment where land use matches capability and with a stable stream network that has a fenced and well vegetated riparian margin along its entire length (at least 5m wide) to assist in providing erosion protection and shade, shelter. - Forest remnants and wetlands are densely vegetated with native plant species, connected to riparian corridors and protected from stock grazing. Native plant regeneration occurs naturally within the native bush remnants. - There are no manmade barriers to native migratory fish. Native fish are abundant and there is a wide diversity of species present including non-climbing native fish.	

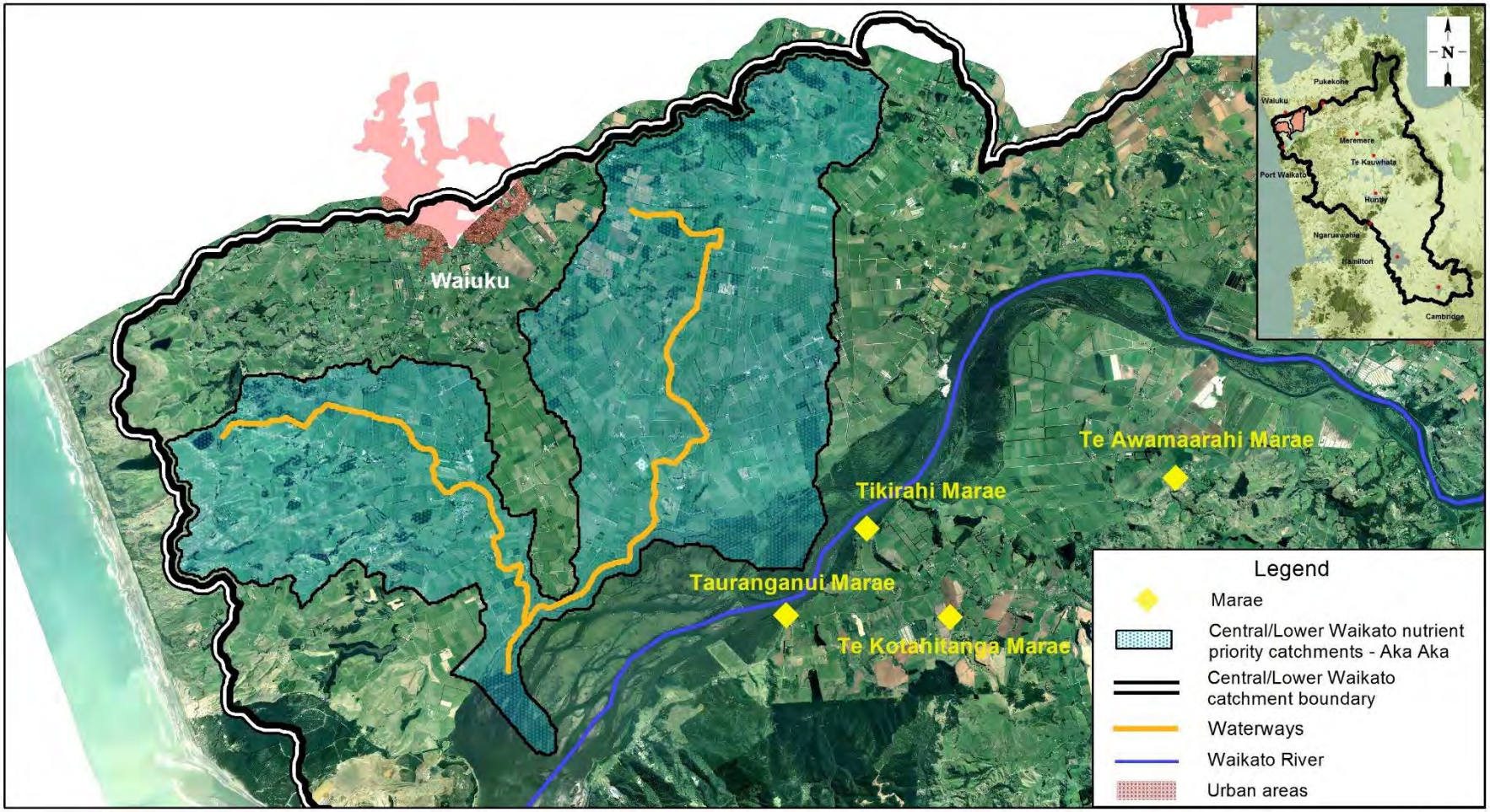
<table>
<tr><td></td><td>- The streams are swimmable, fishable and have access for recreation.
- Iwi and community have a strong connection to the catchment streams and are active in their use, protection and restoration.</td><td></td></tr>
<tr><td>Impact on Vision & Strategy</td><td>In a restored condition, waterways and wetlands in the Aka Aka sub-catchment would have a high impact on giving effect to the Vision & Strategy at a Central and Lower Waikato catchment level.</td><td>VS = 50</td></tr>
<tr><td>Key threats to the feature that this project addresses</td><td><table><tr><th>Key threat</th><th>Impact on feature</th></tr><tr><td>Stock access to the streams and wetlands.</td><td>Reduced water quality and destruction of riparian and wetland vegetation.</td></tr></table></td><td></td></tr>
<tr><td>Project goal/s</td><td>100% of wetlands and seeps greater than 0.1ha are fenced to exclude stock within 15 years of project commencement.</td><td></td></tr>
<tr><td>Priority works for funding</td><td>Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This project could be undertaken as a whole, or in multiple components.

Wetland and ephemeral stream protection
55km of fencing wetlands and seeps >0.1ha and ephemeral streams at $8/m. Fence should be 5 wire – 2 electric ($440,000). The focus should be on wetlands that retain relatively natural hydrology, i.e. water is flowing in and out through the wetland (not via a drain through or around), water is held back and the wetland is functioning year round.

Project management/staffing/incidentals
Staff to carry out landowner liaison, iwi engagement, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing), project reporting and financial management. Incidentals include transport, office overheads, consumables and miscellaneous professional fees.

This is estimated to be 25% of the direct project costs.</td><td></td></tr>
<tr><td>Time lag for benefits to be realised</td><td>If works were implemented at an even pace over a 10-year period, it is estimated that the majority of the project benefits would be seen approximately 8 years after project commencement.</td><td>L = 8</td></tr>
<tr><td>Effectiveness of works</td><td>The waterways and wetlands within the Aka Aka sub-catchment are currently in a poor condition when compared to desired state with few of the Vision and Strategy aspects being met. It is anticipated that there could be some improvement in condition over the next 20 years even in the absence of this project, with</td><td>W = 0.025</td></tr>
</table>

<table>
<tr><td></td><td>some works in the catchment already underway. The project encourages fencing wetlands/seeps and ephemeral streams and is expected to contribute to further improvement in waterway condition. However it is acknowledged that achieving desired state will take longer than the 20 year horizon used for the purposes of the Restoration Strategy, and a fuller range of initiatives over the long term.</td><td></td></tr>
<tr><td>Risk of technical failure</td><td>There is a negligible risk of project failure due to technical feasibility. The project consists solely of fencing wetland areas.</td><td>F = 0.97</td></tr>
<tr><td>Adoptability</td><td>It is estimated that approximately half of landowners would adopt the works if they were fully incentivised. Some may be concerned by loss of marginal grazing areas. Although generally the benefits of avoiding loss of stock in wetlands and protection of nutrient attenuation areas are becoming better recognised, this kind of work has not yet become as widely supported as riparian protection.</td><td>A = 0.5</td></tr>
<tr><td>Information quality</td><td>Poor – based on modelled information and limited local knowledge.</td><td></td></tr>
<tr><td>Knowledge gaps</td><td>Estimates of wetland location and perimeter come from a desk top exercise. Farm scale information will need to be gathered as part of this project. It is uncertain how many wetlands and seeps retain natural hydrology. Farm scale information will need to be gathered as part of this project.</td><td></td></tr>
<tr><td>Socio-political risks</td><td>Very low risk that the project will fail to meet its goals over the long term due to socio-political risks.</td><td>P = 0.97</td></tr>
<tr><td>Project duration (years)</td><td>10 years</td><td></td></tr>
<tr><td>Up-front cost – total for implementation phase/project duration</td><td><table><tr><th>Task</th><th>Cost ($)</th></tr><tr><td>Fencing wetlands and ephemeral streams (55km)</td><td>440,000</td></tr><tr><td>Project management/staffing/incidentals (25%)</td><td>110,000</td></tr><tr><td>Total</td><td>550,000</td></tr></table></td><td>C = 0.55</td></tr>
</table>



Water quality improvement in the Aka Aka catchment

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017

Status: Final
Request No.: N/A
File name:WWRRS.gws

0 1 2 3 4 5
Kilometers

Scale 1:100,000@A4 Landscape

A4

ACKNOWLEDGEMENTS AND DISCLAIMERS

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An example of a small wetland area that would be suitable for fencing and protecting

CLW 2 Priority: high	Īnanga spawning habitat rehabilitation – Hills Drain	BCR value
Relevant unit goal(s)	Aquatic habitats, including spawning grounds, are protected, enhanced, restored and accessible to native fish. The abundance of native fish, including taonga species, in the catchment is restored and protected.	
Name of feature	Whitebait spawning habitat in the lower river	
Brief description of feature	In the Waikato region, īnanga is the main whitebait species, comprising >90% of whitebait recruiting into the river. Īnanga are the only whitebait species to utilise tidal waters in the estuary to spawn. As īnanga spawn on high spring tides, only habitat that is inundated between mean high water spring tide (MHWS) and highest astronomical tide (HAT) is likely to be utilised for spawning. Since flood protection works have been implemented in the lower Waikato River, only 7.5% of the estuary, delta and floodplain that is inundated between MHWS and HAT remains accessible to īnanga. Of the remaining intertidal habitat available to īnanga, ongoing weed infestation, grazing, pest fish proliferation and streambank erosion is reducing the suitability of many sites for spawning. In the late 1980s, 11 spawning sites were located downstream of the Elbow in the lower Waikato River. Presently, spawning only occurs at three of these sites. In addition, the loss of indigenous vegetation and expansion of exotic plant species throughout much of the lower river has resulted in all known īnanga spawning sites to now be located within exotic pasture grasses or perennial plants. The loss of intertidal floodplains and vegetation changes over the past half century is thought to be limiting īnanga spawning habitat and creating a “bottleneck” for īnanga production from the catchment. This is because if spawning habitat is limited, Waikato īnanga become a “sink” population as reduced larval production reduces the Waikato’s contribution to the next generation of whitebait. A 2ha section of streambank adjacent to Hills Drain at the end of Fisherman Road has been identified as a priority for īnanga spawning habitat rehabilitation. In 2013 and 2014, four īnanga spawning sites were identified along the stopbank. These are the first documented īnanga spawning sites associated with the flood protection works on the true right side of the lower Waikato River and therefore this habitat should be protected and enhanced.	

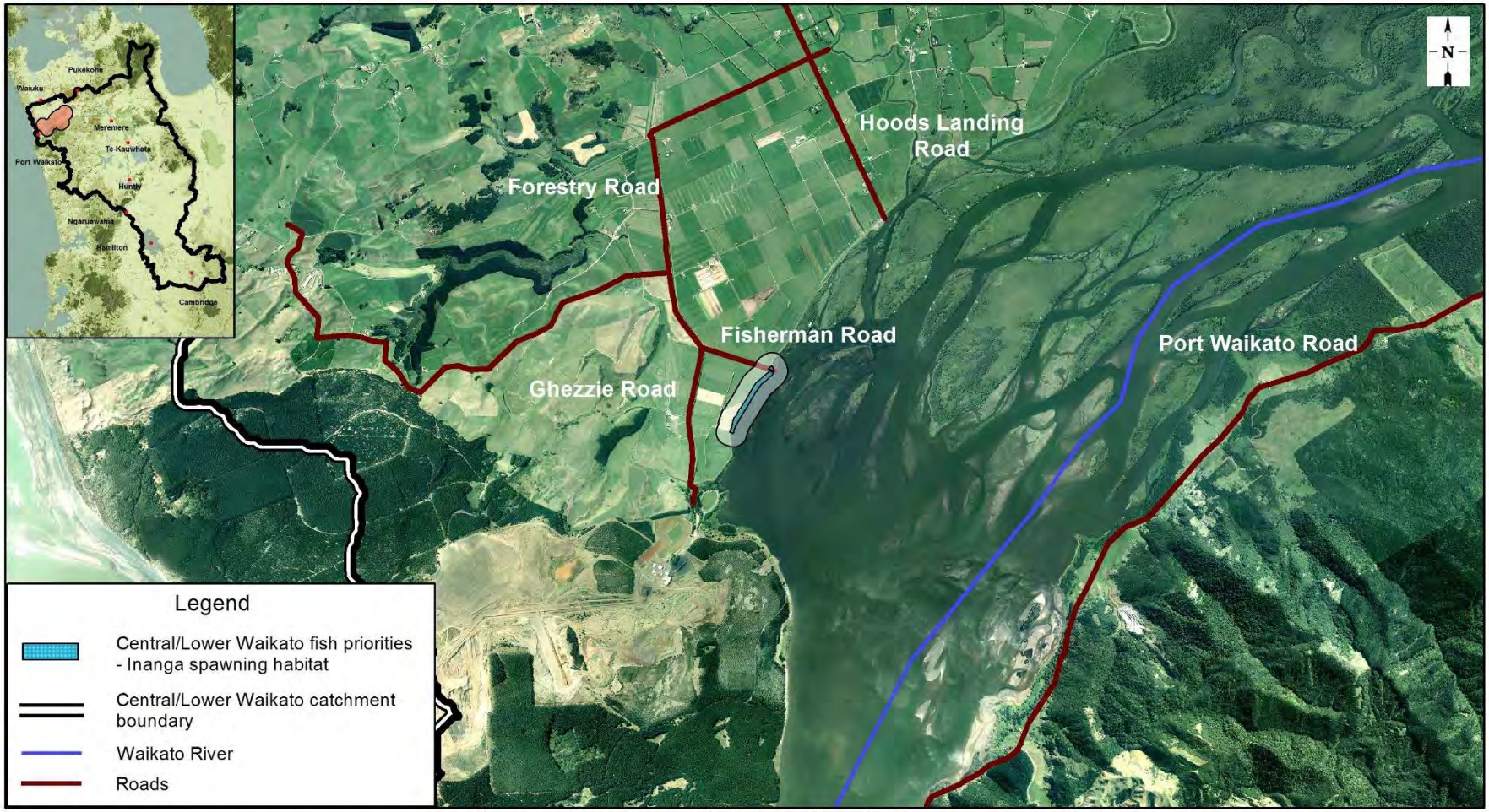
<table>
<tr><td></td><td>Grazing and weed infestation are the main threats to the suitability of the vegetation for īnanga spawning.

The lower Waikato River area is very significant to Waikato-Tainui and the river marae. The lower Waikato River and the river islands sustained the tangata whenua for centuries with īnanga (whitebait), tuna (eel), pātiki (flounder), kāeo and many more mahinga kai species. It was also an important area for trade and travel. Flour and flax mills were established and run by tangata whenua along this stretch. There are many existing and historic pā sites within the area. There are papakāinga, historic settlements and wāhi tapu within this project area. Īnanga and other taonga fisheries are a staple food for marae. Its abundance is regarded as a reflection of the mana of the iwi and marae, and their ability to sustain whānau (family) and manuwhiri (guests or visitors).</td><td></td></tr>
<tr><td>Desired state to achieve Vision & Strategy</td><td>- The remaining intertidal habitat available to īnanga in the lower Waikato River has suitable vegetation to support spawning, is free from grazing stock and is utilised by īnanga for spawning.
- Iwi and communities have a strong connection to the īnanga habitat areas and are active in their protection and restoration.</td><td></td></tr>
<tr><td>Impact on Vision & Strategy</td><td>In a restored condition whitebait spawning habitat in the lower river would have a very high impact on giving effect to the Vision & Strategy at a central and lower Waikato catchment level.</td><td>VS = 200</td></tr>
<tr><td>Key threats to the feature that this project addresses</td><td><table><tr><th>Key threat</th><th>Impact on feature</th></tr><tr><td>Stock access to the stream</td><td>Reduced water quality and destruction of spawning vegetation</td></tr><tr><td>Lack of intertidal spawning vegetation and associated fish habitat</td><td>Reduced habitat for adult fish and reduced reproduction success</td></tr><tr><td>Weed species</td><td>Compete with native plant communities and are a threat to spawning habitats</td></tr></table></td><td></td></tr>
<tr><td>Project goal/s</td><td>Within 5 years of project commencement:
- The intertidal vegetation adjacent to the Waikato River is fenced to exclude stock with a minimum 5 wire (2 electric) fence.
- Weed control is carried out prior to and after native planting to maintain the habitat free of undesirable exotic plant species.
- Native planting is undertaken amongst the desirable exotic vegetation to create a dense plant growth that provides suitable spawning habitats for adult īnanga.</td><td></td></tr>
<tr><td>Priority works for funding</td><td>Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This</td><td></td></tr>
</table>

	project could be undertaken as a whole, or in multiple components. To protect the existing īnanga spawning areas within the site, works should be implemented by an organisation/group with knowledge of īnanga spawning. **Restoration plan** A restoration plan will be developed that details: - the exotic plant species to be removed and retained - the native planting layout - measures that will be undertaken to ensure the existing īnanga spawning sites are not compromised during the enhancement works - methods recommended for weed control - accurate costings. To ensure the success of enhancement and expansion of spawning habitats at this site, planting and weed control needs to be overseen by a suitably experienced fish ecologist. The estimated cost of a restoration plan for this site is $8000. **Fencing** The spawning area should be fenced to exclude stock. Fencing should be at least 5m from the waterway and be a minimum standard of 5 wire (2 electric). Ideally this would be followed immediately by weed control and native planting. The estimated length of fencing required is 640m ($5120). **Weed control** The lower Waikato River has a range of weed species present with varying impacts on īnanga spawning habitats (e.g. sweet reed grass, *Glyceria maxima*, is detrimental to spawning habitat) so a comprehensive weed control plan will be essential to ensure success of the project. Estimated costs for weed control are based on carrying out weed control over the 2ha site for a period of 4 years, using a knapsack, at a cost of $2800 per hectare ($22,440 for four years). **Planting** Native planting should be carried out within open areas to create a native and exotic plant dominated ecosystem over the long term. Using suitable intertidal spawning vegetation (e.g. *Carex* sp., *Juncus* sp., umbrella sedge, swamp millet), high density planting is advised with spacing determined by species. For example, *Carex* sp. should be spaced at 0.75m and *Juncus* sp. and swamp millet spaced at 0.45m. Exotic vegetation utilised by īnanga for spawning should be retained at the site (e.g.	

	wandering willie, Yorkshire fog, Mercer grass, creeping bent and kikuyu). Planting cost estimates assume native planting over 50% of the site at an average spacing of 0.75m ($120,490). This cost estimate assumes planting to cost $117,550 per hectare (at 0.75m spacing) and includes site preparation, plant purchase, planting labour and five releasing events. **Project management/staffing/incidentals** Staff to carry out landowner liaison, iwi engagement, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include transport, office overheads, consumables and miscellaneous professional fees. This is estimated to be 20% of the direct project costs.	
Time lag for benefits to be realised	If works were implemented at an even pace over a 5-year period, it is estimated that the majority of the project benefits would be seen by the time the project is completed.	L = 4.5
Effectiveness of works	When compared with desired state, whitebait spawning habitat in the lower river is currently in poor condition. It is expected that it will deteriorate further over the next 20 years if this project is not undertaken, particularly due to spread of exotic plants that are not suitable for spawning. The whitebait spawning projects identified in the Restoration Strategy represent about 70% (350ha) of all remaining locations in the lower river that retain conditions suitable for spawning. This project makes up only a very small percentage of this area and therefore the overall condition of the feature is still expected to decline even if this project is completed. It will, however, make an important contribution to the retention of this important habitat.	W = 0.003
Risk of technical failure	There is a very high risk of project failure due to technical feasibility. Risks are mostly related to weed control. There is a particularly high risk of project failure due to technical feasibility if weed control isn't well planned and a focus given to key high priority weeds that can be managed to very low levels.	F = 0.4
Adoptability	It is estimated that almost half of landowners would adopt the works if they were fully incentivised. Some may be concerned by loss of marginal grazing areas, however, generally the benefits of avoiding loss of stock in wetlands are becoming well recognised.	A = 0.8
Information quality	Good – judgement of expert, based on detailed knowledge of the species and of the Lower Waikato whitebait spawning habitat. Work requirements estimated mostly through examination of aerial photographs.	

<table>
<tr><td>Knowledge gaps</td><td>Costings for this site is largely based off aerial photography with some local knowledge. Further work is required to determine the specific amounts of planting and weed control required.</td><td></td></tr>
<tr><td>Socio-political risks</td><td>Very low risk that the project will fail to meet its goals over the long term due to socio-political risks.</td><td>P = 0.97</td></tr>
<tr><td>Project duration (years)</td><td>5 years</td><td></td></tr>
<tr><td>Up-front cost – total for implementation phase/project duration</td><td><table>
<tr><th>Task</th><th>Cost ($)</th></tr>
<tr><td>Fencing (640 m)</td><td>5120</td></tr>
<tr><td>Weed control for 4 years</td><td>22,440</td></tr>
<tr><td>Native planting (50% of site at 0.75m spacing)</td><td>120,490</td></tr>
<tr><td>Restoration plan</td><td>8000</td></tr>
<tr><td>Project management/staffing/incidentals (15%)</td><td>23,407</td></tr>
<tr><td>Total</td><td>179,458</td></tr>
</table></td><td>C = 0.18</td></tr>
</table>



Inanga spawning habitat rehabilitation – Hills Drain

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017

Status: Final
Request No.: N/A
File name:WWRRS.gws

0.0 0.4 0.8 1.2 1.6 2.0
Kilometers

Scale 1:40,000@A4 Landscape

A4

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Area where fencing is required to exclude stock from īnanga spawning area. (Source: NIWA)

An area where glyceria control and planting is required. (Source: NIWA)

CLW 3 Priority: high	Īnanga spawning habitat rehabilitation – Tūākau Bridge-Port Waikato Road: Site 3	BCR value
Relevant unit goal(s)	Aquatic habitats, including spawning grounds, are protected, enhanced, restored and accessible to native fish. The abundance of native fish, including taonga species, in the catchment is restored and protected.	
Name of feature	Whitebait spawning habitat in the lower river	
Brief description of feature	In the Waikato region, īnanga is the main whitebait species, comprising >90% of whitebait recruiting into the river. Īnanga are the only whitebait species to utilise tidal waters in the estuary to spawn. As īnanga spawn on high spring tides, only habitat that is inundated between mean high water spring tide (MHWS) and highest astronomical tide (HAT) is likely to be utilised for spawning. Since flood protection works have been implemented in the lower Waikato River, only 7.5% of the estuary, delta and floodplain that is inundated between MHWS and HAT remains accessible to īnanga. Of the remaining intertidal habitat available to īnanga, ongoing weed infestation, grazing, pest fish proliferation and streambank erosion is reducing the suitability of many sites for spawning. In the late 1980s, 11 spawning sites were located downstream of the Elbow in the lower Waikato River. Presently, spawning only occurs at three of these sites. In addition, the loss of indigenous vegetation and expansion of exotic plant species throughout much of the lower river has resulted in all known īnanga spawning sites to now be located within exotic pasture grasses or perennial plants. The loss of intertidal floodplains and vegetation changes over the past half century is thought to be limiting īnanga spawning habitat and creating a “bottleneck” for īnanga production from the catchment. This is because if spawning habitat is limited, Waikato īnanga become a “sink” population as reduced larval production reduces the Waikato’s contribution to the next generation of whitebait. Two unnamed tributary streams feeding into the true left of the lower Waikato River were documented as īnanga spawning sites in the 1980s. Grazing and weed infestation has reduced the suitability of these sites for īnanga spawning and eggs are no longer deposited along the streambanks. Therefore, both	

<table>
<tr><td></td><td>streams have been identified as a priority for īnanga spawning habitat rehabilitation.

The lower Waikato River area is very significant to Waikato-Tainui and the river marae. The lower Waikato River and the river islands sustained the tangata whenua for centuries with īnanga (whitebait), tuna (eel), pātiki (flounder), kāeo and many more mahinga kai species. It was also an important area for trade and travel. Flour and flax mills were established and run by tangata whenua along this stretch. There are many existing and historic pā sites within the area. There are papakāinga, historic settlements and wāhi tapu within this project area. Īnanga and other taonga fisheries are a staple food for marae. Its abundance is regarded as a reflection of the mana of the iwi and marae, and their ability to sustain whānau (family) and manuwhiri (guests or visitors). Discussions will be required with marae.</td><td></td></tr>
<tr><td>Desired state to achieve Vision & Strategy</td><td>- The remaining intertidal habitat available to īnanga in the lower Waikato River has suitable vegetation to support spawning, is free from grazing stock and is utilised by īnanga for spawning.
- Iwi and communities have a strong connection to the īnanga habitat areas and are active in their protection and restoration.</td><td></td></tr>
<tr><td>Impact on Vision & Strategy</td><td>In a restored condition, whitebait spawning habitat in the lower river would have a very high impact on giving effect to the Vision & Strategy at a central and lower Waikato catchment level.</td><td>VS = 200</td></tr>
<tr><td>Key threats to the feature that this project addresses</td><td><table><tr><th>Key threat</th><th>Impact on feature</th></tr><tr><td>Stock access to the stream</td><td>Reduced water quality and destruction of spawning vegetation</td></tr><tr><td>Lack of intertidal spawning vegetation and associated fish habitat</td><td>Reduced habitat for adult fish and reduced reproduction success</td></tr><tr><td>Weed species</td><td>Compete with native plant communities and are a threat to spawning habitats</td></tr></table></td><td></td></tr>
<tr><td>Project goal/s</td><td>Within 5 years of project commencement:
- The intertidal regions of the island provide suitable spawning habitats for adult īnanga.</td><td></td></tr>
</table>

	- Weed control is carried out prior to and after native planting to maintain the habitat free of undesirable exotic plant species. - Native planting is undertaken amongst the desirable exotic vegetation to create a dense plant growth suitable for īnanga spawning.	
Priority works for funding	Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This project could be undertaken as a whole, or in multiple components. To protect the existing īnanga spawning areas within the site, works should be implemented by an organisation/group with knowledge of īnanga spawning. **Restoration plan** A restoration plan should be developed that details: - the exotic plant species to be removed and retained - the native planting layout - methods recommended for weed control - accurate costings. To ensure the resulting vegetation is suitable for adult īnanga spawning, advice on weed control and planting needs to be sought from a suitably experienced fish ecologist. The estimated cost of a restoration plan for this project is $5000 for each site ($10,000). **Fencing** The restoration sites should be fenced adjacent to the tributary streams to exclude stock and horses. Fences should be at least 5m back from waterways. Ideally fencing would be followed immediately by weed control and native planting. Fencing costs are estimated as follows: - Stream A, 620m of fencing required (a minimum of 5 wire with two of those being electric) – $4960 - Stream B, 520m of fencing required (a minimum of 5 wire with two of those being electric) – $4160 **Weed control** The lower Waikato River has a range of weed species present with varying impacts on īnanga spawning habitats (e.g. sweet reed grass, *Glyceria maxima,* is detrimental to spawning habitat) so a comprehensive weed control plan will be essential to ensure success of the project. Estimated costs for weed control are based on carrying out weed control over a period of 4 years, using a knapsack, at $2800 per hectare per year.	

	- Stream A (2.2ha) is $24,640 - Stream B (0.55ha) is $6160 **Planting** Native planting should be carried out within open areas to create a native and exotic plant dominated ecosystem over the long term. Using suitable intertidal spawning vegetation (e.g. *Carex* sp., *Juncus* sp., umbrella sedge, swamp millet), high density planting is advised with spacing determined by species. For example, *Carex* sp. should be spaced at 0.75m and *Juncus* sp. and swamp millet spaced at 0.45m. Exotic vegetation utilised by īnanga for spawning should be retained at the site (e.g. wandering willie, Yorkshire fog, Mercer grass, creeping bent and kikuyu). Planting cost estimates are $117,550 per hectare for planting at 0.75m spacing and $39,552 per hectare for planting at 1.5m spacing) and include site preparation, plant purchase, planting labour and five releasing events, and are based on the following estimates: - Stream A – planting 25% (0.6ha) of the site with grasses/rushes/sedges at 0.75m spacing and 50% (1.1ha) of the site with shrubs at 1.5m spacing ($114,037). - Stream B – planting 20% (0.11ha) of the site with grasses/rushes/sedges at 0.75m spacing (12,691). **Project management/staffing/incidentals** Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include transport, office overheads, consumables and miscellaneous professional fees. This is estimated to be 20% of the direct project costs.	
Time lag for benefits to be realised	If works were implemented at an even pace over a 5-year period, it is estimated that the majority of the project benefits would be seen by the time the project is completed.	L = 4.5
Effectiveness of works	When compared with desired state, whitebait spawning habitat in the lower river is currently in poor condition. It is expected that it will deteriorate further over the next 20 years if this project is not undertaken, particularly due to spread of exotic plants that are not suitable for spawning. The whitebait spawning projects identified in the Restoration Strategy represent about 70% (350ha) of all remaining locations in the lower river that retain conditions suitable for spawning. This	W = 0.004

	project makes up only a very small percentage of this area and therefore the overall condition of the feature is still expected to decline even if this project is completed. It will, however, make an important contribution to the retention of this important habitat.	
Risk of technical failure	There is a very high risk of project failure due to technical feasibility. Risks are mostly related to weed control. There is a particularly high risk of project failure due to technical feasibility if weed control isn't well planned and a focus given to key high priority weeds that can be managed to very low levels.	F = 0.4
Adoptability	It is estimated that 80% of landowners would adopt the works if they were fully incentivised. Some may be concerned by loss of marginal grazing areas, however, generally the benefits of avoiding loss of stock in wetlands are becoming well recognised.	A = 0.8
Information quality	Very good – judgement of expert, based on detailed knowledge of the species and of the Lower Waikato whitebait spawning habitat.	
Knowledge gaps	Costings for this site is largely based off aerial photography with some local knowledge. Further work is required to determine the specific amounts of planting and weed control required. There are also knowledge gaps around the attractiveness of such projects to landowners.	
Socio-political risks	Very low risk that the project will fail to meet its goals over the long term due to socio-political risks.	P = 0.97
Project duration (years)	5 years	

<table>
<tr>
<td>Up-front cost – total for implementation phase/project duration</td>
<td>
<table>
<tr><th>Task – Stream A site</th><th>Cost ($)</th></tr>
<tr><td>Fencing (620 m)</td><td>4960</td></tr>
<tr><td>Weed control for 4 years</td><td>24,640</td></tr>
<tr><td>Native planting (25% of site at 0.75m spacing, 50% at 1.5m spacing)</td><td>114,037</td></tr>
<tr><td>Restoration plan</td><td>5000</td></tr>
<tr><td>Project management/staffing/incidentals (20%)</td><td>29,727</td></tr>
<tr><td>Total</td><td>178,364</td></tr>
</table>
<table>
<tr><th>Task – Stream B site</th><th>Cost ($)</th></tr>
<tr><td>Fencing (520 m)</td><td>4160</td></tr>
<tr><td>Weed control for 4 years</td><td>6,160</td></tr>
<tr><td>Native planting (20% of site at 0.75m spacing)</td><td>12,691</td></tr>
<tr><td>Restoration plan</td><td>5000</td></tr>
<tr><td>Project management/staffing/incidentals (20%)</td><td>5602</td></tr>
<tr><td>Total</td><td>33,613</td></tr>
<tr><td>Grand total</td><td>211,977</td></tr>
</table>
</td>
<td>C = 0.21</td>
</tr>
</table>

Inanga spawning habitat rehabilitation - Tuakau Bridge-Port Waikato Road: Site 3

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017

Status: Final
Request No.: N/A
File name:WWRRS.gws

0.0 0.2 0.4 0.6 0.8 1.0
Kilometers

Scale 1:20,000@A4 Landscape

A4

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Example of glyceria growing along stream margins (Note: glyceria is unsuitable īnanga spawning habitat). Source: NIWA

CLW 4 Priority: high	Īnanga spawning habitat rehabilitation – Tūākau Bridge-Port Waikato Road: Site 2	BCR value
Relevant unit goal(s)	Aquatic habitats, including spawning grounds, are protected, enhanced, restored and accessible to native fish. The abundance of native fish, including taonga species, in the catchment is restored and protected.	
Name of feature	Whitebait spawning habitat in the lower river	
Brief description of feature	In the Waikato region, īnanga is the main whitebait species, comprising >90% of whitebait recruiting into the river. Īnanga are the only whitebait species to utilise tidal waters in the estuary to spawn. As īnanga spawn on high spring tides, only habitat that is inundated between mean high water spring tide (MHWS) and highest astronomical tide (HAT) is likely to be utilised for spawning. Since flood protection works have been implemented in the lower Waikato River, only 7.5% of the estuary, delta and floodplain that is inundated between MHWS and HAT remains accessible to īnanga. Of the remaining intertidal habitat available to īnanga, ongoing weed infestation, grazing, pest fish proliferation and streambank erosion is reducing the suitability of many sites for spawning. In the late 1980s, 11 spawning sites were located downstream of the Elbow in the lower Waikato River. Presently, spawning only occurs at three of these sites. In addition, the loss of indigenous vegetation and expansion of exotic plant species throughout much of the lower river has resulted in all known īnanga spawning sites to now be located within exotic pasture grasses or perennial plants. The loss of intertidal floodplains and vegetation changes over the past half century is thought to be limiting īnanga spawning habitat and creating a “bottleneck” for īnanga production from the catchment. This is because if spawning habitat is limited, Waikato īnanga become a “sink” population as reduced larval production reduces the Waikato’s contribution to the next generation of whitebait. A 750m long section of an unnamed tributary stream and associated wetland along the true left margin of the lower Waikato River has been identified as a priority for īnanga spawning habitat rehabilitation (8.4ha in total). In the 1980s, this location was known to contain a major īnanga spawning site. Weed infestation has reduced the suitability of this	

<table>
<tr><td></td><td>location for īnanga spawning and no spawning has been observed within this site in recent years.

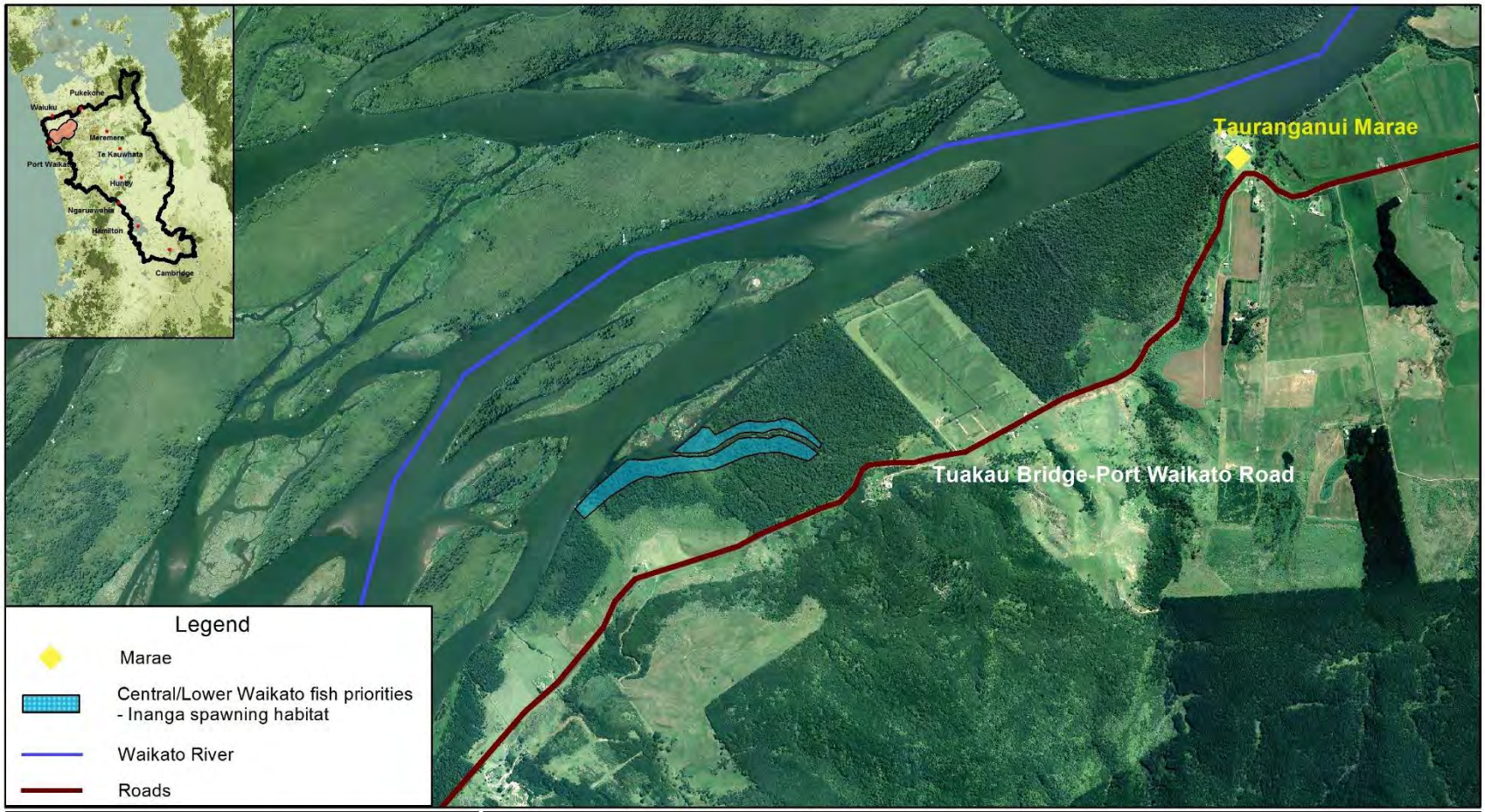
The lower Waikato River area is very significant to Waikato-Tainui and the river marae. The lower Waikato River and the river islands sustained the tangata whenua for centuries with īnanga (whitebait), tuna (eel), pātiki (flounder), kāeo and many more mahinga kai species. It was also an important area for trade and travel. Flour and flax mills were established and run by tangata whenua along this stretch. There are many existing and historic pā sites within the area. There are papakāinga, historic settlements and wāhi tapu within this project area. Īnanga and other taonga fisheries are a staple food for marae. Its abundance is regarded as a reflection of the mana of the iwi and marae, and their ability to sustain whānau (family) and manuwhiri (guests or visitors).</td><td></td></tr>
<tr><td>Desired state to achieve Vision & Strategy</td><td>The remaining intertidal habitat available to īnanga in the lower Waikato River has suitable vegetation to support spawning, is free from grazing stock and is utilised by īnanga for spawning.

Iwi and communities have a strong connection to the īnanga habitat areas and are active in their protection and restoration.</td><td></td></tr>
<tr><td>Impact on Vision & Strategy</td><td>In a restored condition, whitebait spawning habitat in the lower river would have a very high impact on giving effect to the Vision & Strategy at a central and lower Waikato catchment level.</td><td>VS = 200</td></tr>
<tr><td>Key threats to the feature that this project addresses</td><td><table><tr><th>Key threat</th><th>Impact on feature</th></tr><tr><td>Stock access to the stream</td><td>Reduced water quality and destruction of spawning vegetation</td></tr><tr><td>Lack of intertidal spawning vegetation and associated fish habitat</td><td>Reduced habitat for adult fish and reduced reproduction success</td></tr><tr><td>Weed species</td><td>Compete with native plant communities and are a threat to spawning habitats</td></tr></table></td><td></td></tr>
<tr><td>Project goal/s</td><td>Within 5 years of project commencement:
- The intertidal regions of the island provide suitable spawning habitats for adult īnanga.</td><td></td></tr>
</table>

	- Weed control is carried out prior to and after native planting to maintain the habitat free of undesirable exotic plant species. - Native planting is undertaken amongst the desirable exotic vegetation to create a dense plant growth that provides suitable spawning habitats for adult īnanga.	
Priority works for funding	Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This project could be undertaken as a whole, or in multiple components. To protect the existing īnanga spawning areas within the site, works should be implemented by an organisation/group with knowledge of īnanga spawning. **Restoration plan** A restoration plan will be developed that details: - the exotic plant species to be removed and retained - the native planting layout - method recommended for weed control - accurate costings. To ensure the resulting vegetation is suitable for adult īnanga spawning, advice on weed control and planting needs to be sought from a suitably experienced fish ecologist. The estimate cost for a restoration plan is $10,000. **Fencing** The restoration site should be fenced adjacent to the tributary stream and wetland to exclude stock. Fences should be at least 5m back from waterways and be a minimum of 5 wire (2 electric). Ideally, fencing would be followed immediately by weed control and native planting. The estimated length of fencing required is 670m ($5360). **Weed control** The lower Waikato River has a range of weed species present with varying impacts on īnanga spawning habitats (e.g. sweet reed grass, *Glyceria maxima,* is detrimental to spawning habitat) so a comprehensive weed control plan over the 8.4ha site will be essential to ensure success of the project. Estimated costs for weed control are based on carrying out weed control over a period of 4 years, using a knapsack, at $2800 per ($94,080). **Planting** Native planting should be carried out within open areas to create a native and exotic plant dominated ecosystem over	

	the long term. Using suitable intertidal spawning vegetation (e.g. *Carex* sp., *Juncus* sp., umbrella sedge, swamp millet), high density planting is advised with spacing determined by species. For example, *Carex* sp. should be spaced at 0.75m and *Juncus* sp. and swamp millet spaced at 0.45m. Exotic vegetation utilised by īnanga for spawning should be retained at the site (e.g. wandering willie, Yorkshire fog, Mercer grass, creeping bent and kikuyu). Planting cost estimates are $117,550 per hectare and include site preparation, plant purchase, planting labour and five releasing events. Planting cost estimates assume native planting 60% of the site at an average spacing of 0.75m ($592,452). **Project management/staffing/incidentals** Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include transport, office overheads, consumables and miscellaneous professional fees. This is estimated to be 20% of the direct project costs.	
Time lag for benefits to be realised	If works were implemented at an even pace over a 5-year period, it is estimated that the majority of the project benefits would be seen by the time the project is completed.	L = 4.5
Effectiveness of works	When compared with desired state, whitebait spawning habitat in the lower river is currently in poor condition. It is expected that it will deteriorate further over the next 20 years if this project is not undertaken, particularly due to spread of exotic plants that are not suitable for spawning. The whitebait spawning projects identified in the Restoration Strategy represent about 70% (350ha) of all remaining locations in the lower river that retain conditions suitable for spawning. This project makes up only a small percentage of this area and therefore the overall condition of the feature is still expected to decline even if this project is completed. It will, however, make an important contribution to the retention of this important habitat.	W = 0.013
Risk of technical failure	There is a very high risk of project failure due to technical feasibility. Risks are mostly related to weed control. There is a particularly high risk of project failure due to technical feasibility if weed control isn't well planned and a focus given	F = 0.4

<table>
<tr><td></td><td>to key high priority weeds that can be managed to very low levels.</td><td></td></tr>
<tr><td>Adoptability</td><td>It is estimated that about 80% of landowners would adopt the works if they were fully incentivised. Some may be concerned by loss of marginal grazing areas, however, generally the benefits of avoiding loss of stock in wetlands are becoming well recognised.</td><td>A = 0.8</td></tr>
<tr><td>Information quality</td><td>Very good – judgement of expert, based on detailed knowledge of the species and of the Lower Waikato whitebait spawning habitat.</td><td></td></tr>
<tr><td>Knowledge gaps</td><td>Costings for this site is largely based off aerial photography with some local knowledge. Further work is required to determine the specific amounts of planting and weed control required. There are also knowledge gaps around the attractiveness of such projects to landowners.</td><td></td></tr>
<tr><td>Socio-political risks</td><td>Very low risk that the project will fail to meet its goals over the long term due to socio-political risks.</td><td>P = 0.97</td></tr>
<tr><td>Project duration (years)</td><td>5 years</td><td></td></tr>
<tr><td>Up-front cost – total for implementation phase/project duration</td><td><table><tr><th>Task</th><th>Cost ($)</th></tr><tr><td>Fencing (670 m)</td><td>5360</td></tr><tr><td>Weed control for 4 years</td><td>94,080</td></tr><tr><td>Native planting (60% of site at 0.75m spacing)</td><td>592,452</td></tr><tr><td>Restoration Plan</td><td>10,000</td></tr><tr><td>Project Management/staffing/incidentals (20%)</td><td>140,378</td></tr><tr><td>Total</td><td>842,270</td></tr></table></td><td>C = 0.84</td></tr>
</table>



Inanga spawning habitat rehabilitation - Tuakau Bridge-Port Waikato Road: Site 2

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017

Status: Final
Request No.: N/A
File name:WWRRS.gws

0.0 0.2 0.4 0.6 0.8 1.0
Kilometers

Scale 1:20,000@A4 Landscape

A4

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CLW 5 Priority: medium	Īnanga spawning habitat rehabilitation – Tūākau Bridge-Port Waikato Road: Site 1	BCR value
Relevant unit goal(s)	Aquatic habitats, including spawning grounds, are protected, enhanced, restored and accessible to native fish. The abundance of native fish, including taonga species, in the catchment is restored and protected.	
Name of feature	Whitebait spawning habitat in the lower river	
Brief description of feature	In the Waikato region, īnanga is the main whitebait species, comprising >90% of whitebait recruiting into the river. Īnanga are the only whitebait species to utilise tidal waters in the estuary to spawn. As īnanga spawn on high spring tides, only habitat that is inundated between mean high water spring tide (MHWS) and highest astronomical tide (HAT) is likely to be utilised for spawning. Since flood protection works have been implemented in the lower Waikato River, only 7.5% of the estuary, delta and floodplain that is inundated between MHWS and HAT remains accessible to īnanga. Of the remaining intertidal habitat available to īnanga, ongoing weed infestation, grazing, pest fish proliferation and streambank erosion is reducing the suitability of many sites for spawning. In the late 1980s, 11 spawning sites were located downstream of the Elbow in the lower Waikato River. Presently, spawning only occurs at three of these sites. In addition, the loss of indigenous vegetation and expansion of exotic plant species throughout much of the lower river has resulted in all known īnanga spawning sites to now be located within exotic pasture grasses or perennial plants. The loss of intertidal floodplains and vegetation changes over the past half century is thought to be limiting īnanga spawning habitat and creating a “bottleneck” for īnanga production from the catchment. This is because if spawning habitat is limited, Waikato īnanga become a “sink” population as reduced larval production reduces the Waikato’s contribution to the next generation of whitebait. A 2.1ha section of streambank consisting of one unnamed tributary stream along the true left margin of the Waikato River near Port Waikato has been identified as a priority for īnanga spawning habitat rehabilitation. The tributary stream has a tide gate in the lower reaches and the site contains stopbanks limiting tidal penetration. The unregulated 2.1ha area of land	

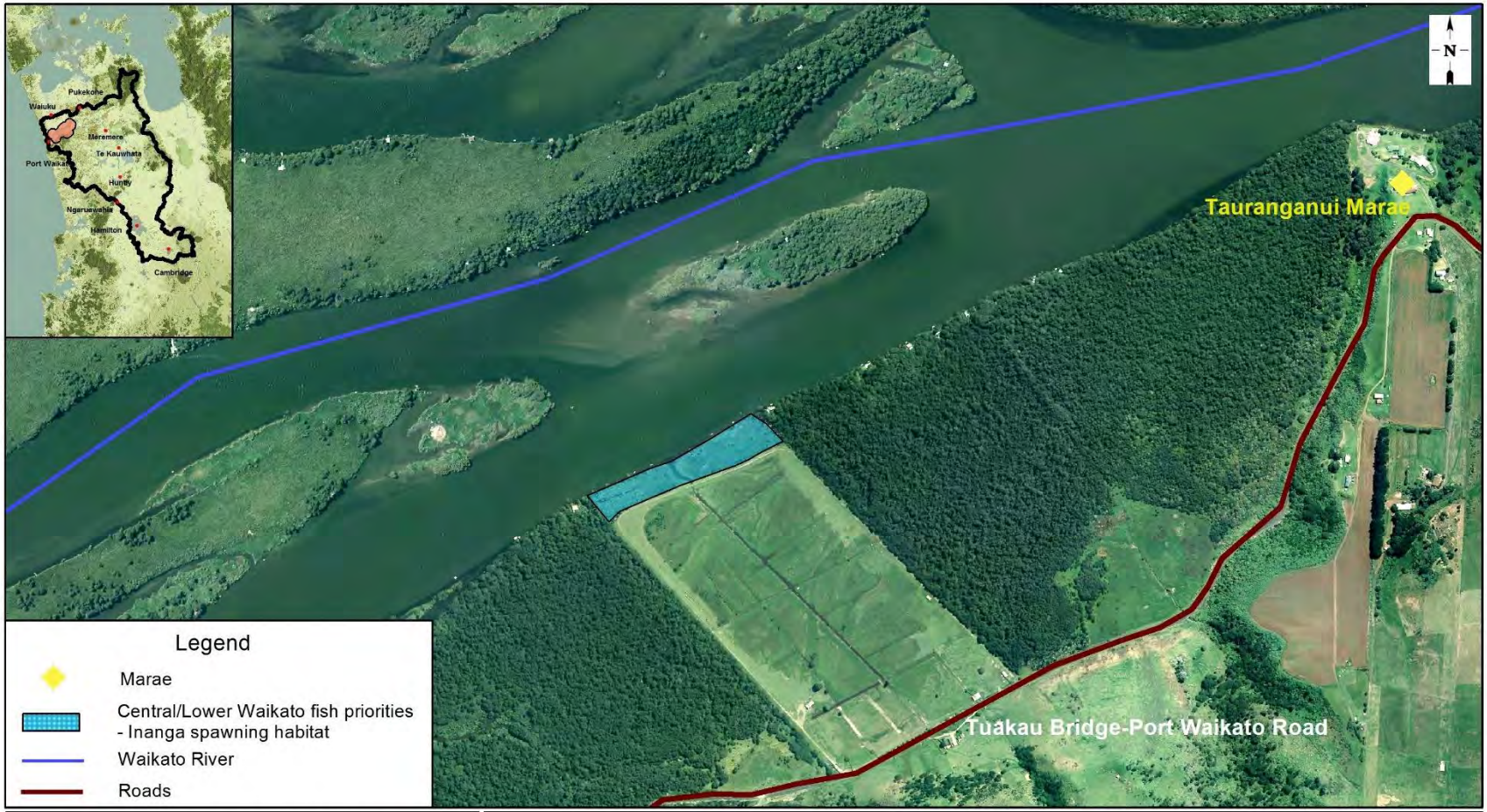
<table>
<tr><td></td><td>adjacent to the river margin is not fenced and lacks continuous suitable spawning vegetation. Weed infestation has reduced the suitability of this site for īnanga spawning since the 1980s.

The lower Waikato River area is very significant to Waikato-Tainui and the river marae. The lower Waikato River and the river islands sustained the tangata whenua for centuries with īnanga (whitebait), tuna (eel), pātiki (flounder), kāeo and many more mahinga kai species. It was also an important area for trade and travel. Flour and flax mills were established and run by tangata whenua along this stretch. There are many existing and historic pā sites within the area. There are papakāinga, historic settlements and wāhi tapu within this project area. Īnanga and other taonga fisheries are a staple food for marae. Its abundance is regarded as a reflection of the mana of the iwi and marae, and their ability to sustain whānau (family) and manuwhiri (guests or visitors).</td><td></td></tr>
<tr><td>Desired state to achieve Vision & Strategy</td><td>- The remaining intertidal habitat available to īnanga in the lower Waikato River has suitable vegetation to support spawning, is free from grazing stock and is utilised by īnanga for spawning.
- Iwi and communities have a strong connection to the īnanga habitat areas and are active in their protection and restoration.</td><td></td></tr>
<tr><td>Impact on Vision & Strategy</td><td>In a restored condition, whitebait spawning habitat in the lower river would have a very high impact on giving effect to the Vision & Strategy at a Central and lower Waikato catchment level.</td><td>VS = 200</td></tr>
<tr><td>Key threats to the feature that this project addresses</td><td><table><tr><th>Key threat</th><th>Impact on feature</th></tr><tr><td>Stock access to the stream</td><td>Reduced water quality and destruction of spawning vegetation</td></tr><tr><td>Lack of intertidal spawning vegetation and associated fish habitat</td><td>Reduced habitat for adult fish and reduced reproduction success</td></tr><tr><td>Weed species</td><td>Compete with native plant communities and are a threat to spawning habitats</td></tr></table></td><td></td></tr>
<tr><td>Project goal/s</td><td>Within 5 years of project commencement:
- The intertidal regions of the island provide suitable spawning habitats for adult īnanga.</td><td></td></tr>
</table>

	- Weed control is carried out prior to and after native planting to maintain the habitat free of undesirable exotic plant species. - Native planting is undertaken amongst the desirable exotic vegetation to create a dense plant growth that provides suitable spawning habitats for adult īnanga.	
Priority works for funding	Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This project could be undertaken as a whole, or in multiple components. To protect the existing īnanga spawning areas within the site, works should be implemented by an organisation/group with knowledge of īnanga spawning. **Restoration plan** A restoration plan will be developed that details: - the exotic plant species to be removed and retained - the native planting layout - methods recommended for weed control - accurate costings. To ensure the resulting vegetation is suitable for adult īnanga spawning, advice on weed control and planting needs to be sought from a suitably experienced fish ecologist. **Fencing** The spawning area should be fenced adjacent to the stopbanks to exclude stock. Fences should be at least 5m back from waterways and fences should be a minimum 5 wire (2 electric) or a lesser standard if the area is flood prone (2 wire electric). Ideally this would be followed immediately by weed control and native planting. The estimated length of fencing required is 350m ($2800). **Weed control** The lower Waikato River has a range of weed species present with varying impacts on īnanga spawning habitats (e.g. sweet reed grass, *Glyceria maxima,* is detrimental to spawning habitat) so a comprehensive weed control plan will be essential to ensure success of the project. Estimated costs for weed control are based on carrying out weed control over the 2.1ha site for a period of 4 years, using a knapsack sprayer, at $2800 per hectare ($23,520 for 4 years). **Planting** Native planting should be carried out within open areas to	

	create a native and exotic plant dominated ecosystem over the long term. Using suitable intertidal spawning vegetation (e.g. *Carex* sp., *Juncus* sp., umbrella sedge, swamp millet), high density planting is advised with spacing determined by species. For example, *Carex* sp. should be spaced at 0.75m and *Juncus* sp. and swamp millet spaced at 0.45m. Exotic vegetation utilised by īnanga for spawning should be retained at the site (e.g. wandering willie, Yorkshire fog, Mercer grass, creeping bent and kikuyu). Planting cost estimates assume native planting over 50% (1.05ha) of the site at an average spacing of 0.75m ($123,427). This cost estimate assumes planting to cost $117,550 per hectare (at 0.75m spacing) and includes site preparation, plant purchase, planting labour and five releasing events. **Project management/staffing/incidentals** Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include transport, office overheads, consumables and miscellaneous professional fees. This is estimated to be 20% of the direct project costs.	
Time lag for benefits to be realised	If works were implemented at an even pace over a 5-year period, it is estimated that the majority of the project benefits would be seen by the time the project is completed.	L = 4.5
Effectiveness of works	When compared with desired state, whitebait spawning habitat in the lower river is currently in poor condition. It is expected that it will deteriorate further over the next 20 years if this project is not undertaken, particularly due to spread of exotic plants that are not suitable for spawning. The whitebait spawning projects identified in the Restoration Strategy represent about 70% (350ha) of all remaining locations in the lower river that retain conditions suitable for spawning. This project makes up only a very small percentage of this area and therefore the overall condition of the feature is still expected to decline even if this project is completed. It will, however, make an important contribution to the retention of this habitat.	W = 0.003
Risk of technical failure	There is a very high risk of project failure due to technical feasibility. Risks are mostly related to weed control. There is a particularly high risk of project failure due to technical	F = 0.4

<table>
<tr><td></td><td>feasibility if weed control isn't well planned and a focus given to key high priority weeds that can be managed to very low levels.</td><td></td></tr>
<tr><td>Adoptability</td><td>It is estimated that about half of landowners would adopt the works if they were fully incentivised. Some may be concerned by loss of marginal grazing areas, however, generally the benefits of avoiding loss of stock in wetlands are becoming well recognised.</td><td>A = 0.5</td></tr>
<tr><td>Information quality</td><td>Very good – judgement of expert, based on detailed knowledge of the species and of the lower Waikato whitebait spawning habitat.</td><td></td></tr>
<tr><td>Knowledge gaps</td><td>Costings for this site is largely based off aerial photography with some local knowledge. Further work is required to determine the specific amounts of planting and weed control required. There are also knowledge gaps around the attractiveness of such projects to landowners.</td><td></td></tr>
<tr><td>Socio-political risks</td><td>Very low risk that the project will fail to meet its goals over the long term due to socio-political risks.</td><td>P = 0.97</td></tr>
<tr><td>Project duration (years)</td><td>5 years</td><td></td></tr>
<tr><td>Up-front cost – total for implementation phase/project duration</td><td><table>
<tr><th>Task</th><th>Cost ($)</th></tr>
<tr><td>Fencing (350 m)</td><td>2800</td></tr>
<tr><td>Weed control for 4 years</td><td>23,520</td></tr>
<tr><td>Native planting (50% of site at 0.75m spacing)</td><td>123,427</td></tr>
<tr><td>Restoration plan</td><td>7000</td></tr>
<tr><td>Project management/staffing/incidentals (20%)</td><td>31,349</td></tr>
<tr><td>Total</td><td>188,096</td></tr>
</table></td><td>C = 0.19</td></tr>
</table>



Inanga spawning habitat rehabilitation - Tuakau Bridge-Port Waikato Road: Site 1

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017

Status: Final
Request No.: N/A
File name:WWRRS.gws

0.0 0.1 0.2 0.3 0.4 0.5
Kilometers

Scale 1:10,000@A4 Landscape

A4

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Photos showing an area where fencing is required to exclude stock. (Source: NIWA)

Example showing an area where control of glyceria and planting is required. (Source: NIWA)

CLW 6 Priority: high	Īnanga spawning habitat rehabilitation – island adjacent to Mawhitiwhiti Road	BCR value
Relevant unit goal(s)	Aquatic habitats, including spawning grounds, are protected, enhanced, restored and accessible to native fish. The abundance of native fish, including taonga species, in the catchment is restored and protected.	
Name of feature	Whitebait spawning habitat in the lower river	
Brief description of feature	In the Waikato region, īnanga is the main whitebait species, comprising >90% of whitebait recruiting into the river. Īnanga are the only whitebait species to utilise tidal waters in the estuary to spawn. As īnanga spawn on high spring tides, only habitat that is inundated between mean high water spring tide (MHWS) and highest astronomical tide (HAT) is likely to be utilised for spawning. Since flood protection works have been implemented in the lower Waikato River, only 7.5% of the estuary, delta and floodplain that is inundated between MHWS and HAT remains accessible to īnanga. Of the remaining intertidal habitat available to īnanga, ongoing weed infestation, grazing, pest fish proliferation and streambank erosion is reducing the suitability of many sites for spawning. In the late 1980s, 11 spawning sites were located downstream of the Elbow in the lower Waikato River. Presently, spawning only occurs at three of these sites. In addition, the loss of indigenous vegetation and expansion of exotic plant species throughout much of the lower river has resulted in all known īnanga spawning sites to now be located within exotic pasture grasses or perennial plants. The loss of intertidal floodplains and vegetation changes over the past half century is thought to be limiting īnanga spawning habitat and creating a “bottleneck” for īnanga production from the catchment. This is because if spawning habitat is limited, Waikato īnanga become a “sink” population as reduced larval production reduces the Waikato’s contribution to the next generation of whitebait. A 188ha island adjacent to Mawhitiwhiti Road along the true right margin of the Waikato River near Aka Aka has been identified as a priority for īnanga spawning habitat rehabilitation. The island contains a mixture of native and exotic vegetation	

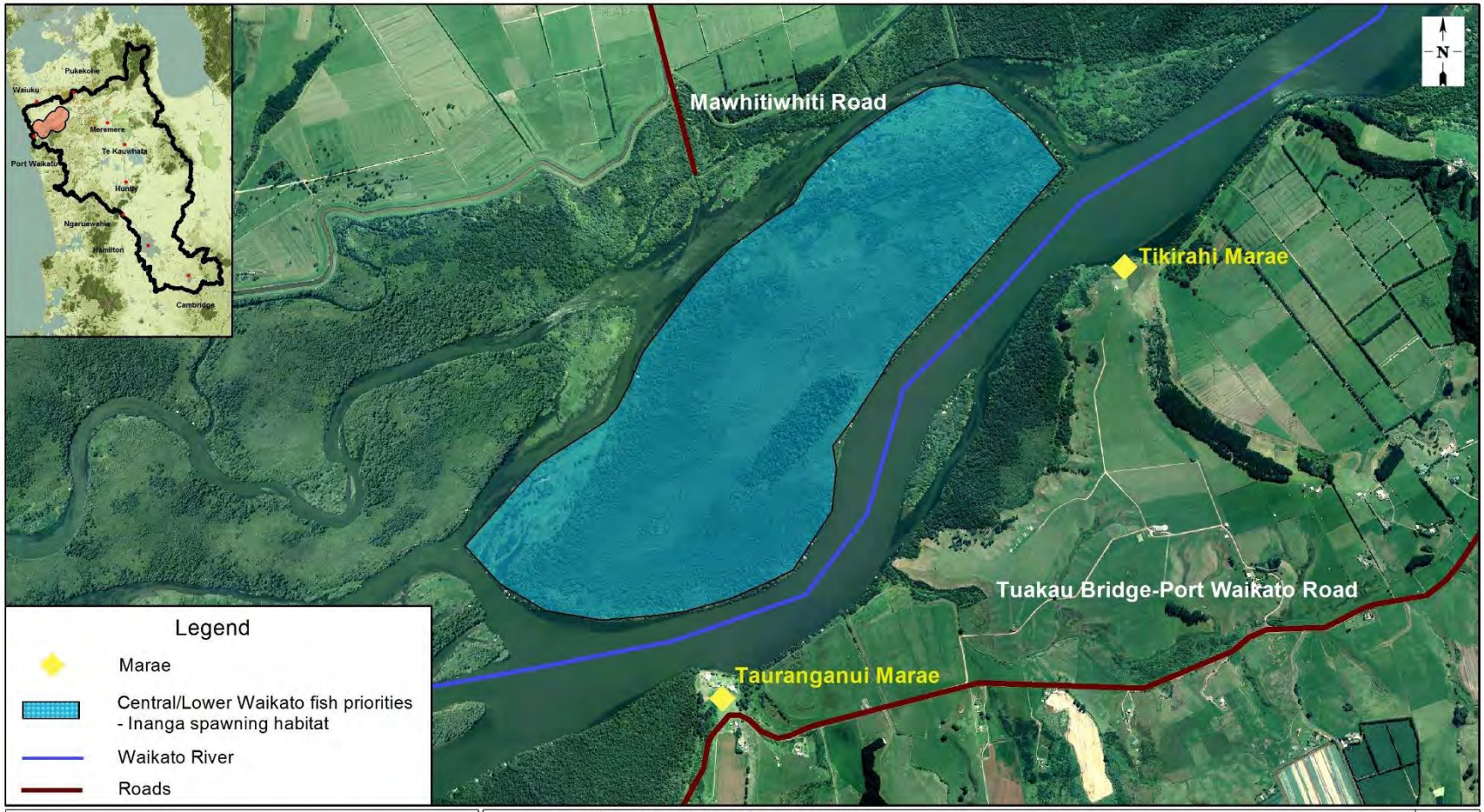
<table>
<tr><td></td><td>with īnanga known to historically use pockets of intertidal vegetation as spawning habitat. Weed infestation has reduced the suitability of much of this island for īnanga spawning.

The lower Waikato River area is very significant to Waikato-Tainui and the river marae. The lower Waikato River and the river islands sustained the tangata whenua for centuries with īnanga (whitebait), tuna (eel), pātiki (flounder), kāeo and many more mahinga kai species. It was also an important area for trade and travel. Flour and flax mills were established and run by tangata whenua along this stretch. There are many existing and historic pā sites within the area. There are papakāinga, historic settlements and wāhi tapu within this project area. Īnanga and other taonga fisheries are a staple food for marae. Its abundance is regarded as a reflection of the mana of the iwi and marae, and their ability to sustain whānau (family) and manuwhiri (guests or visitors).</td><td></td></tr>
<tr><td>Desired state to achieve Vision & Strategy</td><td>The remaining intertidal habitat available to īnanga in the lower Waikato River has suitable vegetation to support spawning, is free from grazing stock and is utilised by īnanga for spawning.</td><td></td></tr>
<tr><td>Impact on Vision & Strategy</td><td>In a restored condition, whitebait spawning habitat in the lower river would have a very high impact on giving effect to the Vision & Strategy at a central and lower Waikato catchment level.</td><td>VS = 200</td></tr>
<tr><td>Key threats to the feature not meeting V&S aspirations</td><td><table><tr><th>Key threat</th><th>Impact on feature</th></tr><tr><td>Lack of intertidal spawning vegetation and associated fish habitat</td><td>Reduced habitat for adult fish and reduced reproduction success</td></tr><tr><td>Weed species</td><td>Compete with native plant communities and are a threat to spawning habitats</td></tr><tr><td>Willow trees</td><td>Shade out native species and spread to other areas</td></tr></table></td><td></td></tr>
<tr><td>Project goal/s</td><td>Within 5-10 years, the intertidal regions across at least half (94ha) of the island provides suitable spawning habitats for adult īnanga. Weed control is carried out prior to and after native planting to maintain the habitat free of undesirable exotic plant species. Native planting is undertaken amongst the desirable exotic vegetation to create a dense plant growth suitable for īnanga spawning.</td><td></td></tr>
<tr><td>Priority works for funding</td><td>Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This project could be undertaken as a whole, or in multiple components.</td><td></td></tr>
</table>

	Restoration plan A restoration plan will be developed that details: - the exotic species to be removed and retained across the 94ha area - the native planting layout. To ensure the resulting vegetation is suitable for adult īnanga spawning, advice on weed control and planting needs to be sought from a suitably experienced fish ecologist. The estimated cost of a restoration plan for this site is $25,100. **Weed control** The lower Waikato River has a range of weed species present with varying impacts on īnanga spawning habitats (e.g. sweet reed grass, *Glyceria maxima,* is detrimental to spawning habitat) so a comprehensive weed control plan will be essential to ensure success of the project. Estimated costs are based on carrying out weed control over a period of 4 years ($1,052,800). This assumes a cost of $2800 per hectare per year, using a knapsack sprayer and appropriate herbicide. **Planting** Native planting should be carried out within open areas to create a native and exotic plant dominated ecosystem over the long term. Using suitable intertidal spawning vegetation (e.g. *Carex* sp., *Juncus* sp., umbrella sedge, swamp millet), high density planting is advised with spacing determined by species. For example, *Carex* sp. should be spaced at 0.75m and *Juncus* sp. and swamp millet spaced at 0.45m. Exotic vegetation utilised by īnanga for spawning should be retained at the site (e.g. wandering willie, Yorkshire fog, Mercer grass, creeping bent and kikuyu). Planting cost estimates assume native planting over 60% of the 94ha area at an average spacing of 0.75m ($6,629,820). The cost estimate includes site preparation, plant purchase, transport to site, planting labour and five releasing events. **Project management/staffing/incidentals** Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include	

	transport, office overheads, consumables and miscellaneous professional fees. This is estimated to be 15% of the direct project costs.	
Time lag for benefits to be realised	If works were implemented at an even pace over a 10-year period, it is estimated that the majority of the project benefits would be seen in the year before project completion.	L = 9.5
Effectiveness of works	When compared with desired state, whitebait spawning habitat in the lower river is currently in poor condition. It is expected that it will deteriorate further over the next 20 years if this project is not undertaken, particularly due to spread of exotic plants that are not suitable for spawning. The whitebait spawning projects identified in the Restoration Strategy represent about 70% (350ha) of all remaining locations in the lower river that retain conditions suitable for spawning. Mawhitiwhiti Island makes up about half of this area. Therefore if this project is successfully completed, then it is expected that whitebait habitat in the lower river will move significantly closer to the desired state to meet the Vision & Strategy.	W = 0.3
Risk of technical failure	There is a very high risk of project failure due to technical feasibility. Risks are mostly related to weed control. There is a particularly high risk of project failure due to technical feasibility if weed control isn't well planned and a focus given to key high priority weeds that can be managed to very low levels.	F = 0.4
Adoptability	It is estimated that almost half of landowners would adopt the works if they were fully incentivised. Some may be concerned by loss of marginal grazing areas, however, generally the benefits of avoiding loss of stock in wetlands are becoming well recognised.	A = 0.5
Information quality	Very good – judgement of expert, based on detailed knowledge of the species and of the Lower Waikato whitebait spawning habitat.	
Knowledge gaps	Costings for this site is largely based off aerial photography with some local knowledge. Further work is required to determine the specific amounts of planting and weed control required. There are also knowledge gaps around the attractiveness of such projects to landowners.	
Socio-political risks	Very low risk that the project will fail to meet its goals over the long term due to socio-political risks.	P = 0.97
Project duration (years)	10 years	

<table>
<tr>
<td>Up-front cost – total for implementation phase/project duration</td>
<td>
<table>
<tr><th>Task</th><th>Cost ($)</th></tr>
<tr><td>Weed control for 4 years</td><td>1,052,800</td></tr>
<tr><td>Native planting (60% of site at 0.75m spacing)</td><td>6,629,820</td></tr>
<tr><td>Restoration plan</td><td>25,100</td></tr>
<tr><td>Project management/staffing/incidentals (15%)</td><td>1,156,158</td></tr>
<tr><td>Total</td><td>8,863,878</td></tr>
</table>
</td>
<td>C = 8.8</td>
</tr>
</table>



Inanga spawning habitat rehabilitation - Island adjacent to Mawhitiwhiti Road

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017

Status: Final
Request No.: N/A
File name:WWRRS.gws

0.0 0.2 0.4 0.6 0.8 1.0
Kilometers

Scale 1:20,000@A4 Landscape

A4

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An example of vegetation present at the site (note the dense area of glyceria).

CLW 7 Priority: very high	Fish habitat rehabilitation in Whauwhautahi Stream, Port Waikato	BCR value
Relevant unit goal(s)	Aquatic habitats, including spawning grounds, are protected, enhanced, restored and accessible to native fish. The abundance of native fish, including taonga species, in the catchment is restored and protected.	
Name of feature	Whauwhautahi Stream	
Brief description of feature	A short stream (approximately 5km long) flowing from hill country near Te Kohanga under Tūākau Bridge, Port Waikato Road, and into the Waikato River near Motutieke Island. The lower 500m of the stream has a stopbank on the western side preventing flood waters from inundating farmland in behind. This stream has been identified as important for īnanga (both for spawning and adult life stages), banded kōkopu, shortfin eel and longfin eel and as a waterway that would benefit from further habitat rehabilitation. Previous native planting work has been undertaken by Genesis Energy on the east side of the stream along a 300m stretch before it enters Waikato River. The lower Waikato River area is very significant to Waikato-Tainui and the river marae. The lower Waikato River and the river islands sustained the tangata whenua for centuries with īnanga (whitebait), tuna (eel), pātiki (flounder), kāeo and many more mahinga kai species. It was also an important area for trade and travel. Flour and flax mills were established and run by tangata whenua along this stretch. There are many existing and historic pā sites within the area. There are papakāinga, historic settlements and wāhi tapu within this project area. Īnanga and other taonga fisheries are a staple food for marae. Its abundance is regarded as a reflection of the mana of the iwi and marae, and their ability to sustain whānau (family) and manuwhiri (guests or visitors).	
Desired state to achieve Vision & Strategy	- There are no manmade barriers to native migratory fish. Native fish are abundant and there is a wide diversity of species present including non-climbing native fish. - The stream is fenced to exclude stock from its entire length. It has a riparian margin (at least 5m wide) that is vegetated with native plants to provide stream shading and cover for fish. - The stream is swimmable, fishable and safe for collecting kai. - Iwi and communities have a strong connection to the streams and are active in their protection and restoration.	

<table>
<tr><td>Impact on Vision & Strategy</td><td>In a restored condition the Whauwhautahi Stream would have a very high impact on giving effect to the Vision & Strategy at a local level.</td><td>VS = 10</td></tr>
<tr><td>Key threats to the feature that this project addresses</td><td><table><tr><th>Key threat</th><th>Impact on feature</th></tr><tr><td>Stock access to the stream</td><td>Reduced water quality and destruction of riparian vegetation</td></tr><tr><td>Lack of riparian cover and associated fish habitat</td><td>Reduced habitat for adult fish</td></tr><tr><td>Weed species</td><td>Compete with native plant communities</td></tr></table></td><td></td></tr>
<tr><td>Project goal/s</td><td>Within 5 years of project commencing:
- The full length of waterways identified are fenced to exclude stock. They have a riparian margin that is at least 5m wide which is vegetated with native plant species to provide stream shade and enhance habitat for adult native fish.
- There are no manmade barriers to native migratory fish.</td><td></td></tr>
<tr><td>Priority works for funding</td><td>Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This project could be undertaken as a whole, or in multiple components.

Riparian management
Undertake native riparian planting along the waterway and carry out associated weed control and maintenance for native plant establishment.

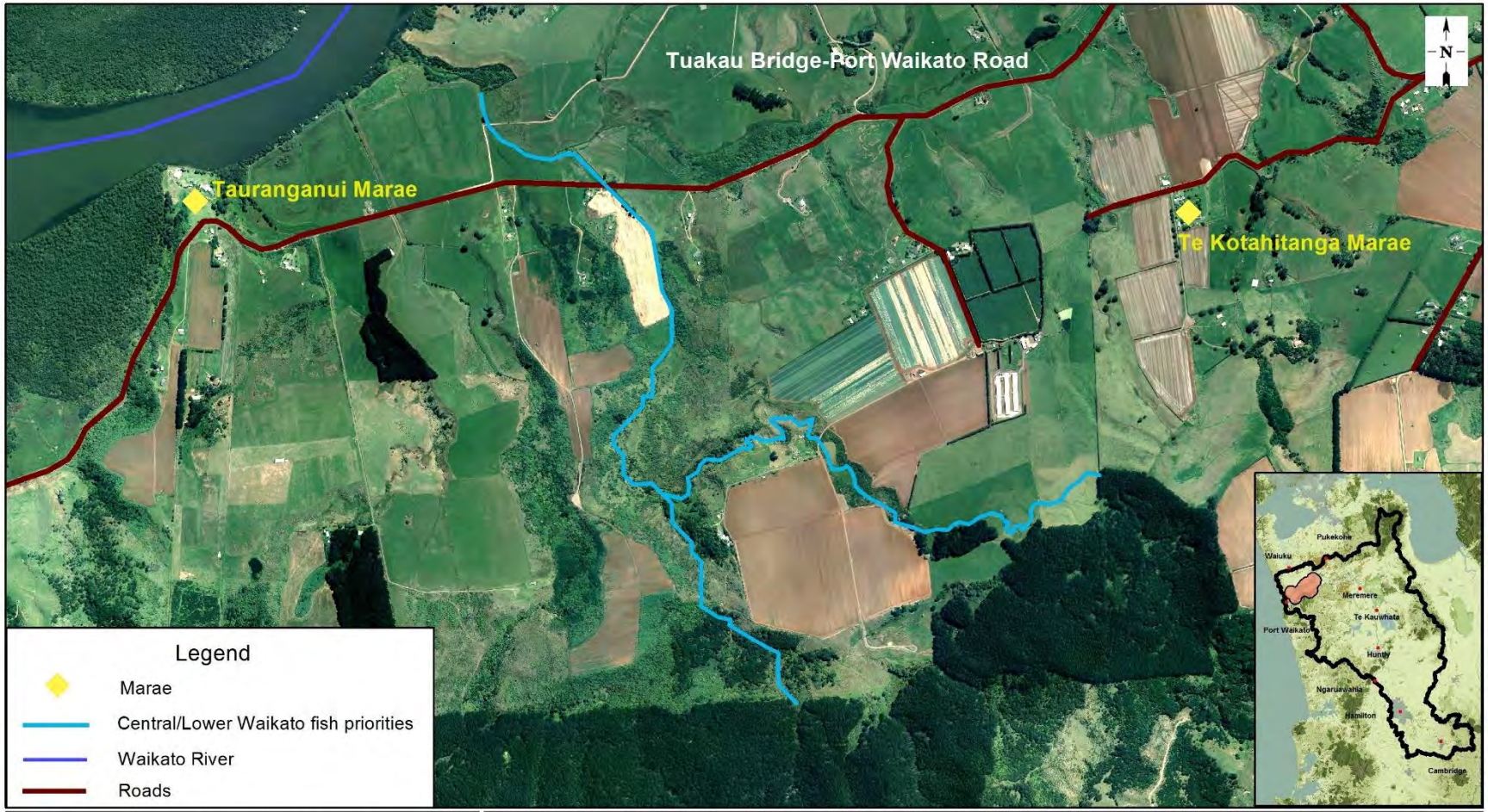
Carry out riparian fencing with a minimum 5m setback from the top of the streambank (5 wire fence – 2 electric wires). Include adjoining wetland areas within the riparian fencing.

- Fencing costs assumes 100% (10km) requires fencing or fence upgrade ($80,000).
- Planting of a 10km length of streambank with a 5m wide margin of plants is 5ha ($197,760). This cost estimate includes site preparation, plant purchase, planting labour and five releasing events.

Weed control
This part of the catchment is known to have a range of weed issues so additional weed control will be important for the success of this project. Weed control, using a knapsack, will be required within riparian areas (10ha) following native plant</td><td></td></tr>
</table>

	establishment, at an estimated cost of $2800 per hectare per year ($84,000). **Remediation of fish barriers** Determine the location and type of barriers to fish passage. It is estimated that there is one barrier/partial barrier to fish passage on this watercourse. Undertake works to remedy fish barriers if required ($5000). **Project management/staffing/incidentals** Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include transport, office overheads, consumables and miscellaneous professional fees. This is estimated to be 20% of the direct project costs.	
Time lag for benefits to be realised	If works were implemented at an even pace over an 8-year period, it is estimated that the majority of the project benefits would be seen at project completion.	L = 8
Effectiveness of works	When compared to desired state, this stream is currently in poor condition with few of the Vision & Strategy desired state aspects being met. Condition is not expected to either decline or improve significantly over the next 20 years in the absence of this project, given existing measures that are in place such as the Dairy Water Accord. However, if this project is successfully completed then the Mangauika Stream is expected to move closer to desired state with aspects related to fish habitat and passage and stock exclusion all being addressed. This project will not fully address the ongoing threats to water quality at this site and it is acknowledged that achieving the Vision & Strategy desired state will take longer than the 20 year horizon used for the purposes of the Restoration Strategy, and a fuller range of initiatives over the long term.	W = 0.15
Risk of technical failure	There is a low risk of project failure due to technical feasibility. Risks are mostly related to plant establishment and weed control.	F = 0.87
Adoptability	It is estimated that almost half of landowners would adopt the works if they were fully incentivised. The extent of the fencing setbacks may be a challenge in terms of uptake.	A = 0.8
Information quality	Average – management requirements estimated using aerial photography and judgement of a fish expert with local knowledge.	

<table>
<tr><td>Knowledge gaps</td><td>It is unknown specifically how much fencing already exists. This would need to be established as part of the project planning. Location of fish barriers would need to be determined in the early stages of the project.</td><td></td></tr>
<tr><td>Socio-political risks</td><td>Low risk that the project will fail to meet its goals over the long term due to socio-political risks.</td><td>P = 0.97</td></tr>
<tr><td>Project duration (years)</td><td>8 years</td><td></td></tr>
<tr><td>Up-front cost – total for implementation phase/project duration</td><td><table>
<tr><th>Task</th><th>Cost ($)</th></tr>
<tr><td>Fencing (10km)</td><td>80,000</td></tr>
<tr><td>Planting (10ha)</td><td>197,768</td></tr>
<tr><td>Weed control</td><td>84,000</td></tr>
<tr><td>Investigation and remediation of fish barriers</td><td>5000</td></tr>
<tr><td>Project management/staffing/incidentals (20% of project cost)</td><td>73,354</td></tr>
<tr><td>Total</td><td>440,122</td></tr>
</table></td><td>C = 0.44</td></tr>
</table>



Fish habitat rehabilitation in Whauwhautahi Stream, Port Waikato

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017

Status: Final
Request No.: N/A
File name:WWRRS.gws

0.0 0.2 0.4 0.6 0.8 1.0
Kilometers

Scale 1:16,500@A4 Landscape

A4

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Whauwhautahi Stream (and upper catchment in background) where riparian planting is recommended.

Whauwhautahi Stream where riparian planting and fence relocation is recommended. Planting may need to be low growing species such as *Carex* to allow for stopbank and stream maintenance work.

CLW 8 Priority: high	Īnanga spawning habitat rehabilitation – wetland opposite Elbow Hill	BCR value
Relevant unit goal(s)	Aquatic habitats, including spawning grounds, are protected, enhanced, restored and accessible to native fish. The abundance of native fish, including taonga species, in the catchment is restored and protected.	
Name of feature	Whitebait spawning habitat in the lower river	
Brief description of feature	In the Waikato region, īnanga is the main whitebait species, comprising >90% of whitebait recruiting into the river. Īnanga are the only whitebait species to utilise tidal waters in the estuary to spawn. As īnanga spawn on high spring tides, only habitat that is inundated between mean high water spring tide (MHWS) and highest astronomical tide (HAT) is likely to be utilised for spawning. Since flood protection works have been implemented in the lower Waikato River, only 7.5% of the estuary, delta and floodplain that is inundated between MHWS and HAT remains accessible to īnanga. Of the remaining intertidal habitat available to īnanga, ongoing weed infestation, grazing, pest fish proliferation and streambank erosion is reducing the suitability of many sites for spawning. In the late 1980s, 11 spawning sites were located downstream of the Elbow in the lower Waikato River. Presently, spawning only occurs at three of these sites. In addition, the loss of indigenous vegetation and expansion of exotic plant species throughout much of the lower river has resulted in all known īnanga spawning sites to now be located within exotic pasture grasses or perennial plants. The loss of intertidal floodplains and vegetation changes over the past half century is thought to be limiting īnanga spawning habitat and creating a “bottleneck” for īnanga production from the catchment. This is because if spawning habitat is limited, Waikato īnanga become a “sink” population as reduced larval production reduces the Waikato’s contribution to the next generation of whitebait. A 140ha wetland opposite Elbow Hill along the true left margin of the lower Waikato River has been identified as a priority for īnanga spawning habitat rehabilitation. Several farm drains and an unnamed tributary flowing through Te Kohanga feed into the Waikato River through the wetland. Īnanga spawning occurred in the lower reaches of the unnamed tributary in the 1980s but	

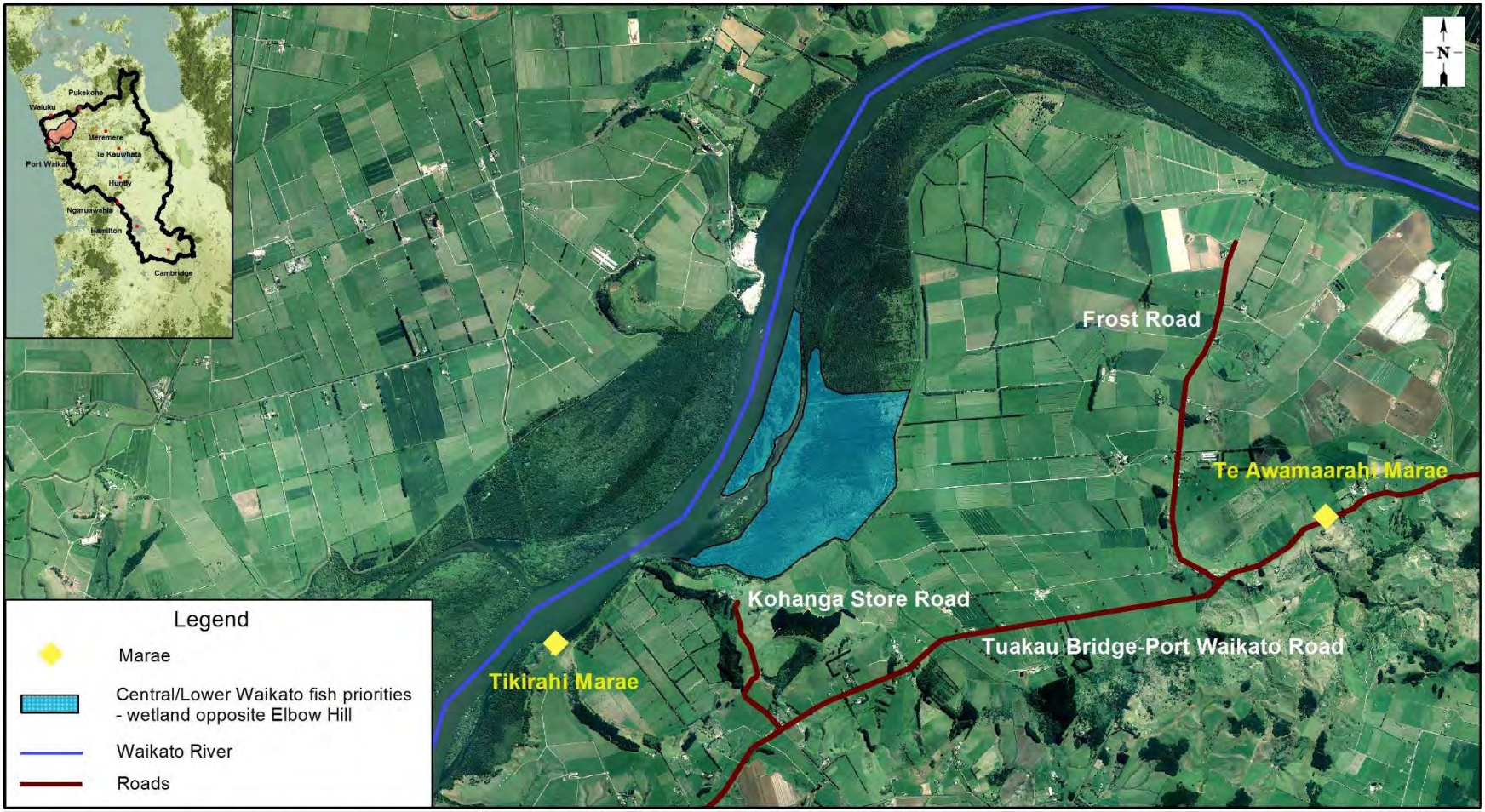
<table>
<tr><td></td><td>weed infestation has reduced the suitability of the stream and much of the wetland for īnanga spawning. Waikato-Tainui have also identified the unnamed tributary as an important site for tuna and whitebait rearing habitat restoration.

The lower Waikato River area is very significant to Waikato-Tainui and the river marae. The lower Waikato River and the river islands sustained the tangata whenua for centuries with īnanga (whitebait), tuna (eel), pātiki (flounder), kāeo and many more mahinga kai species. It was also an important area for trade and travel. Flour and flax mills were established and run by tangata whenua along this stretch. There are many existing and historic pā sites within the area. There are papakāinga, historic settlements and wāhi tapu within this project area. Īnanga and other taonga fisheries are a staple food for marae. Its abundance is regarded as a reflection of the mana of the iwi and marae, and their ability to sustain whānau (family) and manuwhiri (guests or visitors). Discussions will be required with marae, in particular Te Awamārahi and Tikirahi marae.</td><td></td></tr>
<tr><td>Desired state to achieve Vision & Strategy</td><td>- The remaining intertidal habitat available to īnanga in the lower Waikato River has suitable vegetation to support spawning, is free from grazing stock and is utilised by īnanga for spawning.
- Iwi and communities have a strong connection to the īnanga habitat areas and are active in their protection and restoration.</td><td></td></tr>
<tr><td>Impact on Vision & Strategy</td><td>In a restored condition, whitebait spawning habitat in the lower river would have a very high impact on giving effect to the Vision & Strategy at a central and lower Waikato catchment level.</td><td>VS = 200</td></tr>
<tr><td>Key threats to the feature that this project addresses</td><td><table><tr><th>Key threat</th><th>Impact on feature</th></tr><tr><td>Stock access to the stream</td><td>Reduced water quality and destruction of spawning vegetation</td></tr><tr><td>Lack of intertidal spawning vegetation and associated fish habitat</td><td>Reduced habitat for adult fish and reduced reproduction success</td></tr><tr><td>Weed species</td><td>Compete with native plant communities and are a threat to spawning habitats</td></tr></table></td><td></td></tr>
<tr><td>Project goal/s</td><td>Within 5 years of the project commencing:
- The intertidal regions of the wetland provide suitable spawning habitats for adult īnanga.</td><td></td></tr>
</table>

	- The wetland and its associated tributary streams and farm drains are fenced to exclude stock with a minimum 5 wire (2 electric) fence. - Weed control is carried out prior to and after native planting to maintain the habitat free of undesirable exotic plant species. - Native planting is undertaken amongst the desirable exotic vegetation to create a dense plant growth that provides suitable spawning habitats for adult īnanga.	
Priority works for funding	Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This project could be undertaken as a whole, or in multiple smaller components. To protect the existing īnanga spawning areas within the site, works should be implemented by an organisation/group with knowledge of īnanga spawning. **Restoration plan** A restoration plan will be developed that details: - the exotic plant species to be removed and retained - the native planting layout - methods recommended for weed control - accurate costings. To ensure the resulting vegetation is suitable for adult īnanga spawning, advice on weed control and planting needs to be sought from a suitably experienced fish ecologist. The estimated cost of a restoration plan for this site is $25,000. **Fencing** The site should be fenced along the stopbanks that form the perimeter of the wetland to exclude stock. Ideally, this would be followed immediately by weed control and native planting. The estimated length of fencing required is 4000m ($32,000). **Weed control** The lower Waikato River has a range of weed species present with varying impacts on īnanga spawning habitats (e.g. sweet reed grass, *Glyceria maxima,* is detrimental to spawning habitat) so a comprehensive weed control plan will be essential to ensure success of the project. Estimated costs for weed control are based on carrying out weed control over the 140ha site for a period of four years, using a knapsack, at $2800 per hectare ($1,568,000 over four years).	

	Planting Native planting should be carried out within open areas to create a native and exotic plant dominated ecosystem over the long term. Using suitable intertidal spawning vegetation (e.g. *Carex* sp., *Juncus* sp., umbrella sedge, swamp millet), high density planting is advised with spacing determined by species. For example, *Carex* sp. should be spaced at 0.75m and *Juncus* sp. and swamp millet spaced at 0.45m. Exotic vegetation utilised by īnanga for spawning should be retained at the site (e.g. wandering willie, Yorkshire fog, Mercer grass, creeping bent and kikuyu). Planting cost estimates assume native planting over 60% (84ha) of the site at an average spacing of 0.75m ($9,874,200). This cost estimate assumes planting to cost $117,550 per hectare (at 0.75m spacing) and includes site preparation, plant purchase, planting labour and five releasing events. **Project management/staffing/incidentals** Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include transport, office overheads, consumables and miscellaneous professional fees. This is estimated to be 20% of the direct project costs.	
Time lag for benefits to be realised	If works were implemented at an even pace over a 15-year period, it is estimated that the majority of the project benefits would be seen approximately 9-10 years after project commencement.	L = 9.5
Effectiveness of works	When compared with desired state, whitebait spawning habitat in the lower river is currently in poor condition. It is expected that it will deteriorate further over the next 20 years if this project is not undertaken, particularly due to spread of exotic plants that are not suitable for spawning. The whitebait spawning projects identified in the Restoration Strategy represent about 70% (350ha) of all remaining locations in the lower river that retain conditions suitable for spawning. This wetland makes up more than a third of this area. Therefore, if this project is successfully completed, it is expected that whitebait habitat in the lower river will move significantly closer to the desired state to meet the Vision & Strategy.	W = 0.22

<table>
<tr><td>Risk of technical failure</td><td>There is a very high risk of project failure due to technical feasibility. Risks are mostly related to weed control. There is a particularly high risk of project failure due to technical feasibility if weed control isn't well planned and a focus given to key high priority weeds that can be managed to very low levels.</td><td>F = 0.4</td></tr>
<tr><td>Adoptability</td><td>It is estimated that about 80% of landowners would adopt the works if they were fully incentivised. Some may be concerned by loss of marginal grazing areas, however, generally the benefits of avoiding loss of stock in wetlands are becoming well recognised.</td><td>A = 0.8</td></tr>
<tr><td>Information quality</td><td>Good – judgement of expert, based on detailed knowledge of the species and of the Lower Waikato whitebait spawning habitat.</td><td></td></tr>
<tr><td>Knowledge gaps</td><td>Costings for this site is largely based off aerial photography with some local knowledge. Further work is required to determine the specific amounts of planting and weed control required. There are also knowledge gaps around the attractiveness of such projects to landowners.</td><td></td></tr>
<tr><td>Socio-political risks</td><td>Very low risk that the project will fail to meet its goals over the long term due to socio-political risks.</td><td>P = 0.97</td></tr>
<tr><td>Project duration (years)</td><td>15 years</td><td></td></tr>
<tr><td>Up-front cost – total for implementation phase/project duration</td><td><table>
<tr><th>Task</th><th>Cost ($)</th></tr>
<tr><td>Fencing (4000 m)</td><td>32,000</td></tr>
<tr><td>Weed control for 4 years</td><td>1,568,000</td></tr>
<tr><td>Native planting (60% of site at 0.75m spacing)</td><td>9,874,200</td></tr>
<tr><td>Restoration plan</td><td>25,000</td></tr>
<tr><td>Project management/staffing/incidentals (20%)</td><td>2,299,840</td></tr>
<tr><td>Total</td><td>13,799,040</td></tr>
</table></td><td>C = 13.8</td></tr>
</table>



Inanga spawning habitat rehabilitation – Wetland opposite Elbow Hill

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017

Status: Final
Request No.: N/A
File name:WWRRS.gws

0.0 0.4 0.8 1.2 1.6 2.0
Kilometers

Scale 1:30,000@A4 Landscape

A4

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Island wetland identified for enhancement of spawning habitat. (Source: NIWA)

CLW 9 Priority: very high	Increased control of yellow flag iris and alligator weed within the Lower Waikato River catchment	BCR value
Relevant unit goal(s)	Wetlands are protected, enhanced and where feasible expanded and re-established. Ecosystems, forest fragments and ecological corridors associated with aquatic environments are protected, enhanced and expanded.	
Name of feature	Waikato River between Rangiriri and Port Waikato	
Brief description of feature	The Waikato River between Rangiriri and Port Waikato extends over 67km as it passes through large areas of mineralised swamp and takes in the outflows of many shallow lakes. It flows through a diverse delta habitat to the sea at Port Waikato. From Rangiriri to Port Waikato the river is generally broad and meandering, with elongated low-lying islands in its lower reaches. The Waikato River provides rich habitat for a range of fish and bird species, including rare and threatened species such as banded rail, spotless crake and Australasian bittern; and fish species such as longfin eel, shortfin eel, four whitebait species, grey mullet and common smelt. The river delta contains a number of islands, some of which are vegetated with native kahikatea and tōtara. There are large wetland communities that support a variety of plant and animal species which are uncommon or rare elsewhere in New Zealand. A serious threat to biodiversity in this section of the river (as well as the north Waikato lakes, Whangamarino Wetland and upstream to Ngāruawāhia) are the plant pest species yellow flag iris and alligator weed. Both are aggressive aquatic plants and can take over low lying flood plains, lake margins, and wetland areas, leading to the loss of wetland habitat and a decline in the diversity and abundance of indigenous plants and fauna (Reeves 2012). Once established, yellow flag develops a thick rhizome mat that can suppress germination of other plant seedlings and also elevate local topography by trapping sediment and creating a drier habitat. This can allow it to spread into previously unsuitable habitat and also enable other species to invade, altering successional trajectories (Thomas 1980). Alligator weed occupies similar habitat to yellow flag iris and the species have been found together along the banks of the	

	Waikato River. The wide range of habitats occupied and severity of impacts make alligator weed one of, if not the greatest, weed threat to the Waikato (Champion 2016). The Waikato Regional Council Biosecurity group currently undertakes some control of alligator weed and yellow flag iris where it occurs along the banks of the Waikato River and its tributaries. Most of the effort is concentrated between Ngāruawāhia and Rangiriri for the yellow flag control, due to the limited resources available and the upstream areas of infestation needing to be controlled first to prevent seeds floating downstream. At the current rate of 14km every 3 years, it would take 12 years before the council is in a position to undertake control at Port Waikato (60km downstream of Rangiriri). During this time, habitat will be lost for native fish species, including tuna and white bait, and also birds, invertebrate species and native flora. The lower Waikato River area is very significant to Waikato-Tainui and the river marae. The lower Waikato River and its tributaries sustained tangata whenua for centuries with īnanga (whitebait), tuna (eel), kāeo, birds and many more taonga species. Its abundance is regarded as a reflection of the mana of the iwi and marae, and their ability to sustain whānau (family) and manuwhiri (guests or visitors). Waikato was known for its richness in resources. It was also an important area for trade and travel along its entire length. Flour and flax mills were established and run by tangata whenua. There are many existing and historic pā sites within the area. Papakāinga, historic settlements and wāhi tapu are strategically located within this project area.	
Desired state to achieve Vision & Strategy	- Native fish are healthy, abundant and the full range of species expected to be found in the waterway can be found there. - The Waikato River is fenced to exclude stock along 100% of its margin, and the margin is at least 10 metres wide and vegetated with native species. - Forest remnants and wetlands adjacent to the river are densely vegetated with native plant species, connected to riparian corridors and protected from grazing stock. - Native plant regeneration occurs naturally within the native bush and wetland areas and these areas are protected from further invasion by new and existing weed species. - The river is swimmable, fishable and has access for recreation and collection of kai.	

<table>
<tr><td></td><td>- Iwi and communities have a strong connection to the waterways and are active in their protection and restoration.</td><td></td></tr>
<tr><td>Impact on Vision & Strategy</td><td>In a restored condition, the Waikato River between Rangiriri and Port Waikato would have a very high impact on giving effect to the Vision & Strategy at a central and lower Waikato catchment level.</td><td>VS = 375</td></tr>
<tr><td>Key threats to the feature that this project addresses</td><td><table><tr><th>Key threat</th><th>Impact on feature</th></tr><tr><td>Weed species</td><td>Compete with native plant communities and are a threat to agriculture.
Displace native plant communities and spawning habitat for native fish species.</td></tr></table></td><td></td></tr>
<tr><td>Project goal/s</td><td>Within 6 years of project commencement, infestations of yellow flag iris and alligator weed within the lower Waikato River catchment are significantly reduced to a point where Waikato Regional Council’s control programme is able to eradicate any remaining and/or new infestations.</td><td></td></tr>
<tr><td>Priority works for funding</td><td>Works could be implemented either by an organisation or private citizens (using contractors or their own labour) but it is envisaged that a project manager would be required to co-ordinate with the Waikato Regional Council, provide information and manage aspects of the project.

Herbicide control
Yellow flag iris is easily controlled by using the herbicide metsulfuron-methyl. However, the seed bank that is left after initial control can be substantial, requiring follow up spraying for up to 5 years.

To reduce the alligator weed infestations in the Lower Waikato, each site requires herbicide control at least 3 times per season. Alligator weed will grow underwater so at some sites the opportunity to spray is reduced due to water levels. Perseverance is therefore required.

The following resources are required (additional to Waikato Regional Council’s programme):<table><tr><th>Work required</th><th>Cost per year for years 1,2,3</th><th>Cost per year for years 4,5,6</th></tr><tr><td>Land based control of yellow flag and alligator weed around Lake Whangape.
- Years 1,2,3 – two contractors for 10 days per year ($1000 per day)</td><td>$10,000</td><td>$5000</td></tr></table></td><td></td></tr>
</table>

<table>
<tr><td></td><td>
<table>
<tr><td>- Years 4,5,6 – two contractors for 5 days per year</td><td></td><td></td></tr>
<tr><td>Extend yellow flag iris control area to include Rangiriri to Port Waikato (60km)
- Years 1,2,3 – two contractors for 96 days per year
- Years 4,5,6 – two contractors for 48 days per year</td><td>$96,000</td><td>$48,000</td></tr>
<tr><td>Opuatia Wetland – extend current WRC control area to cover an additional 65ha areas
- Years 1,2,3 – two contractors for 40 days per year
- Years 4,5,6 – two contractors for 20 days per year</td><td>$40,000</td><td>$20,000</td></tr>
<tr><td>Land based control of alligator weed on the lower Waikato River
- Years 1,2,3 – two contractors for 10 days per year
- Years 4,5,6 – two contractors for 5 days per year</td><td>$10,000</td><td>$5000</td></tr>
</table>

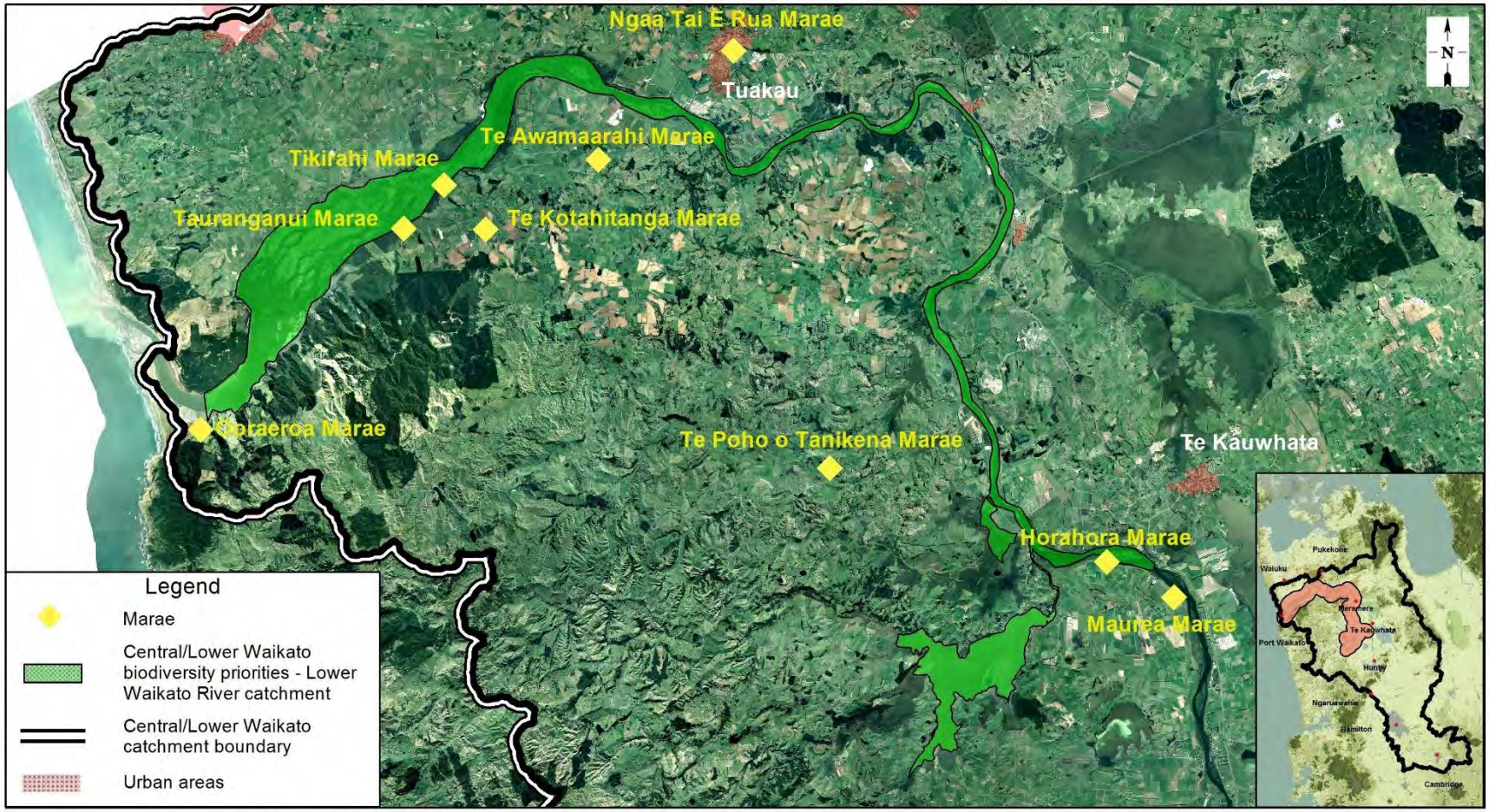
Project management/staffing/incidentals
Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include transport, office overheads, consumables and miscellaneous professional fees.

This is estimated to be 20% of the direct project costs.
</td><td></td></tr>
<tr><td>Time lag for benefits to be realised</td><td>If works were implemented at an even pace over a 6-year period, it is estimated that the majority of the project benefits would be seen approximately 4 years after project commencement.</td><td>L = 4</td></tr>
<tr><td>Effectiveness of works</td><td>The Waikato River between Rangiriri and Port Waikato is currently in poor condition with few of the Vision & Strategy desired state aspects being met. The river has unsatisfactory levels of E. coli and is not safe for swimming in places, the riparian condition is generally poor and stock have access to the river at a number of locations. The river still has very important values, however, and is used by iwi and the community for recreation and the collection of kai. It retains very significant cultural values.

Some deterioration in overall condition is expected over the next 20 years in the absence of this project, with impacts of the upper catchment likely to lead to further decline in water</td><td>W = 0.05</td></tr>
</table>

	quality and habitat for fish. Invasive weeds are also expected to cause a decline in ecological values and continue to be an impediment to restoration efforts. This expected decline would be offset by the outcomes of this project which will improve the ecological values of the river and provide an important contribution to assisting other projects that are threatened by the presence of alligator weed and yellow flag iris. It is acknowledged that achieving the Vision & Strategy desired state along this stretch of river will take longer than the 20 year horizon used for the purposes of the Restoration Strategy, and a fuller range of initiatives over the long term. Whilst this project will not directly improve water quality in the river it will have secondary impacts on other projects focusing on water quality, fish habitat, biodiversity, recreation and cultural values.	
Risk of technical failure	There is a high risk of project failure due to technical feasibility. Work should be carried out by experienced practitioners to ensure control of these pest plants is effective.	F = 0.82
Adoptability	It is estimated that this work would be fully adopted. The Waikato Regional Council already has a small control programme in place and has expressed interest in upscaling this programme if funding was available. There is strong community support for the programme to be upscaled as it has benefits to the agricultural industry as well as agencies and groups undertaking environmental projects along the lower Waikato River and connected lakes and wetlands.	A = 1
Information quality	Very good – based on information from Waikato Regional Council staff who are very familiar with the area and the work requirements.	
Knowledge gaps	Costs are estimates based on current work programmes, however, actual costs may vary as work is undertaken and sites reassessed.	
Socio-political risks	Low risk that the project will fail to meet its goals over the long term due to socio-political risks.	P = 0.85
Project duration (years)	6 years	

<table>
<tr>
<td>Up-front cost – total for implementation phase/project duration</td>
<td>
<table>
<tr><th>Task</th><th>Cost ($)</th></tr>
<tr><td>Herbicide control – Year 1</td><td>156,000</td></tr>
<tr><td>Herbicide control – Year 2</td><td>156,000</td></tr>
<tr><td>Herbicide control – Year 3</td><td>156,000</td></tr>
<tr><td>Herbicide control – Year 4</td><td>78,000</td></tr>
<tr><td>Herbicide control – Year 5</td><td>78,000</td></tr>
<tr><td>Herbicide control – Year 6</td><td>78,000</td></tr>
<tr><td>Project management/staffing/incidentals (20%)</td><td>140,000</td></tr>
<tr><td>Total</td><td>842,400</td></tr>
</table>
</td>
<td>C = 0.84</td>
</tr>
</table>



Increased control of Yellow Flag Iris and Alligator Weed within the Lower Waikato River catchment

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017

Status: Final
Request No.: N/A
File name:WWRRS.gws

0 2 4 6 8 10
Kilometers

Scale 1:200,000@A4 Landscape

A4

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Yellow flag iris in Kimihia Wetland, Huntly.

Alligator weed in Tumate Mahuta Lagoon, Huntly.

Yellow flag iris dominates Maurea Islands.

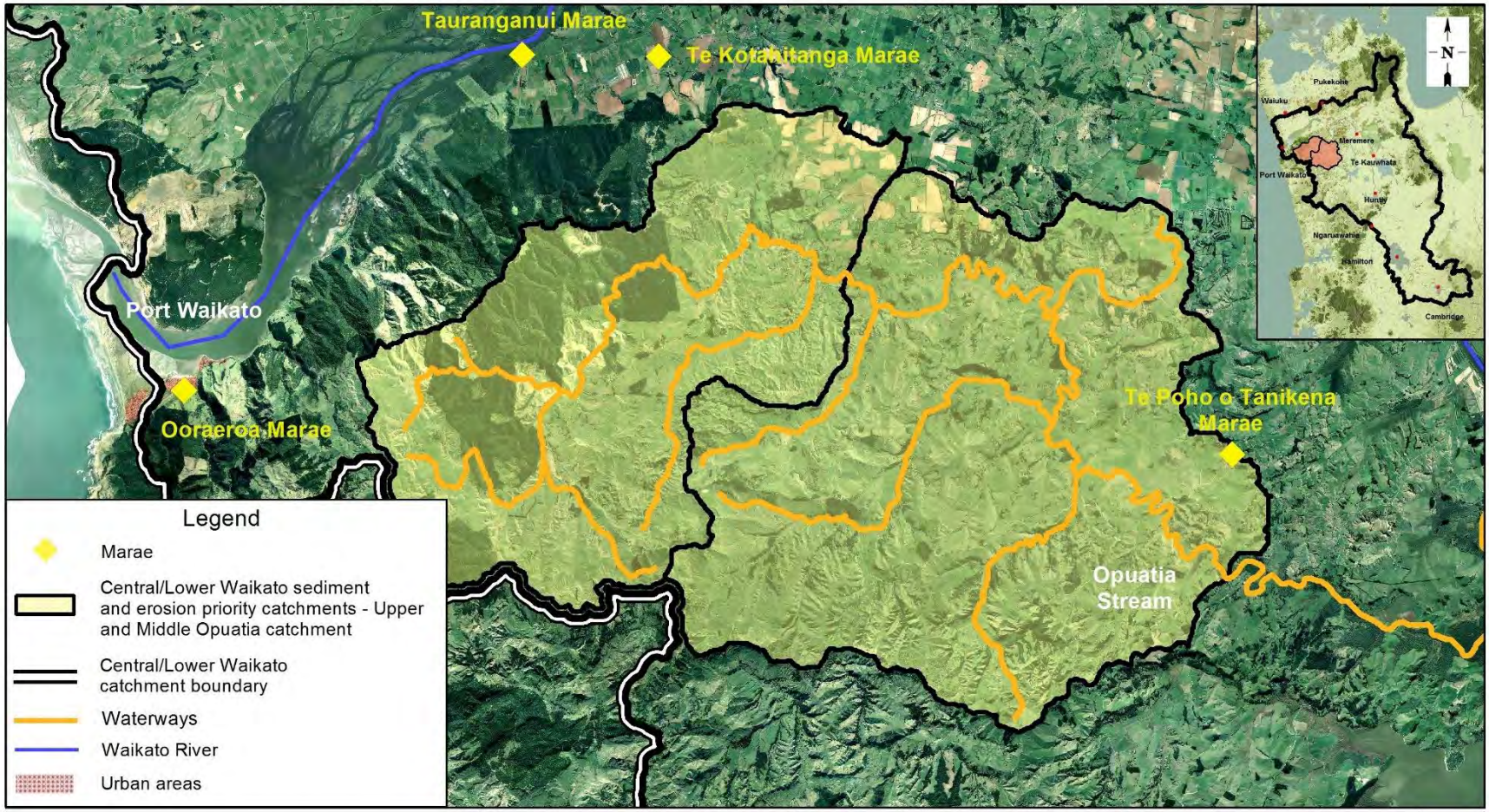
CLW 10 Priority: medium	Upper and middle Opuatia catchment hill country erosion protection and remediation	BCR value
Relevant unit goal(s)	Highly erodible land is effectively managed including through native or exotic reforestation and retirement of marginal lands. Sediment inputs to wetlands and waterbodies are reduced by 50%. The mauri/life supporting capacity of fresh water is protected and restored for aquatic species	
Name of feature	Opuatia sub-catchment including the wetland	
Brief description of feature	The upper and middle Opuatia catchments consist of 18,251ha of steep to rolling land, and drain from the northwest into the Opuatia wetland. 80% of this area is in pasture and nearly 10,400ha of this is Land Use Capability (LUC) class 6e or 7. The predominant land use in the catchment is dry stock farming. The target part of the catchment extends from Port Waikato Hills (Klondyke Road) southeast to where SH22 crosses the Opuatia Stream. Below this, the Opuatia Stream eventually drains through the Opuatia Wetland and into the Waikato River at Churchill Road. The Opuatia Wetland is a nationally significant wetland that covers approximately 950ha of low lying land at the bottom of the Opuatia catchment. The wetland is largely privately owned and contains several wetland types including fen, fen-young bog and swamp. The Opuatia area was regularly visited and traversed by Waikato River marae to gather foods, as the seasons dictated. There are many marae and historic papakāinga within the project area. There are some historic soil conservation works that have been carried out in the upper and middle catchment but these are now aged and likely due for replacement. There have been some more recent works undertaken through the use of pole planting, including through private landowner initiative, but there is scope for significant additional soil conservation works. Modelling undertaken in 2016 indicates that the upper and middle Opuatia are a high priority for management of hill country erosion.	
Desired state to achieve Vision & Strategy	- A sub-catchment where land use matches capability and with a stable stream network that has a fenced and well vegetated riparian margin along its entire length (at least 5m wide).	

<table>
<tr><td></td><td>- Forest remnants and wetlands adjacent to streams are densely vegetated with native plant species, connected to riparian corridors and protected from stock grazing.
- Native plant regeneration occurs naturally within the native bush remnants.
- There are no manmade barriers to native migratory fish. Native fish are abundant and there is a wide diversity of species present, including non-climbing native fish.
- The catchment streams are swimmable, fishable and have access for recreation.
- Iwi and community have a strong connection to the catchment and stream and are active in its use, protection and restoration.</td><td></td></tr>
<tr><td>Impact on Vision & Strategy</td><td>In a restored condition, the Opuatia would have a very high impact on giving effect to the Vision & Strategy at a central and lower Waikato catchment level.</td><td>VS = 200</td></tr>
<tr><td>Key threats to the feature that this project addresses</td><td><table><tr><th>Key threat</th><th>Impact on feature</th></tr><tr><td>Hill country erosion</td><td>Contributes significant sediment to the catchment streams, Opuatia Wetland and the lower Waikato River.</td></tr><tr><td>Stock access to wetlands</td><td>Reduced water quality and destruction of the wetland ecosystem.</td></tr></table></td><td></td></tr>
<tr><td>Project goal/s</td><td>Within 20 years of project commencement:
- LUC class 7 soils are managed within their capabilities and are retired from heavy stock grazing.
- There is a 40% reduction in suspended sediment in the Opuatia Stream.</td><td></td></tr>
<tr><td>Priority works for funding</td><td>Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This project could be undertaken as a whole, or in multiple smaller components.

Hill country soil conservation
- 1259ha LUC 6e land managed with open space pole planting at $3000 per hectare
- 1259ha LUC 6e land managed with plantation species (pine or manuka) at $3000 per hectare
- 225km of fencing the managed LUC 6e land at $25 per metre (8-wire and batten)
- 319ha LUC 7 land managed with plantation species (pine or mānuka) at $3000 per hectare
- 36km of fencing the managed LUC 7 land at $25 per metre (8-wire and batten)
- 8ha reducing sediment to waterways outside LUC class 6e, 7 and 8 land at $8000ha (e.g. dewatering, retiring seepages, etc)</td><td></td></tr>
</table>

	- 54km fencing existing indigenous forest cover at $25 per metre (8-wire and batten) - 104 hunter days per year for 3 years of goat control while plantings on 6e and 7 establish. Control carried out over a 10,400ha area. **Project management/staffing/incidentals** Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include transport, office overheads, consumables and miscellaneous professional fees. This is estimated to be 30% of the direct project costs.	
Time lag for benefits to be realised	If works were implemented at an even pace over a 20-year period, it is estimated that the majority of the project benefits would be seen approximately 15 years after project commencement.	L = 15
Effectiveness of works	The Opuatia sub-catchment is in moderate to poor condition when compared to desired state, with few of the Vision & Strategy aspirations being met. It is expected that over the next 20 years there may be a deterioration in the condition of the catchment in the absence of this project. It is acknowledged that achieving the Vision & Strategy desired state will take longer than the 20-year horizon used for the purposes of the Restoration Strategy. However, works included in this project address some of the key threats to the feature and it is anticipated that if the project is fully completed the sub-catchment will be significantly closer to the Vision & Strategy desired state in 20 years' time, particularly when it comes to land use matching capability and waterways being swimmable. The project does not directly address E. coli, fish habitat and biodiversity, however, the proposed fencing and planting works provide secondary benefits which would be expected to reduce E.coli to waterways, improve habitat and enhance local biodiversity.	W = 0.3
Risk of technical failure	There is a low risk of project failure due to technical feasibility. Risks are mostly related to establishment of plantings or loss of works due to weather events/erosion.	F = 0.87
Adoptability	It is estimated that about one third of landowners would adopt the works if they were fully incentivised. Uptake of management of LUC class 6e and 7 land may be low and we are not aware of significant similar works being undertaken in this catchment to date. Early community engagement, flexibility of approach and	A = 0.3

<table>
<tr><td></td><td>identifying key farmers will be very important for the success of this project.</td><td></td></tr>
<tr><td>Information quality</td><td>Average – estimates are based on modelled information and input from catchment officers who are familiar with the sub-catchment.</td><td></td></tr>
<tr><td>Knowledge gaps</td><td>Estimates of LUC classes 6e and 7 come from a desktop exercise. Farm scale information will need to be gathered as part of this project.</td><td></td></tr>
<tr><td>Socio-political risks</td><td>Low risk that the project will fail to meet its goals over the long term due to socio-political risks.</td><td>P = 0.85</td></tr>
<tr><td>Project duration (years)</td><td>20 years</td><td></td></tr>
<tr><td>Up-front cost – total for implementation phase/project duration</td><td>
<table>
<tr><th>Task</th><th>Cost ($)</th></tr>
<tr><td>1259ha LUC 6e managed with pole planting</td><td>3,777,000</td></tr>
<tr><td>1259ha LUC 6e managed with pole planting</td><td>3,777,000</td></tr>
<tr><td>Fencing managed LUC 6e land (225km)</td><td>5,625,000</td></tr>
<tr><td>319ha LUC 7 managed with plantation species</td><td>957,000</td></tr>
<tr><td>Fencing managed LUC 7 land (36km)</td><td>900,000</td></tr>
<tr><td>Reducing sediment outside LUC 6e, 7 and 8 (8ha)</td><td>64,000</td></tr>
<tr><td>Fencing existing indigenous vegetation (54km)</td><td>1,350,000</td></tr>
<tr><td>Goat control on treated 6e and 7</td><td>127,185</td></tr>
<tr><td>Project management/staffing/incidentals (30%)</td><td>4,973,155</td></tr>
<tr><td>Total</td><td>21,550,340</td></tr>
</table>
</td><td>C = 21.6</td></tr>
</table>



Upper and Middle Opuatia catchment hill country erosion protection and remediation

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017

Status: Final
Request No.: N/A
File name:WWRRS.gws

0.0 1.5 3.0 4.5 6.0 7.5
Kilometers

Scale 1:120,000@A4 Landscape

A4

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Hill country is prone to erosion in the upper Opuatia catchment.

Examples of poplar and willow pole planting to prevent erosion in the Middle Opuatia.

CLW 11 Priority: high	Naike catchment hill country erosion protection and remediation	BCR value
Relevant unit goal(s)	Highly erodible land is effectively managed, including through native or exotic reforestation and retirement of marginal lands. Sediment inputs to wetlands and waterbodies are reduced by 50%. The mauri/life supporting capacity of fresh water is protected and restored for aquatic species	
Name of feature	Naike catchment	
Brief description of feature	This is a relatively large catchment of 10,608 ha. It extends from the west at the catchment divide and in the north at Matakitaki Road and travels east down to where the Maire Stream crosses under SH22 and becomes the Awaroa Stream. Approximately 87% of the catchment is in pasture and 6230ha is estimated to be LUC 6e or 7 in pasture. The predominant land use is dry stock farming. This area was travelled and established by Waikato-Tainui as its sits between the lakes, the sea and the Waikato River. Old papakāinga and midden sites reflect the areas and paths that were populated. The seasonal weather determined where hunting and gathering would occur within this area. The main waterways in the catchment are the Maire, Naike and Taringapeka streams, all of which are tributaries to the Awaroa Stream and eventually drain into the Awaroa Wetland adjacent to Lake Whangape. There are a number of fenced and covenanted bush blocks in the steeper parts of the catchment, along with areas of riparian protection and enhancement. There are also areas of regenerating native bush, however, there remains significant scope for soil conservation works in the catchment. Modelling undertaken in 2016 indicates that the Naike catchment is a high priority for hill country erosion management.	
Desired state to achieve Vision & Strategy	- A sub-catchment where land use matches capability and with a stable stream network that has a fenced and well vegetated riparian margin along its entire length (at least 5m wide). - Forest remnants and wetlands adjacent to streams are densely vegetated with native plant species, connected to riparian corridors and protected from stock grazing. Native plant regeneration occurs naturally within the native bush remnants. - There are no manmade barriers to native migratory fish. Native fish are abundant and there is a wide diversity of species present, including non-climbing native fish.	

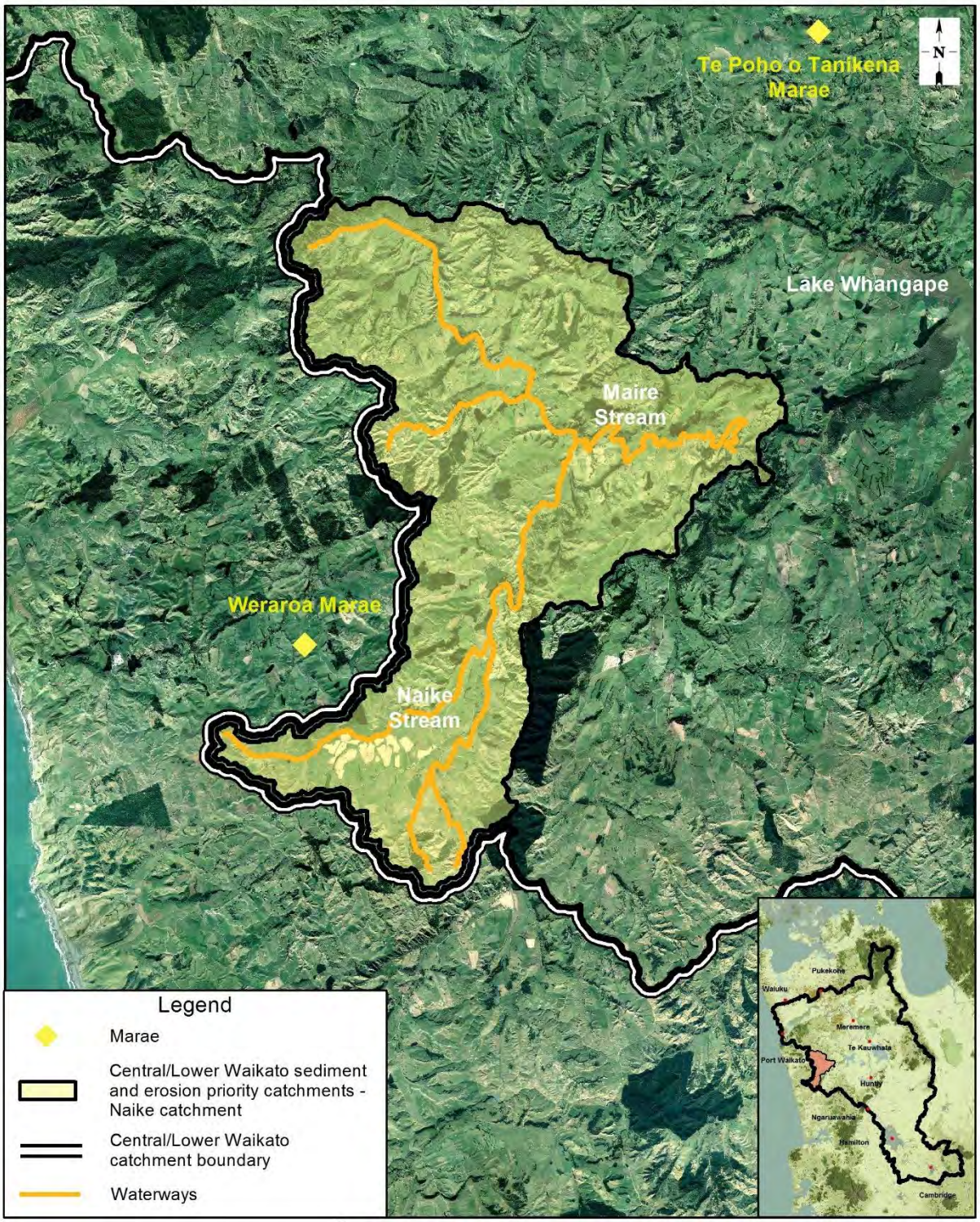
<table>
<tr><td></td><td>- The streams are swimmable, fishable and have access for recreation.
- Iwi and community have a strong connection to the streams and are active in their use, protection and restoration.</td><td></td></tr>
<tr><td>Impact on Vision & Strategy</td><td>In a restored condition, the Naike sub-catchment would have a very high impact on giving effect to the Vision & Strategy at a central and lower Waikato catchment level.</td><td>VS = 200</td></tr>
<tr><td>Key threats to the feature that this project addresses</td><td><table><tr><th>Key threat</th><th>Impact on feature</th></tr><tr><td>Hill country erosion</td><td>Contributes significant sediment to the catchment streams, Lake Whangape and the lower Waikato River.</td></tr></table></td><td></td></tr>
<tr><td>Project goal/s</td><td>Within 20 years of project commencement:
- LUC class 7 soils are managed within their capabilities and are retired from heavy stock grazing.
- There is a 40% reduction in suspended sediment in the Maire and Naike streams.</td><td></td></tr>
<tr><td>Priority works for funding</td><td>Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This project could be undertaken as a whole, or in multiple smaller components.

Hill country soil conservation
- 730ha LUC 6e land managed with open space pole planting at $3000 per hectare
- 730ha LUC 6e land managed with plantation species (pine or mānuka) at $3000 per hectare
- 133km of fencing the managed LUC 6e land at $25 per metre (8-wire and batten)
- 392ha LUC 7 land managed with plantation species (pine or mānuka) at $3000 per hectare
- 47km of fencing the managed LUC 7 land at $25 per metre (8-wire and batten)
- 3ha reducing sediment to waterways outside LUC class 6e, 7 and 8 land at $8000 per ha (e.g. dewatering, retiring seepages, etc)
- 38km fencing existing indigenous forest cover at $25 per m (8-wire and batten)
- 62 hunter days per year for 3 years of goat control while plantings on 6e and 7 establish. Control carried out over a 6200ha area.

Project management/staffing/incidentals
Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include</td><td></td></tr>
</table>

	transport, office overheads, consumables and miscellaneous professional fees. This is estimated to be 30% of the direct project costs.	
Time lag for benefits to be realised	If works were implemented at an even pace over a 20-year period, it is estimated that the majority of the project benefits would be seen approximately 15 years after project commencement.	L = 15
Effectiveness of works	The Naike sub-catchment is in moderate to poor condition when compared to desired state, with few of the Vision & Strategy aspirations being met. It is expected that over the next 20 years there may be a deterioration in the condition of the catchment in the absence of this project. It is acknowledged that achieving the Vision & Strategy desired state will take longer than the 20-year horizon used for the purposes of the Restoration Strategy. However, works included in this project address some of the key threats to the feature and it is anticipated that if the project is fully completed the sub-catchment will be significantly closer to the Vision & Strategy desired state in 20 years' time, particularly when it comes to land use matching capability and waterways being swimmable. The project does not directly address E. coli, fish habitat and biodiversity, however, the proposed fencing and planting works provide secondary benefits which would be expected to reduce E.coli to waterways, improve habitat and enhance local biodiversity.	W = 0.3
Risk of technical failure	There is a low risk of project failure due to technical feasibility. Risks are mostly related to establishment of plantings or loss of works due to weather events/erosion.	F = 0.87
Adoptability	It is estimated that about one third of landowners would adopt the works if they were fully incentivised. Uptake of management of LUC class 6e and 7 land may be low and we are not aware of significant similar works being undertaken in this catchment to date. Early community engagement, flexibility of approach and identifying key farmers will be very important for the success of this project.	A = 0.3
Information quality	Average – estimates are based on modelled information and input from catchment officers who are familiar with the sub-catchment.	
Knowledge gaps	Estimates of LUC classes 6e and 7 come from a desktop exercise. Farm scale information will need to be gathered as part of this project.	

<table>
<tr><td>Socio-political risks</td><td>Low risk that the project will fail to meet its goals over the long term due to socio-political risks.</td><td>P = 0.85</td></tr>
<tr><td>Project duration (years)</td><td>20 years</td><td></td></tr>
<tr><td>Up-front cost – total for implementation phase/project duration</td><td>
<table>
<tr><th>Task</th><th>Cost ($)</th></tr>
<tr><td>730ha LUC 6e managed with pole planting</td><td>2,190,000</td></tr>
<tr><td>730ha LUC 6e managed with plantation species</td><td>2,190,000</td></tr>
<tr><td>Fencing managed LUC 6e land (133km)</td><td>3,325,000</td></tr>
<tr><td>392ha LUC 7 managed with plantation species</td><td>1,176,000</td></tr>
<tr><td>Fencing managed LUC 7 land (47km)</td><td>1,175,000</td></tr>
<tr><td>Reducing erosion outside LUC 6e, 7 and 8 (3ha)</td><td>24,000</td></tr>
<tr><td>Fencing existing indigenous vegetation (38km)</td><td>950,000</td></tr>
<tr><td>Goat control on treated 6e and 7</td><td>75,888</td></tr>
<tr><td>Project management/staffing/incidentals (30%)</td><td>3,331,766</td></tr>
<tr><td>Total</td><td>14,437,654</td></tr>
</table>
</td><td>C = 14.4</td></tr>
</table>



Naike catchment hill country erosion protection and remediation

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017

Status: Final
Request No.: N/A
File name: WWRRS.gws

0 1 2 3 4 5
Kilometers

Scale 1:130,000@A4 Portrait

A4

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Active erosion and potential erosion in the Naike catchment hill country.

Active erosion and potential erosion in the Naike catchment hill country.

Example of a hill country wetland that could be retired for erosion and sedimentation prevention and protection.

CLW 12 Priority: very high	Middle Mangatawhiri Stream erosion protection and remediation	BCR value
Relevant unit goal(s)	Sediment inputs to wetlands and waterbodies are reduced by 50%. The mauri/life supporting capacity of freshwater is protected and restored for aquatic species.	
Name of feature	Mangatawhiri Stream	
Brief description of feature	This 4305ha section of the Mangatawhiri catchment extends from DOC reserve boundary southwest and down to where the stream becomes stopbanked. The upper catchment (not included in this project) includes the Mangatawhiri Dam and is predominantly in indigenous vegetation. The middle Mangatawhiri catchment itself also retains some indigenous vegetation with only 60% of the catchment in pasture. Approximately 47km of stream network lies within this pastoral area and is considered high priority for prevention and remediation of bank erosion. The lower extent of the middle Mangatawhiri is where the stream crosses under Lyons Road. Below this the stream is bordered by stopbanks on both sides until it reaches a Fish & Game wetland and enters the Waikato River north of Mercer. The catchment land use includes dairy farms and lifestyle blocks. The Dilworth Rural Campus also sits within the catchment which provides outdoor education activities and could present an opportunity for a catchment partnerships. Some riparian planting has been undertaken upstream of the campus. The Mangatawhiri is regarded as the aukati (boundary) with which the British troops crossed and triggered the Waikato invasion. Papakāinga, marae and historic sites populate the area. This area provided food resources for the tangata whenua and is very significant to iwi and marae.	
Desired state to achieve Vision & Strategy	- A sub-catchment where land use matches capability and with a stable stream network that has a fenced and well vegetated riparian margin along its entire length (at least 5m wide) to assist in providing erosion protection, shade and shelter. - Forest remnants and wetlands adjacent to streams are densely vegetated with native plant species, connected to	

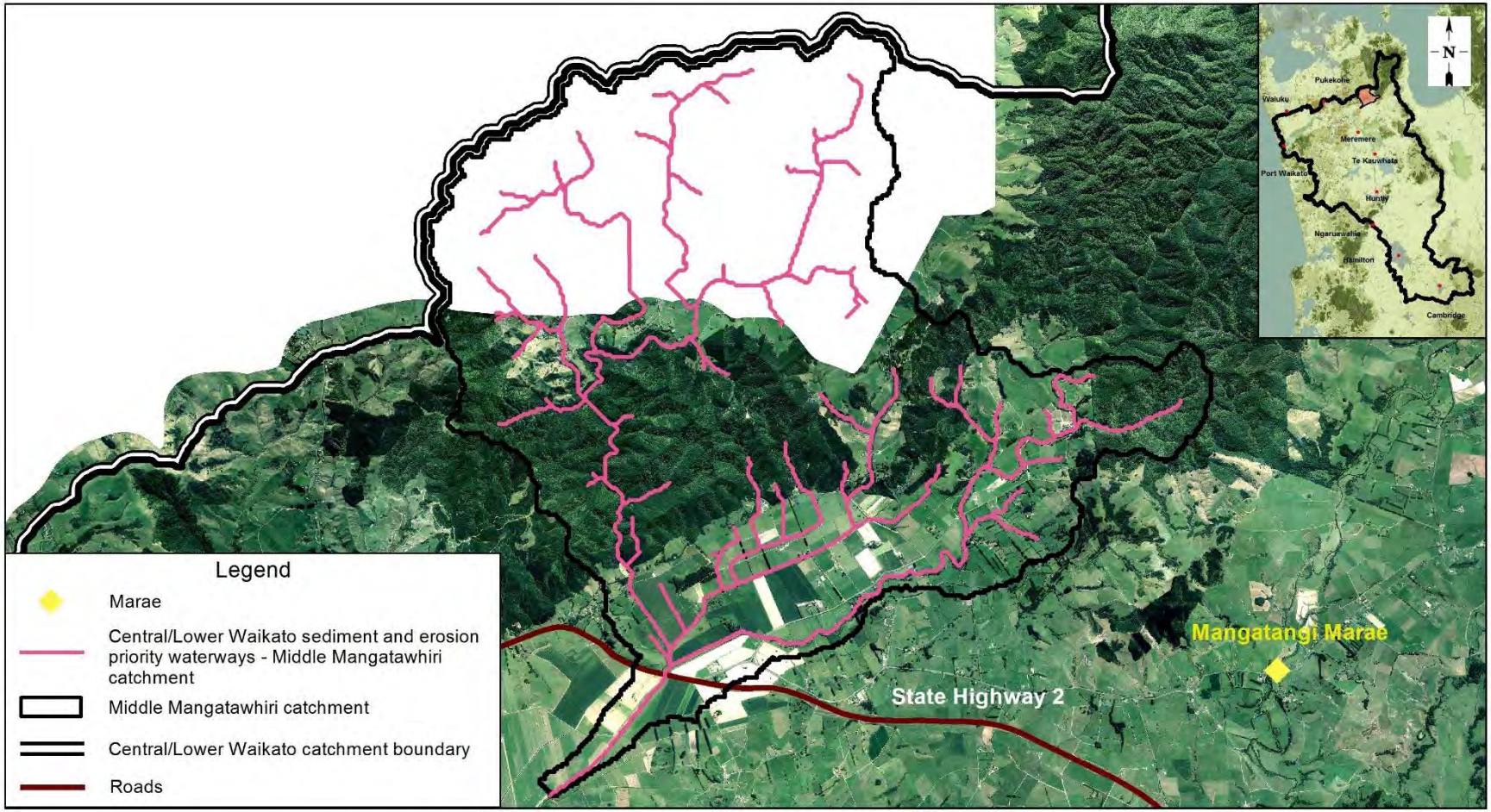
<table>
<tr><td></td><td>riparian corridors and protected from stock grazing. Native plant regeneration occurs naturally within the native bush remnants.
- There are no manmade barriers to native migratory fish. Native fish are abundant and there is a wide diversity of species present, including non-climbing native fish.
- The stream is swimmable, fishable and has access for recreation.
- Iwi and community have a strong connection to the stream and are active in its use, protection and restoration.</td><td></td></tr>
<tr><td>Impact on Vision & Strategy</td><td>In a restored condition, the Mangatawhiri Stream would have a high impact on giving effect to the Vision & Strategy at a central and lower Waikato catchment level.</td><td>VS = 40</td></tr>
<tr><td>Key threats to the feature that this project addresses</td><td><table><tr><th>Key threat</th><th>Impact on feature</th></tr><tr><td>Riverbank erosion</td><td>Contributes significant sediment load to the Mangatawhiri Stream and lower Waikato River.</td></tr><tr><td>Stock access to the stream</td><td>Reduced water quality and destruction of riparian vegetation.</td></tr></table></td><td></td></tr>
<tr><td>Project goal/s</td><td>Within 5 years of project commencement:
- The main channel and tributaries of the middle Mangatawhiri Stream are stable and fenced to exclude stock with a minimum 3-wire electric fence.
- Native and exotic planting (and associated weed control) is established within areas of the riparian margin most susceptible to erosion.</td><td></td></tr>
<tr><td>Priority works for funding</td><td>Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This project could be undertaken as a whole, or in multiple smaller components.

Riparian management of rivers/streams in pasture for soil conservation purposes
Costs for fencing are based on a 5-wire (2 electric) fence, however, in these flood prone streams a 3-wire electric fence would also be acceptable.

Carry out riparian fencing with a minimum 5m setback from the top of the streambank (preferably 5-wire with 2 electric wires at $8 per metre) along an estimated 27km of streambank (13.5km of stream length). Include adjoining wetland areas within the riparian fencing ($216,000). Undertake a mix of native and exotic soil conservation riparian planting within the fenced area (where it doesn't exist naturally), estimated to be 10ha of planting and associated weed control and maintenance</td><td></td></tr>
</table>

	($373,520). 2369 poplar poles are estimated to be required for stream erosion control ($33,163). The main reach of the middle Mangatawhiri is 9km long and it is estimated that erosion control structures would be required at a frequency of 1 per km ($2500 per km for a total cost of $22,500). **Project management/staffing/incidentals** Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include transport, office overheads, consumables and miscellaneous professional fees. This is estimated to be 20% of the direct project costs.	
Time lag for benefits to be realised	If works were implemented at an even pace over a 5-year period, it is estimated that the majority of the project benefits would be seen approximately 1-2 years after project completion.	L = 6.5
Effectiveness of works	The Mangatawhiri Stream is in a moderate condition when compared with the Vision & Strategy desired state. The stream is not safe for swimming due to high levels of E. coli, and has poor clarity by the time it reaches Lyons Road. In the absence of this project, significant changes to stream condition are not expected in the next 20 years. The work addresses mainly sedimentation from streambank erosion but this would also reduce the amount of E.coli and nutrients entering the waterways to further improve fisheries and catchment biodiversity. The project doesn't address catchment processes that are driving erosion and it is acknowledged that achieving the Vision & Strategy desired state here will take longer than the 20 year horizon used for the purposes of the Restoration Strategy. However, this work is expected to move the catchment streams closer towards this state if fully completed.	W = 0.125
Risk of technical failure	There is a moderate risk of project failure due to technical feasibility. Risks are mostly related to establishment of plantings or loss of works due to flooding and/or erosion before they are established. This would be minimised by the fencing setbacks being at least 5m, and by planting sterile willow poles to stabilise banks while native plantings establish.	F = 0.82
Adoptability	It is estimated that approximately three-quarters of the landowners would adopt the works if they were fully incentivised. The extent of the fencing setbacks may provide	A = 0.75

<table>
<tr><td></td><td>some challenge in terms of uptake, and some landowners may be concerned about maintenance of fences following floods. However, this should be minimised once plantings mature.</td><td></td></tr>
<tr><td>Information quality</td><td>Average – estimates are based on modelled information, Lower Waikato riparian surveys and input from catchment officers who are familiar with the sub-catchment.</td><td></td></tr>
<tr><td>Knowledge gaps</td><td>Estimates of stream fencing requirements come from a desktop exercise and local knowledge. Farm scale information will need to be gathered as part of this project.</td><td></td></tr>
<tr><td>Socio-political risks</td><td>Low risk that the project will fail to meet its goals over the long term due to socio-political risks.</td><td>P = 0.97</td></tr>
<tr><td>Project duration (years)</td><td>5 years</td><td></td></tr>
<tr><td>Up-front cost – total for implementation phase/project duration</td><td><table><tr><th>Task</th><th>Cost</th></tr><tr><td>Riparian fencing (27km)</td><td>216,000</td></tr><tr><td>Riparian willow/poplar pole planting (2369 poles)</td><td>33,163</td></tr><tr><td>Native riparian planting (10ha)</td><td>375,520</td></tr><tr><td>Erosion control structures</td><td>22,500</td></tr><tr><td>Project management/staffing/incidentals (20%)</td><td>129,436</td></tr><tr><td>Total</td><td>776,619</td></tr></table></td><td>C = 0.78</td></tr>
</table>



Middle Mangatawhiri Stream erosion protection and remediation

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017

Status: Final
Request No.: N/A
File name:WWRRS.gws

0.00 0.75 1.50 2.25 3.00 3.75
Kilometers

Scale 1:65,000@A4 Landscape

A4

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Erosion and unfenced banks along the Mangatawhiri Stream.

Example of fencing and planting on the Mangatawhiri Stream

CLW 13 Priority: very high	Northern Mangatangi Stream erosion protection and remediation	BCR value
Relevant unit goal(s)	Sediment inputs to wetlands and waterbodies are reduced by 50%. The mauri/life supporting capacity of fresh water is protected and restored for aquatic species.	
Name of feature	Mangatangi Stream	
Brief description of feature	The 5200ha northern Mangatangi catchment extends southwest from the DOC reserve on the southern side of the Hunua Ranges at Workman Road to the Maramarua River at SH2. The Maramarua joins the Whangamarino River at Island Block Road. Almost 30% of the catchment retains indigenous vegetation. There is an approximately 90km stream network in this catchment, with 67km estimated to run through pastoral land. Land use in the catchment is a mix of dairy and dry stock. The Maramarua and Whangamarino are very significant to Waikato-Tainui and the marae. The wetland and tributaries sustained tangata whenua for centuries with īnanga (whitebait), tuna (eel), kāeo, birds and many more taonga species. Its abundance is regarded as a reflection of the mana of the iwi and marae, and their ability to sustain whānau (family) and manuwhiri (guests or visitors). There are many existing and historic pā sites within the area. Papakāinga, historic settlements and wāhi tapu are strategically located within this project area. Previous attempts to fence and plant the Mangatangi have been hampered by severe weather events and loss of works. Some in-channel willow management and bank stabilisation plantings have been undertaken over the past 10 years with some success. The stream is very incised and in order for works to be successful, fencing and planting will need to be carried out in conjunction with riverbank stabilisation work. Modelling has identified the catchment as a high priority for prevention and management of streambank erosion.	
Desired state to achieve Vision & Strategy	- A sub-catchment where land use matches capability and with a stable stream network that has a fenced and well vegetated riparian margin along its entire length (at least 5m wide) to assist in providing erosion protection, shade and shelter.	

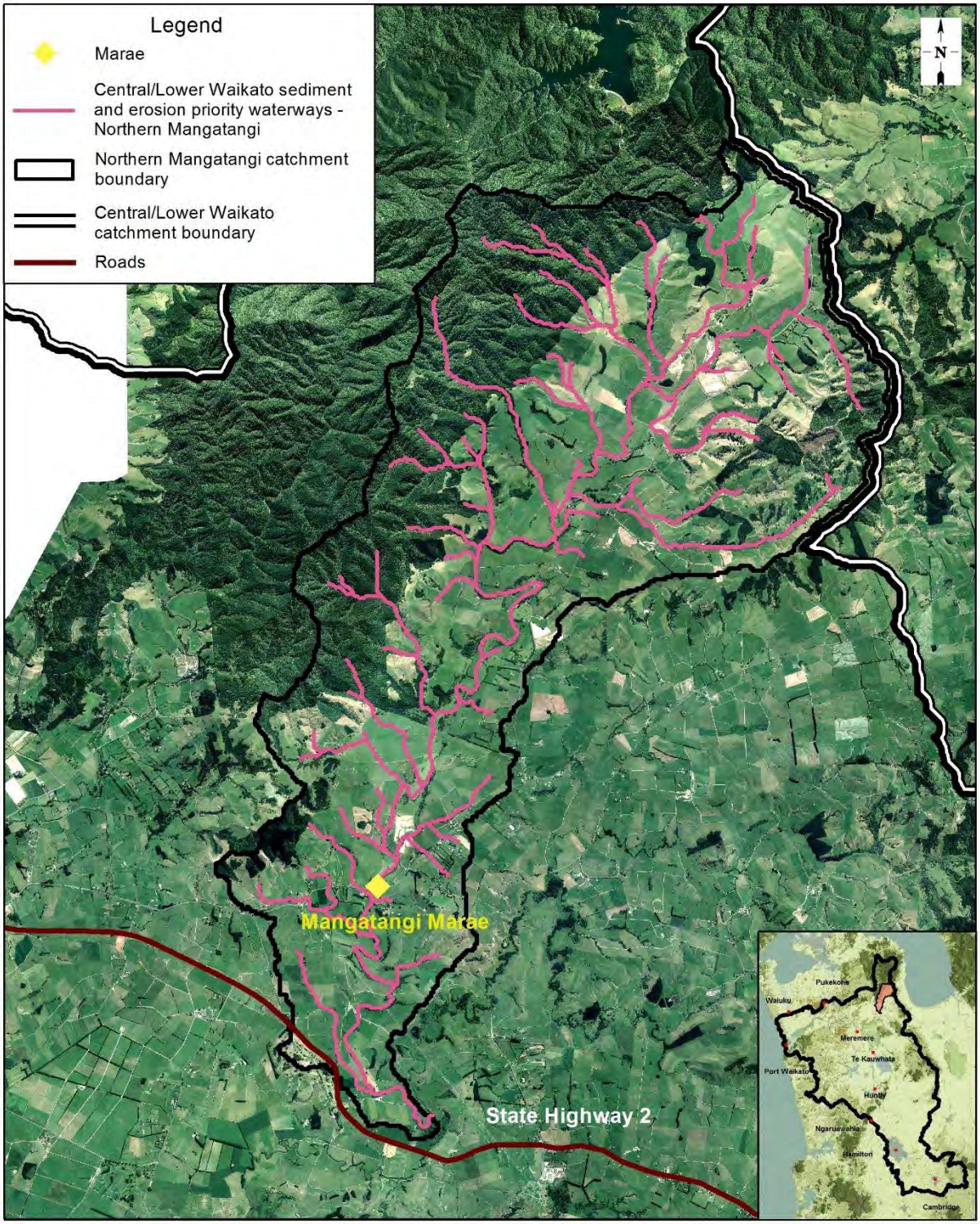
<table>
<tr><td></td><td>- Forest remnants and wetlands adjacent to streams are densely vegetated with native plant species, connected to riparian corridors and protected from stock grazing. Native plant regeneration occurs naturally within the native bush remnants.
- There are no manmade barriers to native migratory fish. Native fish are abundant and there is a wide diversity of species present, including non-climbing native fish.
- The stream is swimmable, fishable and has access for recreation.
- Iwi and community have a strong connection to the stream and are active in its use, protection and restoration.</td><td></td></tr>
<tr><td>Impact on Vision & Strategy</td><td>In a restored condition, the Mangatangi Stream would have a high impact on giving effect to the Vision & Strategy at a central and lower Waikato catchment level.</td><td>VS = 50</td></tr>
<tr><td>Key threats to the feature that this project addresses</td><td><table><tr><th>Key threat</th><th>Impact on feature</th></tr><tr><td>Riverbank erosion</td><td>Contributes significant sediment load to the Mangatangi Stream and lower Waikato River.</td></tr><tr><td>Stock access to the streams</td><td>Reduced water quality and destruction of riparian vegetation.</td></tr></table></td><td></td></tr>
<tr><td>Project goal/s</td><td>Within 10 years of project commencement:
- The main channel and tributaries of the northern Mangatangi Stream are stable and fenced to exclude stock with a minimum 3-wire electric fence.
- Native and exotic planting (and associated weed control) is established within areas of the riparian margin most susceptible to erosion.</td><td></td></tr>
<tr><td>Priority works for funding</td><td>Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This project could be undertaken as a whole, or in multiple smaller components.

Riparian management of rivers/streams in pasture for soil conservation purposes
Costs for fencing are based on a 5-wire (2 electric) fence, however, in these flood prone streams a 3-wire electric fence would also be acceptable.

Carry out riparian fencing/fence upgrade with a minimum 5m setback from the top of the streambank (preferably 5 wire with 2 electric wires at $8 per metre) along an estimated 37km of streambank (18.5km of stream length). Include adjoining wetland areas within the riparian fencing. Undertake a mix of native and exotic soil conservation riparian planting within the fenced area (where it doesn't exist naturally), estimated to be 14ha of</td><td></td></tr>
</table>

	planting and associated weed control and maintenance. 3325 poplar poles are estimated to be required for stream erosion control. The main reach of the Mangatangi is 20km long and it is estimated that erosion control structures would be required at a frequency of 1 per km ($2500 per km). **Project management/staffing/incidentals** Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include transport, office overheads, consumables and miscellaneous professional fees. This is estimated to be 20% of the direct project costs.	
Time lag for benefits to be realised	If works were implemented at an even pace over a 10-year period, it is estimated that the majority of the project benefits would be seen approximately 9 years after project commencement.	L = 9
Effectiveness of works	The Mangatangi Stream is in a moderate condition when compared with the Vision & Strategy desired state. The stream is not safe for swimming due to high levels of E. coli, and has poor clarity by the time it reaches Maramarua. In the absence of this project, significant changes to stream condition are not expected in the next 20 years. Works included address mainly sedimentation from streambank erosion but would also reduce the amount of E.coli and nutrients entering the waterways, further improving fisheries and catchment biodiversity. The project doesn't address catchment processes that are driving erosion and it is acknowledged that achieving the Vision & Strategy desired state here will take longer than the 20 year horizon used for the purposes of the Restoration Strategy. However, this work is expected to move the catchment streams measurably closer towards this state if fully completed.	W = 0.125
Risk of technical failure	There is a moderate risk of project failure due to technical feasibility. Risks are mostly related to establishment of plantings or loss of works due to flooding and/or erosion before they are established. This would be minimised by the fencing setbacks being at least 5m, and by planting sterile willow poles to stabilise banks while native plantings establish.	F = 0.82
Adoptability	It is estimated that approximately half of the landowners would adopt the works if they were fully incentivised. The extent of the fencing setbacks may provide some challenge in terms of uptake,	A = 0.5

<table>
<tr><td></td><td>and some landowners may be concerned about maintenance of fences following floods. However, this should be minimised once plantings mature.</td><td></td></tr>
<tr><td>Information quality</td><td>Average – estimates are based on modelled information, Lower Waikato riparian surveys and input from catchment officers who are familiar with the sub-catchment.</td><td></td></tr>
<tr><td>Knowledge gaps</td><td>Estimates of stream fencing requirements come from a desktop exercise and local knowledge. Farm scale information will need to be gathered as part of this project.</td><td></td></tr>
<tr><td>Socio-political risks</td><td>Moderate risk that the project will fail to meet its goals over the long term due to socio-political risks. Early stakeholder engagement will be very important for the successful delivery of this project.</td><td>P = 0.75</td></tr>
<tr><td>Project duration (years)</td><td>10 years</td><td></td></tr>
<tr><td>Up-front cost – total for implementation phase/project duration</td><td><table><tr><th>Task</th><th>Cost ($)</th></tr><tr><td>Riparian fencing (37km)</td><td>296,000</td></tr><tr><td>Riparian willow/poplar pole planting (3325 poles)</td><td>46,548</td></tr><tr><td>Native riparian planting (14ha)</td><td>525,728</td></tr><tr><td>Erosion control structures</td><td>50,000</td></tr><tr><td>Project management/staffing/incidentals (20%)</td><td>183,655</td></tr><tr><td>Total</td><td>1,101,931</td></tr></table></td><td>C = 1.10</td></tr>
</table>



Northern Mangatangi Stream erosion protection and remediation

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017
Status: Final
Request No.: N/A
File name: WWRRS.gws

0.0 0.5 1.0 1.5 2.0 2.5
Kilometers

Scale 1:70,000@A4 Portrait

A4

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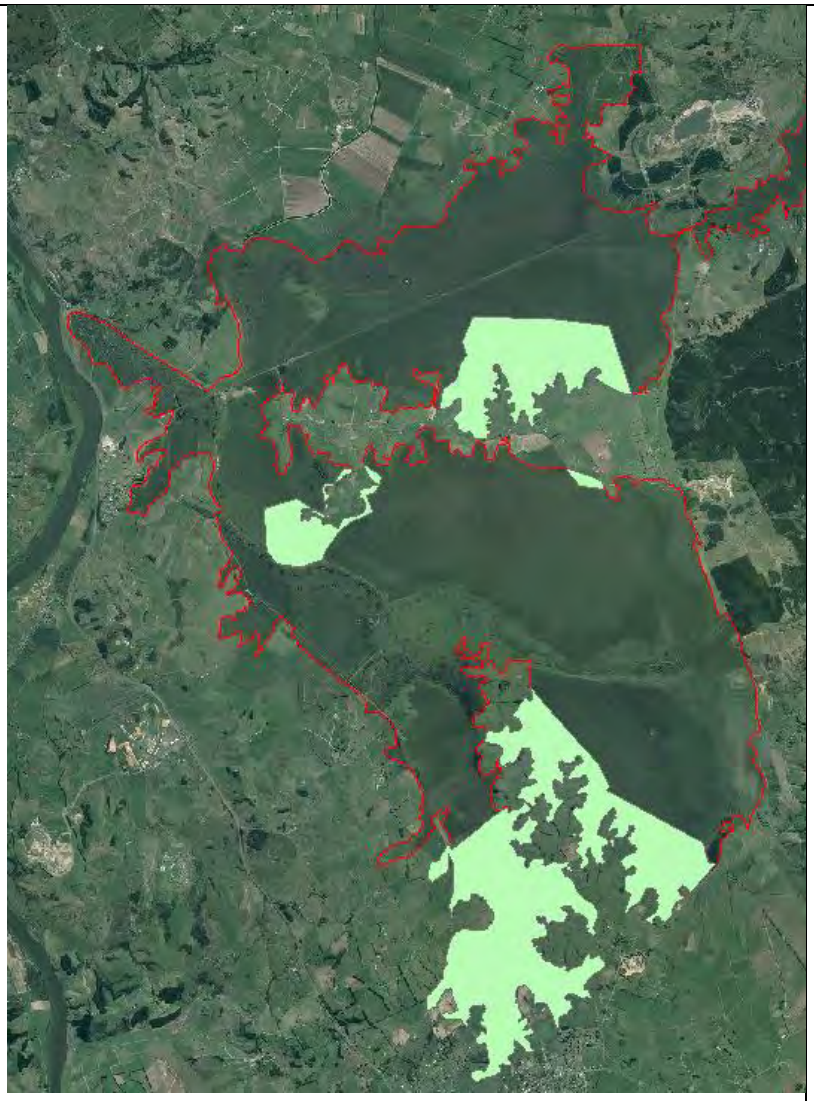
An example of a retired margin along the Mangatangi Stream.

CLW 14 Priority: high	Biodiversity enhancement of Whangamarino Wetland	BCR value
Relevant unit goal(s)	Wetlands are protected, enhanced and, where feasible, expanded and re-established. Ecosystems, forest fragments and ecological corridors associated with aquatic environments are protected, enhanced and expanded.	
Name of feature	Whangamarino Wetland	
Brief description of feature	The Whangamarino Wetland is 7290 hectares in size and located between Meremere and Te Kauwhata. It is the largest bog and swamp complex in the North Island and is of international significance under the Ramsar Convention. Most of the wetland is owned and managed by the Department of Conservation and the second largest landowner is Fish & Game New Zealand who manage wetland habitat for gamebird hunting. The wetland is also an integral part of the Lower Waikato Flood Control Scheme managed by Waikato Regional Council. The Whangamarino contains a rich and representative variety of wetland ecosystems, including peat bog, swamp, open water, mesotrophic lags and river systems. It contains a number of uncommon or extremely rare plants, including watermilfoil *Myriophyllum robustum*, clubmoss *Lycopodium serpentinum* and the critically endangered swamp helmet orchid (*Anzybas carseii*), not found nowhere else in the world. These diverse ecosystems provide habitat to a wide range of native wetland birds including the Australasian bittern/matuku (*Botaurus poiciloptilus*), spotless crake/pūweto (*Porzana tabuensis plumbea*), marsh crake/koitareke (*Porzana pusilla*), North Island fernbird/mātātā (*Bowdleria punctata vealeae*), and New Zealand dabchick/weweia (*Poliocephalus rufopectus*). Occasionally, the Whangamarino is visited by other unusual birds such as royal spoonbill/kōtuku-ngutupapa (*Platalea regia*) and Japanese snipe (*Gallinago hardwickii*). The wetland is also home to a range of native freshwater fish including longfin and shortfin eel, galaxid species and the black mudfish (nationally endangered). The Whangamarino is culturally and historically significant to Waikato-Tainui. There are many historic pā surrounding the	

<table>
<tr><td></td><td>wetland including Te Teoteo, reflective of the pakanga (battles) that occurred as part of the Waikato invasion. The wetland provided habitat for many of the resources that iwi accessed for kai, clothing and medicines.</td><td></td></tr>
<tr><td>Desired state to achieve Vision & Strategy</td><td>- The wetland is fully fenced and stock are excluded.
- The wetland is densely vegetated with native plant species, and native plant regeneration occurs naturally.
- There is minimal threat from invasive weed species to native plants and animal species.
- A sub-catchment where land use matches capability.
- Wetland margins retain natural hydrological function and are well vegetated with native plant communities that support indigenous fauna.
- Native fish are abundant and the full range of species expected to be found in the waterway can be found there e.g. kōkopu, tuna, black mudfish.
- Water quality within the wetland is fishable and safe for collection of kai.
- Iwi and communities have a strong connection to the wetland and are active in its use, protection and restoration.</td><td></td></tr>
<tr><td>Impact on Vision & Strategy</td><td>In a restored condition, the Whangamarino Wetland would have a very high impact on giving effect to the Vision & Strategy at a central and lower Waikato catchment level.</td><td>VS = 375</td></tr>
<tr><td>Key threats to the feature that this project addresses</td><td><table><tr><th>Key threat</th><th>Impact on feature</th></tr><tr><td>Stock access to the wetland</td><td>Reduced water quality, destruction of wetland vegetation, compaction of peat.</td></tr><tr><td>Weed species</td><td>Compete with and modify native plant communities and spread to other areas.</td></tr><tr><td>Land drainage</td><td>Lowers water levels in the bog causing peat oxidation and changes to vegetation.</td></tr><tr><td>Environmental impacts from upper catchment</td><td>The condition of the wetland and the ecosystem types present in it are impacted by nutrient and sediment runoff from upstream catchment land use.</td></tr><tr><td>Vegetation clearance</td><td>Reduced cover, habitat and food (invertebrates) for native species.</td></tr></table></td><td></td></tr>
<tr><td>Project goal/s</td><td>- Within 5 years of project commencement, the DOC reserve boundary is 100% fenced and stock are excluded from the wetland.</td><td></td></tr>
</table>

	- Within 5 years of carrying out fencing, previously grazed pasture areas are regenerating with native vegetation or planted with native plants.	
Priority works for funding	The project seeks to influence DOC to restrict grazing on DOC land and fence the reserve boundaries to exclude stock. Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour) and need to be carried out in collaboration with DOC and Fish & Game. This project could be undertaken as a whole, or in multiple smaller components. **Fencing** Carry out fencing of unfenced areas of public conservation land to exclude stock from the Whangamarino Wetland. The areas of focus are shown in green on the map below. These are areas of wetland that are unfenced and that stock are able to access. Approximately 35km of fencing is required to prevent stock accessing the wetland. Fencing should be 7-wire post and batten ($595,000).	



Map of Whangamarino Wetland (red boundary) showing public conservation land where there is no fencing present to exclude stock (green shaded areas).

Native planting

Newly fenced areas where cattle grazing previously occurred may regenerate into native wetland vegetation naturally. However, it is estimated that 50% of these areas will require native planting (25ha).

Native planting should be undertaken using a mix of species that would grow naturally in the wetland ecosystem. The estimate cost for 25ha of native planting in a previously grazed area is $938,800.

Project management/staffing/incidentals

Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include

	transport, office overheads, consumables and miscellaneous professional fees. This is estimated to be 20% of the direct project costs.	
Time lag for benefits to be realised	If works were implemented at an even pace over a 5-year period, it is estimated that the majority of the project benefits would be seen within one year of project completion.	L = 5.5
Effectiveness of works	The Whangamarino wetland is currently in a moderate condition when compared to Vision & Strategy desired state. It remains very significant and highly valued by iwi and the community, but is under considerable threat as a result of stock access, catchment land use, pest plants and animals, and modified hydrology. Because of these threats and in absence of this project, it is expected that the wetland will decline in condition over the next 20 years. If this project is successfully completed, then it will locally address and offset some of these threats, however the wetland will still be expected to decline. It is acknowledged that achieving the Vision & Strategy desired state will take a fuller ranger of initiatives and a longer period of time than the 20 year horizon used for the purposes of the Restoration Strategy. However, this project will complement other actions undertaken to protect and restore the wetland.	W = 0.015
Risk of technical failure	There is a very low risk of project failure due to technical feasibility. Risks are mostly related to establishment of plantings but these are generally minimal in wetland areas.	F = 0.92
Adoptability	It is estimated that about two-thirds of landowners would adopt the works if they were fully incentivised. Some may be concerned by loss of marginal grazing areas, however, generally the benefits of avoiding loss of stock in wetlands are becoming well recognised.	A = 0.65
Information quality	Very good – detailed knowledge from Department of Conservation staff who manage the wetland.	
Knowledge gaps	Specific details on area and numbers of plantings would need to be developed once stock are removed from the wetland and fences are erected.	
Socio-political risks	Low risk that the project will fail to meet its goals over the long term due to socio-political risks.	P= 0.85
Project duration (years)	5 years	

<table>
<tr>
<td>Up-front cost – total for implementation phase/project duration</td>
<td>
<table>
<tr><th>Task</th><th>Cost ($)</th></tr>
<tr><td>Fencing (35km)</td><td>595,000</td></tr>
<tr><td>Native planting (25ha)</td><td>938,800</td></tr>
<tr><td>Project management/staffing/incidentals (20%)</td><td>306,760</td></tr>
<tr><td>TOTAL</td><td>1,840,560</td></tr>
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<td>C = 1.84</td>
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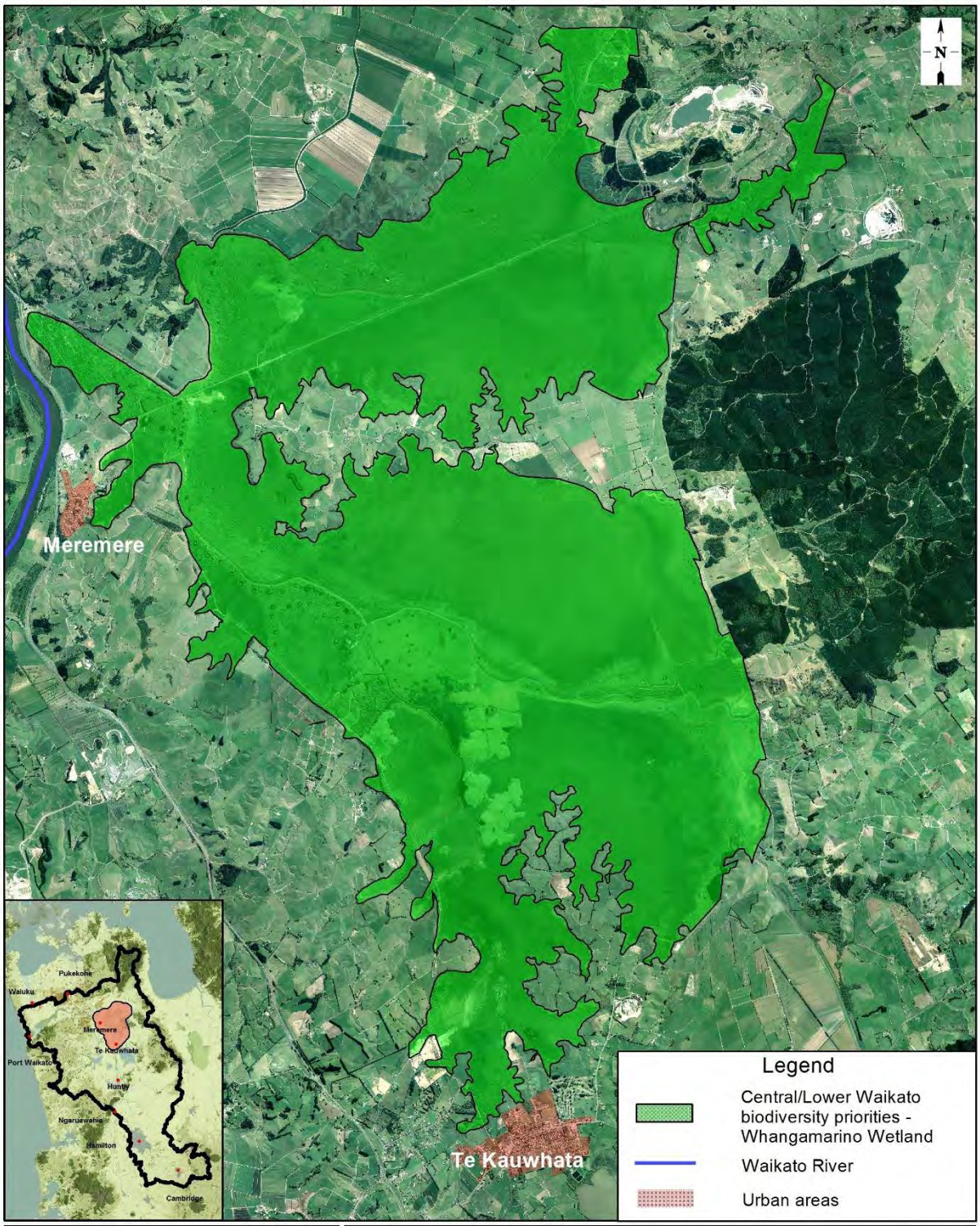

Biodiversity enhancement of Whangamarino Wetland

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017

Status: Final
Request No.: N/A
File name: WWRRS.gws

0.0 0.6 1.2 1.8 2.4 3.0
Kilometers

Scale 1:75,000@A4 Portrait

A4

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Whangamarino Wetland

CLW 15 Priority: high	Biodiversity enhancement of selected lowland forest fragments with strong connections to waterways	BCR value
Relevant unit goal(s)	Wetlands are protected, enhanced and, where feasible, expanded and re-established. Ecosystems, forest fragments and ecological corridors associated with aquatic environments are protected, enhanced and expanded.	
Name of feature	Lower Waikato lowland forest remnants	
Brief description of feature	This project involves three lowland forest remnants (or clusters of kahikatea within a few hundred metres of each other) located in the lower Waikato River catchment. The remnants are dominated by kahikatea trees. A total of 67ha of forest remnants have been identified. Fragments range in size from 0.5ha to 36ha as follows: - A cluster of kahikatea remnants near Meremere located in close proximity to each other (45ha in total) - Two nearby kahikatea remnants at Naike (16ha) - Kahikatea remnants at the end of Jefferis Road, Waerenga (6ha). All of these sites have components that are within the top 30% of sites for biodiversity protection within the Waikato catchment because of their terrestrial biodiversity values and representativeness of this ecosystem type. Biodiversity values are under threat from a range of factors, but particularly invasion from weeds. Most of the sites identified are lowland kahikatea forest remnants. This forest type used to cover 42,800ha of the Lower Waikato catchment. Only 1.3% of the former extent remains. Kahikatea was a valuable resource to tangata whenua. Te koroī berry was eadible and also consumed by birds. The bark was burnt to create dyes and apply to bruises.	
Desired state to achieve Vision & Strategy	- The identified forest remnants are densely vegetated with native plant species, connected to riparian corridors where possible and protected from livestock grazing. - Native plant regeneration occurs naturally within the native bush remnants.	
Impact on Vision & Strategy	In a restored condition, the Lower Waikato lowland forest remnants would have a very high impact on giving effect to the Vision & Strategy at a local level.	VS = 7

<table>
<tr>
<td>Key threats to the feature that this project addresses</td>
<td>
<table>
<tr><th>Key threat and underlying cause</th><th>Impact on the feature</th></tr>
<tr><td>Further fragmentation of forest fragments</td><td>Affects the viability of the forest fragment through increasing edge effects, increasing potential for weed and animal pest invasion. Also reduces the habitat available for native species.</td></tr>
<tr><td>Livestock access to native forest fragments</td><td>Livestock prevent native regeneration, trample roots and open up areas to plant pests.</td></tr>
<tr><td>Weeds</td><td>Compete with native vegetation.</td></tr>
</table>
</td>
<td></td>
</tr>
<tr>
<td>Project goal/s</td>
<td>Within 10 years of this project commencing:
- The identified forest remnants and associated waterways are 100% fenced to exclude livestock with a minimum 5 wire (2 electric) fence, and connected to other forest remnants and riparian areas where possible.
- Riparian margins are at least 5m wide and native planting (and associated weed control) is carried out within the riparian margin and open areas at 1.5m spacing.
- Weed species present are dramatically reduced and native re-generation occurs naturally in extensive areas across all bush remnants.</td>
<td></td>
</tr>
<tr>
<td>Priority works for funding</td>
<td>Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This project could be undertaken as a whole, or in multiple smaller components.

Further investigation is required to determine the exact amount of fencing and planting and weed control required. However, based on aerial photographs and local knowledge, the following estimates and assumptions have been made:

Fencing
Fencing would be required to exclude livestock from forest remnants and associated waterways. Fences should be a minimum of 5m back from waterways and a minimum of 5-wire (2 electric) for cattle and 7-wire post and batten for sheep.
<u>Kahikatea remnants near Meremere</u> – 8km of fencing (7 wire post and batten), $136,000.

<u>Kahikatea remnants at Naike</u> – 3km fencing (a minimum of 5 wire with 2 electric wires), $24,000.</td>
<td></td>
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</table>

	Kahikatea remnants at the end of Jefferis Road, Waerenga – 2.5km fencing (a minimum of 5 wire with 2 electric wires), $20,000. **Native planting** Native planting may be required to infill open areas within and around native bush remnants. Native planting should be undertaken with 1.5m spacing between plants. Plant species selected for planting should be hardy colonising species that would have naturally existed within the location. The following native planting requirements have been estimated. Cost estimates include site preparation, plant purchase, planting labour and five releasing events: Kahikatea remnants near Meremere – 2ha of native planting within open areas at a cost of $39,552 per hectare ($79,104). Kahikatea remnants at Naike – 1.5ha of native planting within open areas at a cost of $39,552 per hectare ($59,328). Kahikatea remnants at the end of Jefferis Road, Waerenga – 0.5ha of native planting within open areas at a cost of $39,552 per hectare ($19,776). **Weed control** Weed control is required to promote regeneration of native species and enhance biodiversity. The following weed control estimates have been made (note: these are in addition to native plant releasing which is provided in the native planting costs). Kahikatea remnants near Meremere – weed control will be required over a 4ha area for 3 years. It is assumed that the most appropriate method of weed control will be undertaken using a knapsack sprayer at a cost of $2800 per hectare for a 2ha portion of the site and more intensive control required over a further 2ha area at an estimated cost of $4000 per hectare ($40,800). Kahikatea remnants at Naike – ground control of pest willow trees using x-trail basal and general control of other weed species required over a 1ha area for 3 years at $4000 per hectare ($12,000).	

	Kahikatea remnants at the end of Jefferis Road – weed control required over a 0.5ha area for 3 years at $1400 per hectare per year ($2100). **Animal pest control** Possum control is recommended during the establishment of native plantings. Lowland kahikatea remnants at Naike and Meremere are both within the northwest Waikato possum control scheme area so no further possum control is currently required. Possum control is recommended in the Waerenga site. Kahikatea remnants at the end of Jefferis Road, Waerenga – possum control (using bait stations) for native plant establishment over a 6ha area ($3600 over 3 years). **Project management/staffing/incidentals** Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include transport, office overheads, consumables and miscellaneous professional fees. This is estimated to be 20% of the direct project costs.	
Time lag for benefits to be realised	If works were implemented at an even pace over a 10-year period, it is estimated that the majority of the project benefits would be seen approximately 8 years after project commencement.	L = 8
Effectiveness of works	These fragments are currently in a moderate condition when compared to Vision & Strategy desired state. They also remain at risk of further fragmentation, loss of important hydrological conditions to sustain them, and further invasion by plant pests. As a result of these threats it is expected that the fragments will deteriorate slowly over the next 20 years if this project is not undertaken. If this project is successfully completed, then it is expected that these forest fragments will be in an improved condition in 20 years' time due to increased regeneration of native species and reduction in weeds. However, this project does not address the concerns around retention of wetland hydrology at these sites.	W = 0.125
Risk of technical failure	There is a low risk of project failure due to technical feasibility. Risks are mostly related to weed control – to minimise this, work should be carried out by experienced practitioners to ensure it is effective.	F = 0.82

<table>
<tr><td>Adoptability</td><td>It is estimated that about two-thirds of landowners would adopt the works if they were fully incentivised. Some may be concerned by loss of marginal grazing areas, however, generally the values of these remnants are well accepted.</td><td>A = 0.65</td></tr>
<tr><td>Information quality</td><td>Poor information – quantity of work required and costings for sites are based off aerial photography and minimal local knowledge.</td><td></td></tr>
<tr><td>Knowledge gaps</td><td>Further work is required to determine specific amounts of fencing, planting and weed control required. This should be carried out during project planning.</td><td></td></tr>
<tr><td>Socio-political risks</td><td>Very low risk that the project will fail to meet its goals over the long term due to socio-political risks.</td><td>P = 0.97</td></tr>
<tr><td>Project duration (years)</td><td>10 years</td><td></td></tr>
<tr><td>Up-front cost – total for implementation phase/project duration</td><td>
<table>
<tr><th>Task</th><th>Cost ($)</th></tr>
<tr><td>Fencing</td><td></td></tr>
<tr><td>- Meremere (8km)</td><td>136,000</td></tr>
<tr><td>- Naike (3km)</td><td>24,000</td></tr>
<tr><td>- Waerenga (2.5km)</td><td>20,000</td></tr>
<tr><td>Native planting</td><td></td></tr>
<tr><td>- Meremere (2ha)</td><td>79,104</td></tr>
<tr><td>- Naike (1.5ha)</td><td>59,328</td></tr>
<tr><td>- Waerenga (0.5ha)</td><td>19,776</td></tr>
<tr><td>Weed control</td><td></td></tr>
<tr><td>- Meremere</td><td>40,800</td></tr>
<tr><td>- Naike</td><td>12,000</td></tr>
<tr><td>- Waerenga</td><td>2100</td></tr>
<tr><td>Animal Pest Control</td><td></td></tr>
<tr><td>- Waerenga</td><td>3600</td></tr>
<tr><td>Project management/staffing/incidentals (20%)</td><td>79,341</td></tr>
<tr><td>Total</td><td>476,050</td></tr>
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</td><td>C = 0.48</td></tr>
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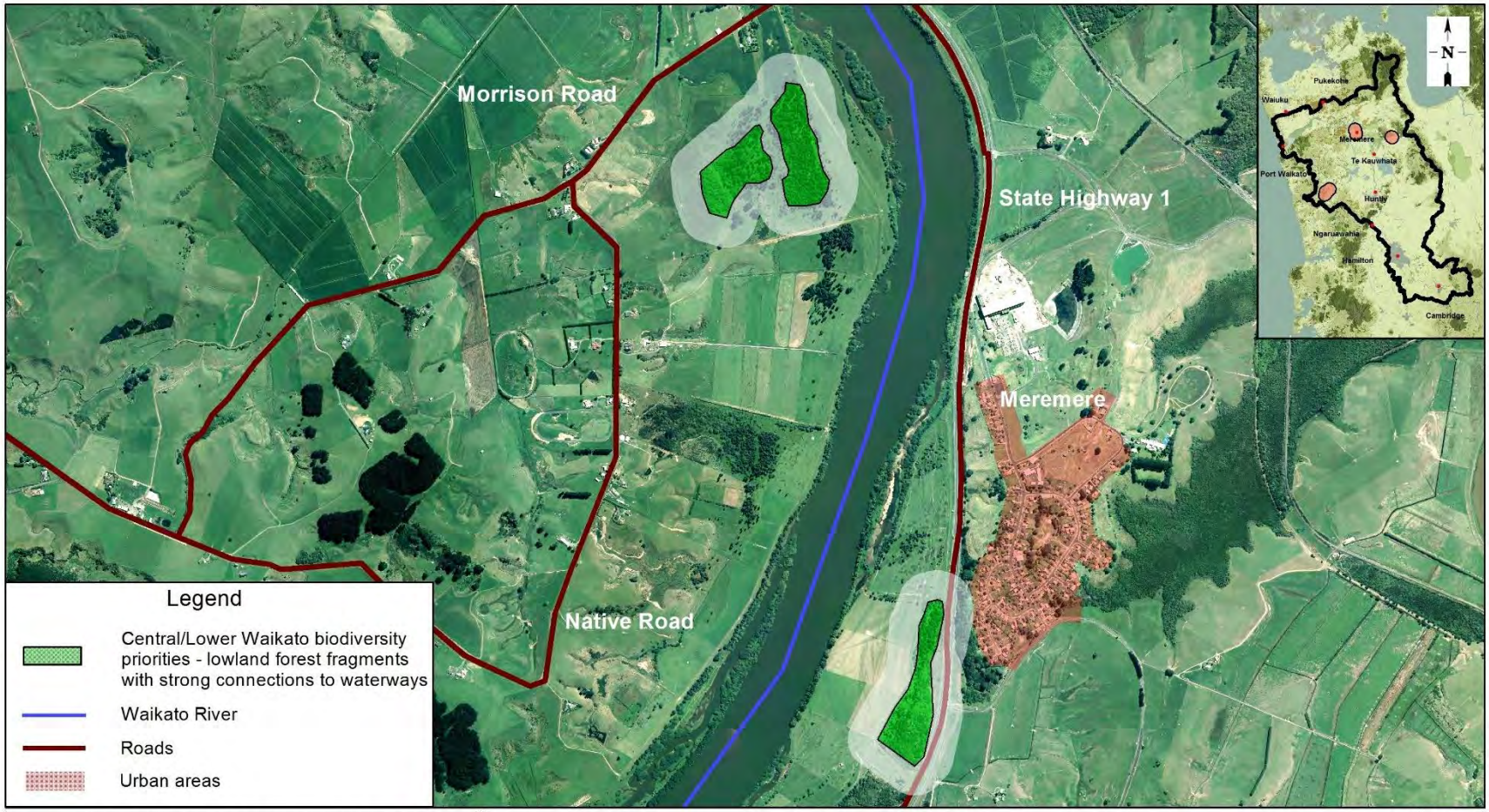

Biodiversity enhancement of selected lowland forest fragments with strong connections to waterways Map 1/3

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017

Status: Final
Request No.: N/A
File name:WWRRS.gws

0.0 0.2 0.4 0.6 0.8 1.0
Kilometers

Scale 1:18,000@A4 Landscape

A4

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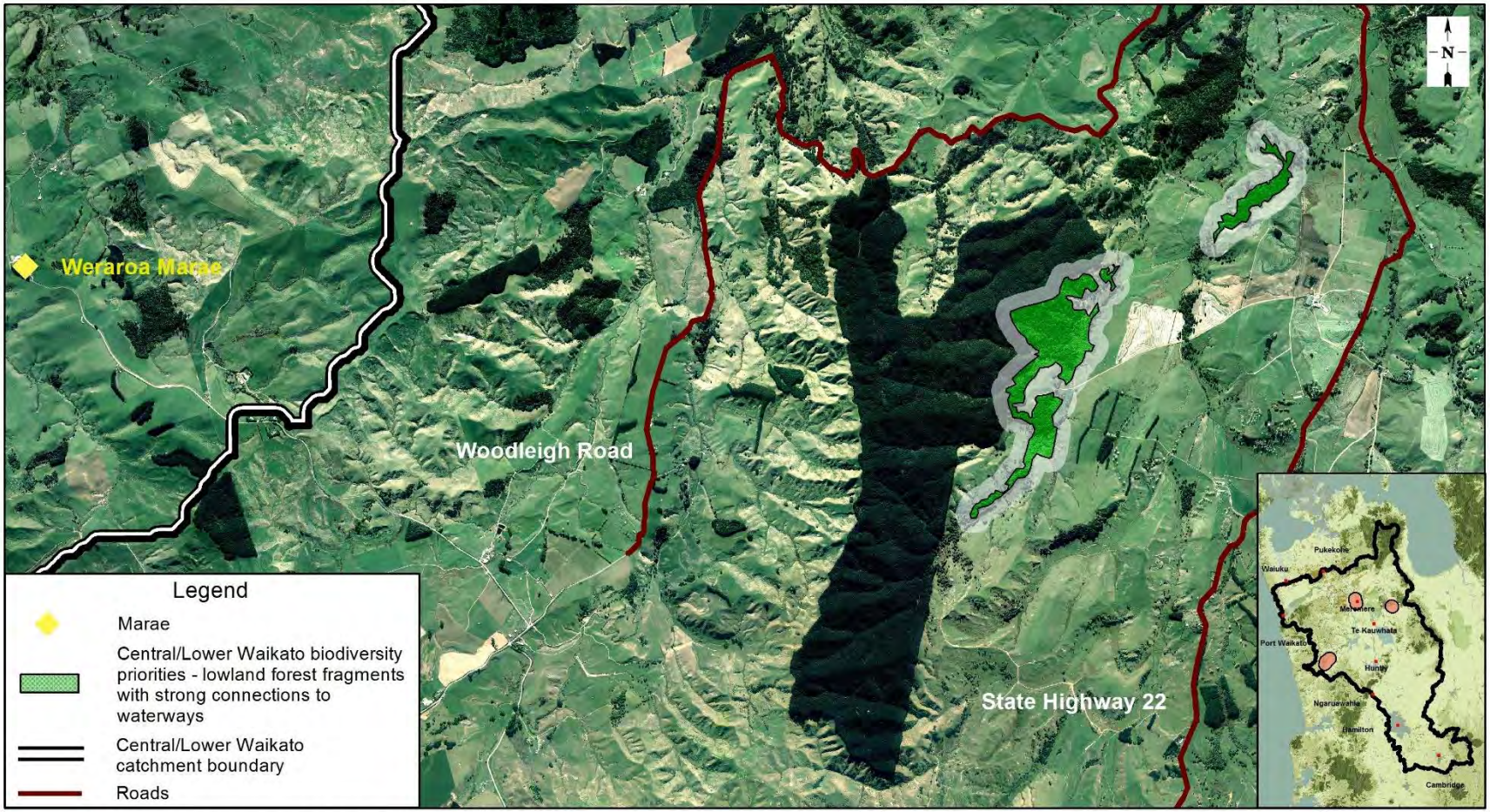

Legend

- Marae
- Central/Lower Waikato biodiversity priorities - lowland forest fragments with strong connections to waterways
- Central/Lower Waikato catchment boundary
- Roads

Biodiversity enhancement of selected lowland forest fragments with strong connections to waterways Map 2/3

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017

Status: Final
Request No.: N/A
File name:WWRRS.gws

0.0 0.4 0.8 1.2 1.6 2.0
Kilometers

Scale 1:37,000@A4 Landscape

A4

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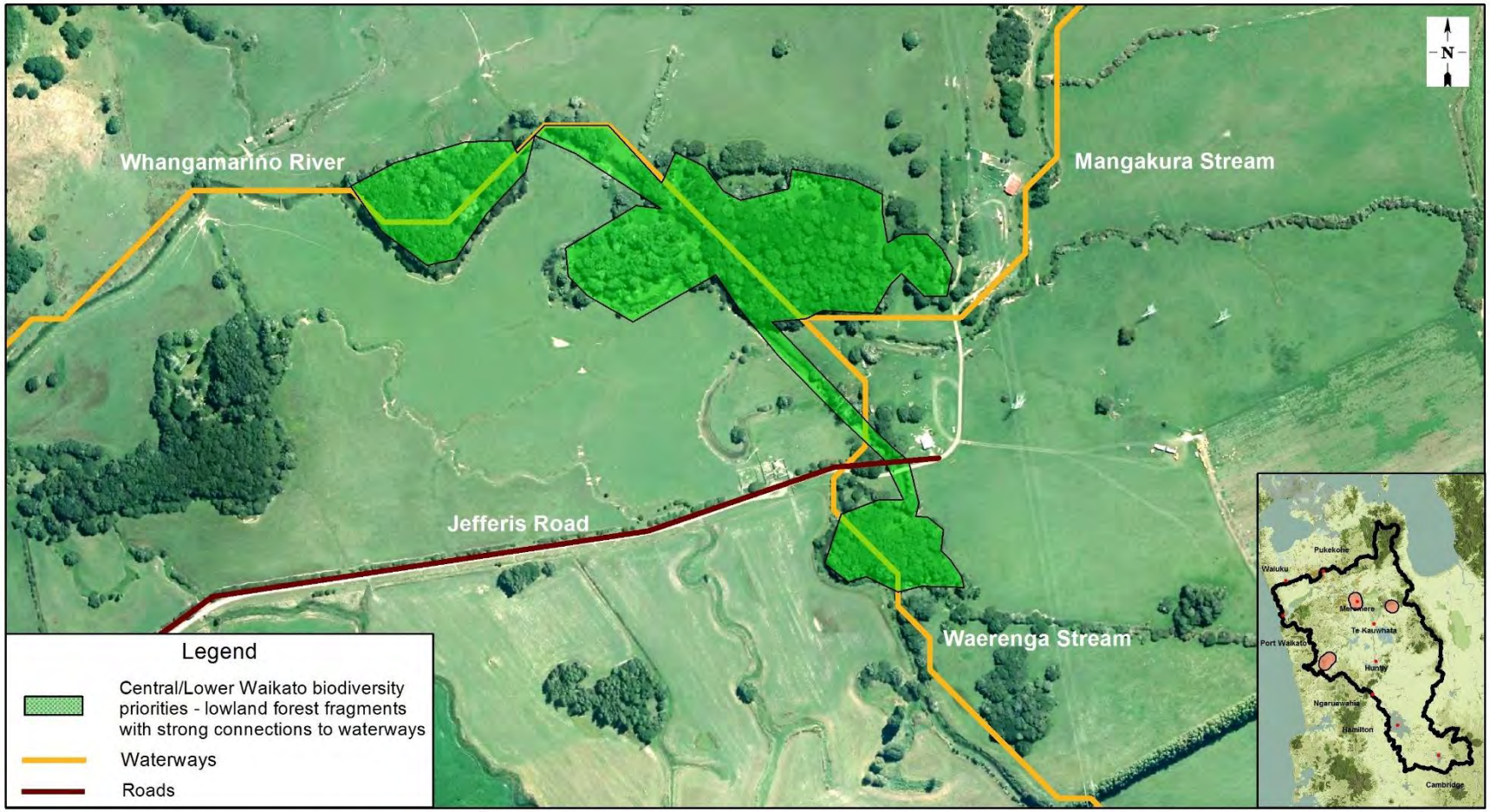

Biodiversity enhancement of selected lowland forest fragments with strong connections to waterways Map 3/3

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017

Status: Final
Request No.: N/A
File name:WWRRS.gws

0.00 0.06 0.12 0.18 0.24 0.30
Kilometers

Scale 1:5,000@A4 Landscape

A4

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CLW 16 Priority: high	Waerenga catchment hill country and streambank erosion protection and remediation	BCR value
Relevant unit goal(s)	Highly erodible land is effectively managed including through native or exotic reforestation and retirement of marginal lands. Sediment inputs to wetlands and waterbodies are reduced by 50%. The mauri/life supporting capacity of fresh water is protected and restored for aquatic species.	
Name of feature	Waerenga catchment	
Brief description of feature	The Waerenga catchment comprises 13,627ha of steep to rolling land. 75% of this is estimated to be in pasture, however, there are also reasonably large areas of forestry (18%) and indigenous vegetation (7%). The 4321ha upper catchment has been identified as a priority for hill country erosion protection and remediation. An estimated 2300ha of this area is Land Use Capability (LUC) class 6e in pasture. The middle 9306ha catchment is a high priority for protection and remediation of streambank erosion, with an estimated 110km stream network lying within pastoral areas. Land use is a mix of dry stock and dairy with dairy predominant in the middle to lower reaches. The catchment originates in the northern Hapuakohe Range and the main waterway is the Waerenga Stream which extends northwest down the catchment and joins the Whangamarino River at Jefferis Road. The Taniwha Stream lies on the western boundary of the catchment and is a tributary to the Waerenga. Landowners have previously undertaken a range of riparian protection works in the catchment, however, scope remains for further river and hill country protection work. The middle to lower parts of the Waerenga Stream are susceptible to flooding during large rain events. The Waerenga area provides valuable resources to marae, in particular Waikare, Taniwha and Okaeria marae. The streams and puna (springs) provided drinking and cleaning water for tangata whenua. Fisheries and pā tuna (eel weirs) were plentiful here and a symbol of mana (authority).	
Desired state to achieve Vision & Strategy	- A sub-catchment where land use matches capability and with a stable stream network that has a fenced and well vegetated riparian margin along its entire length (at least 5m wide) to assist in providing erosion protection, shade and shelter.	

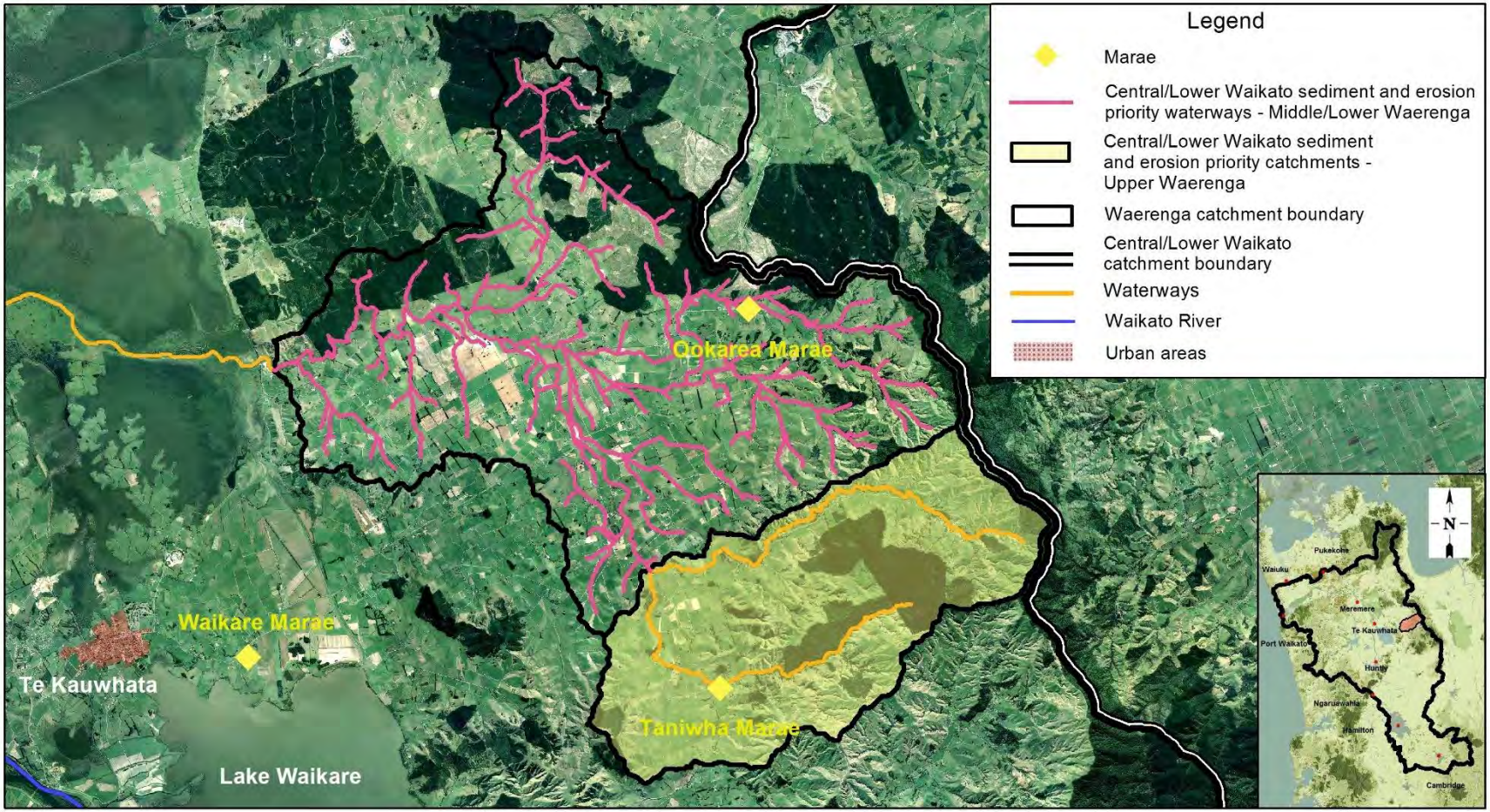
<table>
<tr><td></td><td>- Forest remnants and wetlands adjacent to streams are densely vegetated with native plant species, connected to riparian corridors and protected from stock grazing. Native plant regeneration occurs naturally within the native bush remnants.
- There are no manmade barriers to native migratory fish. Native fish are abundant and there is a wide diversity of species present, including non-climbing native fish.
- The stream is swimmable, fishable and has access for recreation.
- Iwi and community have a strong connection to the stream and are active in its use, protection and restoration.</td><td></td></tr>
<tr><td>Impact on Vision & Strategy</td><td>In a restored condition, the Waerenga sub-catchment would have a very high impact on giving effect to the Vision & Strategy at a local level.</td><td>VS = 275</td></tr>
<tr><td>Key threats to the feature that this project addresses</td><td><table><tr><th>Key threat</th><th>Impact on feature</th></tr><tr><td>Hill country erosion</td><td>Contributes significant sediment to the catchment streams, the Whangamarino Wetland and the lower Waikato River.</td></tr><tr><td>Riverbank erosion</td><td>Contributes significant sediment load to the catchment streams, the Whangamarino Wetland and the lower Waikato River.</td></tr><tr><td>Stock access to the stream</td><td>Reduced water quality and destruction of riparian vegetation.</td></tr></table></td><td></td></tr>
<tr><td>Project goal/s</td><td>Within 15 years of project commencement:
- The main channel and tributaries of identified waterways are stable and fenced to exclude stock with a minimum 3-wire electric fence.
- Native and exotic planting (and associated weed control) is established within areas of the riparian margin most susceptible to erosion.
- There is a 30% reduction in suspended sediment in the Waerenga Stream.</td><td></td></tr>
<tr><td>Priority works for funding</td><td>Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This project could be undertaken as a whole, or in multiple smaller components.

Hill country soil conservation
- 287ha LUC 6e land managed with open space pole planting at $3000 per hectare
- 287ha LUC 6e land managed with plantation species (pine or mānuka) at $3000 per hectare</td><td></td></tr>
</table>

	- 50km of fencing the managed LUC 6e land at $25 per metre (8-wire and batten) - 13km fencing existing indigenous forest cover at $25 per metre (8-wire and batten). **Riparian management of rivers/streams in pasture for soil conservation purposes** *Costs for fencing are based on a 5-wire (2 electric) fence, however, in these flood prone streams a 3-wire electric fence would also be acceptable.* Carry out riparian fencing with a minimum 5m setback from the top of the streambank (at least 5 wire with 2 electric wires at $8 per metre) along an estimated 101km of streambank (50.5km of stream length). Include adjoining wetland areas within the riparian fencing. Undertake a mix of native and exotic soil conservation riparian planting within the fenced area (where it doesn't exist naturally), estimated to be 38ha of planting and associated weed control and maintenance. 7466 willow poles are estimated to be required for river and stream erosion control. The main channel of the Waerenga Stream through this reach is 20km long (40km of streambank). It is estimated that 4km of streambank will require vegetation or rock structures at a cost of $20,000 per km ($80,000). **Project management/staffing/incidentals** Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include transport, office overheads, consumables and miscellaneous professional fees. This is estimated to be 30% of the direct project costs.	
Time lag for benefits to be realised	If works were implemented at an even pace over a 15-year period, it is estimated that the majority of the project benefits would be seen approximately 12-13 years after project commencement.	L = 12.5
Effectiveness of works	The Waerenga sub-catchment retains some very important values, however, the overall condition of the sub-catchment is significantly below desired state for meeting the Vision & Strategy. Over the next 20 years it is expected that some aspects may deteriorate in the absence of this project. Works included here address several key threats and it is anticipated that if the project is fully completed, the catchment will move substantially closer to the Vision & Strategy desired state in	W = 0.25

	areas such as land use meeting capability and streambank stability. The project has secondary benefits in protecting and improving water quality by reducing E. coli to waterways, and in enhancing catchment biodiversity. It is acknowledged that achieving the Vision & Strategy desired state in the Waerenga will take a fuller range of initiatives over the longer term, and will take longer than the 20 year horizon used for the purposes of the Restoration Strategy, however, this project is expected to make a measurable difference to the sub-catchment.	
Risk of technical failure	There is a moderate risk of project failure due to technical feasibility. Risks are mostly related to establishment of plantings or loss of works due to flooding and/or erosion before they are established. This would be minimised by the stream fencing setbacks being at least 5m, and by planting sterile willow poles to stabilise banks while native plantings establish. Erosion prevention and protection works should be planned by people with appropriate technical expertise and local knowledge.	F = 0.82
Adoptability	It is estimated that about a third of landowners would adopt the works if they were fully incentivised. Uptake of management of LUC class 6e land may be low and we are not aware of significant similar works being undertaken in this catchment to date. There are large sections of streams that are erosive in nature and likely to flood on a regular basis. Landowners may be unwilling to erect fences in these locations due to the potential maintenance costs. Fencing setbacks of at least 5m from the top of banks should help to minimise this, however, this loss of grazing land may also be a challenge with uptake. It would be beneficial to establish sites that demonstrate the benefits of stable, vegetated stream margins. Early community engagement, flexibility of approach and identifying key farmers will be very important for the success of this project.	A = 0.35
Information quality	Average – estimates are based on modelled information, Lower Waikato riparian surveys and input from catchment officers who are familiar with the sub-catchment.	
Knowledge gaps	Estimates of LUC class 6e and stream lengths come from a desktop exercise. Farm scale information will need to be gathered as part of this project.	
Socio-political risks	Moderate risk that the project will fail to meet its goals over the long term due to socio-political risks. Early stakeholder engagement will be very important for the successful delivery of this project.	P = 0.75
Project duration (years)	15 years	

<table>
<tr>
<td>Up-front cost – total for implementation phase/project duration</td>
<td>
<table>
<tr><th>Task</th><th>Cost ($)</th></tr>
<tr><td>287ha LUC 6e managed with pole planting</td><td>861,000</td></tr>
<tr><td>287ha LUC 6e managed with plantation species</td><td>861,000</td></tr>
<tr><td>Fencing managed LUC 6e land (50km)</td><td>1,250,000</td></tr>
<tr><td>Fencing existing indigenous vegetation (13km)</td><td>325,000</td></tr>
<tr><td>Riparian fencing (101km)</td><td>808,000</td></tr>
<tr><td>Riparian willow/poplar pole planting (7466 poles)</td><td>125,917</td></tr>
<tr><td>Native riparian planting (38ha)</td><td>1,426,976</td></tr>
<tr><td>Erosion control structures</td><td>80,000</td></tr>
<tr><td>Project management/staffing/incidentals (30%)</td><td>1,721,368</td></tr>
<tr><td>Total</td><td>7,459,261</td></tr>
</table>
</td>
<td>C = 7.5</td>
</tr>
</table>



Waerenga catchment hill country and stream bank erosion protection and remediation

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017

Status: Final
Request No.: N/A
File name:WWRRS.gws

0.0 1.5 3.0 4.5 6.0 7.5
Kilometers

Scale 1:120,000@A4 Landscape

A4

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An example of unfenced margin of the Waerenga Stream.

CLW 17 Priority: high	Matahuru catchment hill country and streambank erosion protection and remediation	BCR value
Relevant unit goal(s)	Highly erodible land is effectively managed including through native or exotic reforestation and retirement of marginal lands. Sediment inputs to wetlands and waterbodies are reduced by 50%. The mauri/life supporting capacity of fresh water is protected and restored for aquatic species. Nutrient and sediment inputs to lakes are reduced by a proportion that leads to noticeable improvements in lake water quality and so that lakes are safe for swimming and gathering of taonga species.	
Name of feature	Matahuru sub-catchment and selected tributaries to Lake Waikare	
Brief description of feature	This collection of sub-catchments lie to the southeast of Lake Waikare and collectively contain 9971 ha. 87% of this is pasture, 9% indigenous vegetation and 5% forestry. 4892ha (50%) of the catchment is LUC class 6e or 7 in pasture. Some 160km of streams extend through these catchments, with the 50km stream network in the middle Matahuru being particularly susceptible to erosion risk. The two main streams within this area are the Mangapiko and Matahuru streams, with the former a tributary of the latter joining at Mangapiko Valley Road. Onekura Stream and several unnamed waterways also flow directly into Lake Waikare. Upper catchment streams have a stony bottom whereas the streams lower in the catchment tend to be silty bottomed. Streams in the Matahuru catchment are deeply incised with highly erodible banks and are prone to flash flooding. This needs to be taken into account when fencing setbacks and standards are determined. Land use in the upper catchment is predominantly dry stock, however, there are some dairy farms in the lower end of these catchments. Some bush remnants in the upper catchment have been fenced and some landowners have undertaken riparian fencing. The Matahuru rohe (area) feeds Lake Waikare and is home to taniwha, taonga species for gathering and historic pā sites. The catchment and lake, although degraded, is still of high significance to the local marae, in particular Matahuru, Taniwha,	

<table>
<tr><td></td><td>Waitii and Hoe-o-tainui. There are many historic routes along the Hapuakohe Range.

Modelling undertaken in 2016 has identified these catchments as a high priority for management of hill country and streambank erosion. Water quality monitoring by Waikato Regional Council indicates that the Matahuru Stream at Waiterimu Road is not suitable for swimming due to high levels of E. coli.</td><td></td></tr>
<tr><td>Desired state to achieve Vision & Strategy</td><td>- A sub-catchment where land use matches capability and with a stable stream network that has a fenced and well vegetated riparian margin along its entire length (at least 5m wide) to assist in providing erosion protection, shade and shelter.
- Forest remnants and wetlands adjacent to streams are densely vegetated with native plant species, connected to riparian corridors and protected from stock grazing. Native plant regeneration occurs naturally within the native bush remnants.
- There are no manmade barriers to native migratory fish. Native fish are abundant and there is a wide diversity of species present, including non-climbing native fish.
- The stream is swimmable, fishable and has access for recreation.
- Iwi and community have a strong connection to the stream and are active in its use, protection and restoration.</td><td></td></tr>
<tr><td>Impact on Vision & Strategy</td><td>In a restored condition, the Matahuru catchment and selected tributaries to Lake Waikare would have a very high impact on giving effect to the Vision & Strategy at a central and lower Waikato catchment level.</td><td>VS = 300</td></tr>
<tr><td>Key threats to the feature that this project addresses</td><td><table><tr><th>Key threat</th><th>Impact on feature</th></tr><tr><td>Hill country erosion</td><td>Contributes significant sediment to the catchment streams, Lake Waikare and the lower Waikato River. This reduces water and habitat quality.</td></tr><tr><td>Riverbank erosion</td><td>Contributes significant sediment load to the catchment streams, Lake Waikare and the lower Waikato River.</td></tr><tr><td>Stock access to the stream</td><td>Reduced water quality and destruction of riparian vegetation.</td></tr></table></td><td></td></tr>
<tr><td>Project goal/s</td><td>Within 20 years of project commencement:
- 100% of LUC class 8 soils are retired from grazing.</td><td></td></tr>
</table>

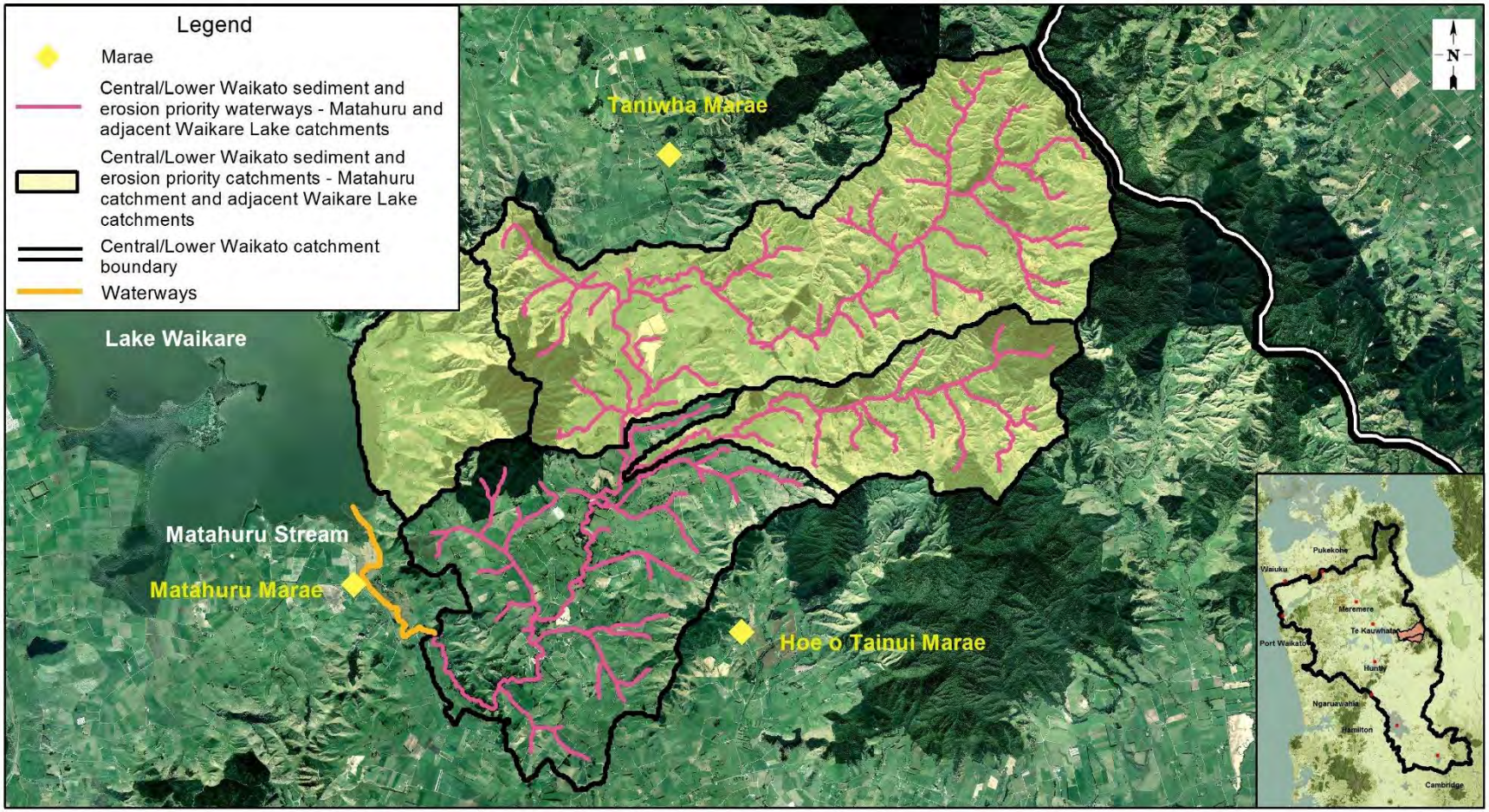
	- LUC class 7 soils are managed within their capabilities and are retired from heavy stock grazing. - The main channel and tributaries of identified waterways are stable and fenced to exclude stock with a minimum 3-wire electric fence. - Native and exotic planting (and associated weed control) is established within areas of the riparian margin most susceptible to erosion. - There is a 40% reduction in suspended sediment in the Matahuru Stream.	
Priority works for funding	Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This project could be undertaken as a whole, or in multiple smaller components. **Hill country soil conservation** *These apply to the Mangapiko, upper Matahuru and Waikare east catchments:* - 452ha LUC 6e land managed with open space pole planting at $3000 per hectare - 452ha LUC 6e land managed with plantation species (pine or mānuka) at $3000 per hectare - 76km of fencing the managed LUC 6e land at $25 per metre (8-wire and batten) - 655ha LUC 7 land managed with plantation species (pine or mānuka) at $3000 per hectare - 51km of fencing the managed LUC 7 land at $25 per metre (8-wire and batten) - 12ha reducing sediment to waterways outside LUC class 6e, 7 and 8 land at $8000 per hectare (e.g. dewatering, retiring seepages, etc) - 18km fencing existing indigenous forest cover at $25 per metre (8-wire and batten). **Riparian management of rivers/streams in pasture for soil conservation purposes** *These apply to the Mangapiko, upper Matahuru and middle Matahuru catchments. For these catchments, fencing estimates were double those used for the rest of the Lower Waikato. This was based on the advice of local land management staff familiar with the catchment and who estimated that less than 25% of the target waterways were currently fenced. Costs for fencing are based on a 5-wire (2 electric) fence, however, in these flood prone streams a 3-wire electric fence would also be acceptable.* Carry out riparian fencing with a minimum 5m setback from the top of the streambank (at least 5 wire with 2 electric wires at $8 per metre) along an estimated 120km of streambank (60km of stream length). Include adjoining wetland areas within the riparian fencing. Undertake a mix of native and exotic soil	

	conservation riparian planting within the fenced area (where it doesn't exist naturally), estimated to be 44ha of planting and associated weed control and maintenance. 12,436 willow poles are estimated to be required for river and stream erosion control. 25% of newly fenced streambanks are estimated to require a combination of hard and soft erosion structures. This equates to 30km of streambank with an estimated cost of $20,000 per km. (Note: Waikato Regional Council holds a current resource consent for such works and should therefore be consulted on river management proposals.) **Project management/staffing/incidentals** Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include transport, office overheads, consumables and miscellaneous professional fees. This is estimated to be 30% of the direct project costs.	
Time lag for benefits to be realised	If works were implemented at an even pace over a 20-year period, it is estimated that the majority of the project benefits would be seen approximately 15 years after project commencement.	L = 15
Effectiveness of works	The Matahuru sub-catchment and tributaries to Lake Waikare retain some very important values, however the overall condition of the sub-catchment is significantly below desired state for meeting the Vision & Strategy. Over the next 20 years it is expected that some aspects may deteriorate in the catchment in the absence of this project. Works included here address several key threats and it is anticipated that if the project is fully completed, the catchment will move substantially closer to the Vision & Strategy desired state in areas such as land use meeting capability and streambank stability. The project has secondary benefits in protecting and improving water quality by reducing E. coli to waterways, and enhancing catchment biodiversity. It is acknowledged that achieving the Vision & Strategy desired state in these locations will take a fuller range of initiatives over the longer term and will take longer than the 20 year horizon used for the purposes of the Restoration Strategy, however, this project is expected to make a measurable difference to the Matahuru sub-catchment.	W = 0.3
Risk of technical failure	There is a moderate risk of project failure due to technical feasibility. Risks are mostly related to establishment of plantings or loss of works due to flooding and/or erosion before they are	F = 0.82

	established. This would be minimised by the stream fencing setbacks being at least 5m, and by planting sterile willow poles to stabilise banks while native plantings establish. Erosion prevention and protection works should be planned by people with appropriate technical expertise and local knowledge.	
Adoptability	It is estimated that about a quarter of landowners would adopt the works if they were fully incentivised. Uptake of management of LUC class 6e and 7 land may be low and we are not aware of significant similar works being undertaken in this catchment to date. There are large sections of streams that are meandering and erosive in nature and likely to flood on a regular basis. Landowners may be unwilling to erect fences in these locations due to the potential maintenance costs. Fencing setbacks of at least 5m from the top of banks should help to minimise this, however, this loss of grazing land may also be a challenge with uptake. It would be beneficial to establish sites that demonstrate the benefits of stable, vegetated stream margins. Early community engagement, flexibility of approach and identifying key farmers will be very important for the success of this project.	A = 0.25
Information quality	Average – estimates are based on modelled information, Lower Waikato riparian surveys and input from catchment officers who are familiar with the sub-catchments.	
Knowledge gaps	Estimates of LUC classes 6e and 7 and 8 and stream lengths come from a desktop exercise. Farm scale information will need to be gathered as part of this project.	
Socio-political risks	Moderate risk that the project will fail to meet its goals over the long term due to socio-political risks. Early stakeholder engagement will be very important for the successful delivery of this project.	P = 0.75
Project duration (years)	20 years	

Up-front cost – total for implementation phase/project duration		C = 15.32

Task	**Cost ($)**
452ha LUC 6e managed with pole planting	1,356,000
452ha LUC 6e managed with plantation species	1,356,000
Fencing managed LUC 6e land (76km)	1,900,000
655ha LUC 7 managed with plantation species	1,965,000
Fencing managed LUC 7 land (51km)	1,275,000
Erosion control outside LUC 6e, 7 and 8 (12ha)	96,000
Fencing existing indigenous vegetation (18km)	450,000
Riparian fencing (120km)	960,000
Riparian willow/poplar pole planting (12,436 poles)	174,104
Native riparian planting (44ha)	1,652,288
Erosion control structures	600,000
Project management/staffing/incidentals (30%)	3,535,317
Total	**15,319,709**



Matahuru catchment hill country and stream bank erosion protection and remediation

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017

Status: Final
Request No.: N/A
File name:WWRRS.gws

0 1 2 3 4 5
Kilometers

Scale 1:100,000@A4 Landscape

A4

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Hill country in the upper Matahuru catchment.

Hill country in the Mangapiko Stream catchment (a tributary of the Matahuru Stream).

A slip in the Matahuru catchment has been planting with poles in an attempt to stabilise.

The Matahuru Stream where it enters Lake Waikare.

Erosion on the Matahuru Stream.

An unfenced and eroding section of the Matahuru Stream.

Active erosion on hill country adjacent to Lake Waikare.

CLW 18 Priority: high	Rehabilitation of banded kōkopu habitat on selected inflows to Lake Puketirini and Lake Waahi	BCR value
Relevant unit goal(s)	Aquatic habitats, including spawning grounds, are protected, enhanced, restored and accessible to native fish. The abundance of native fish, including taonga species, in the catchment is restored and protected.	
Name of feature	Selected inflows to Lake Puketirini and Lake Waahi	
Brief description of feature	Waterways identified for this project include: - Awaroa Stream from Waikokowai Road (near Rotowaro Coal Mine) to Lake Waahi: this section of stream is approximately 4.5km long and flows through flat intensively farmed pasture land. - Waitawhara Stream: flowing from rugged hill country southwest of Lake Waahi (approximately 50% pasture and 50% native bush), it then flows alongside Rotowaro Road to join Awaroa Stream near Rotowaro Coal Mine. - Mangakōtukutuku Stream flowing downstream from Hakarimata Range for approximately 2km to where it enters the Rotowaro Mine site. The stream flows through a mixture of farmland, exotic forest and regenerating native forest. - A 4.5km length of unnamed tributaries to Lake Puketirini immediately west of Hillside Heights Road and flowing under Rotowaro Road to Lake Puketirini. Riparian vegetation consists mainly of pasture grasses. These waterways were identified as priorities as they are known to have populations of banded and giant kōkopu and these are expected to respond well to habitat rehabilitation. The total length of waterways identified is 23km. Puketirini and Lake Waahi are a valuable for source of mahinga kai for many marae within the Rahui Pokeka (Huntly) area.	
Desired state to meet Vision & Strategy	- Waterways are fenced to exclude stock from their entire length. - Waterways have riparian margins that are vegetated with native plants to provide stream shading and cover for fish. - Native fish are abundant, particularly banded kōkopu and giant kōkopu. - There are no manmade barriers to native migratory fish. - The streams are swimmable, fishable and have access for recreation. - Iwi and communities have a strong connection to the streams and are active in their use, protection and restoration.	

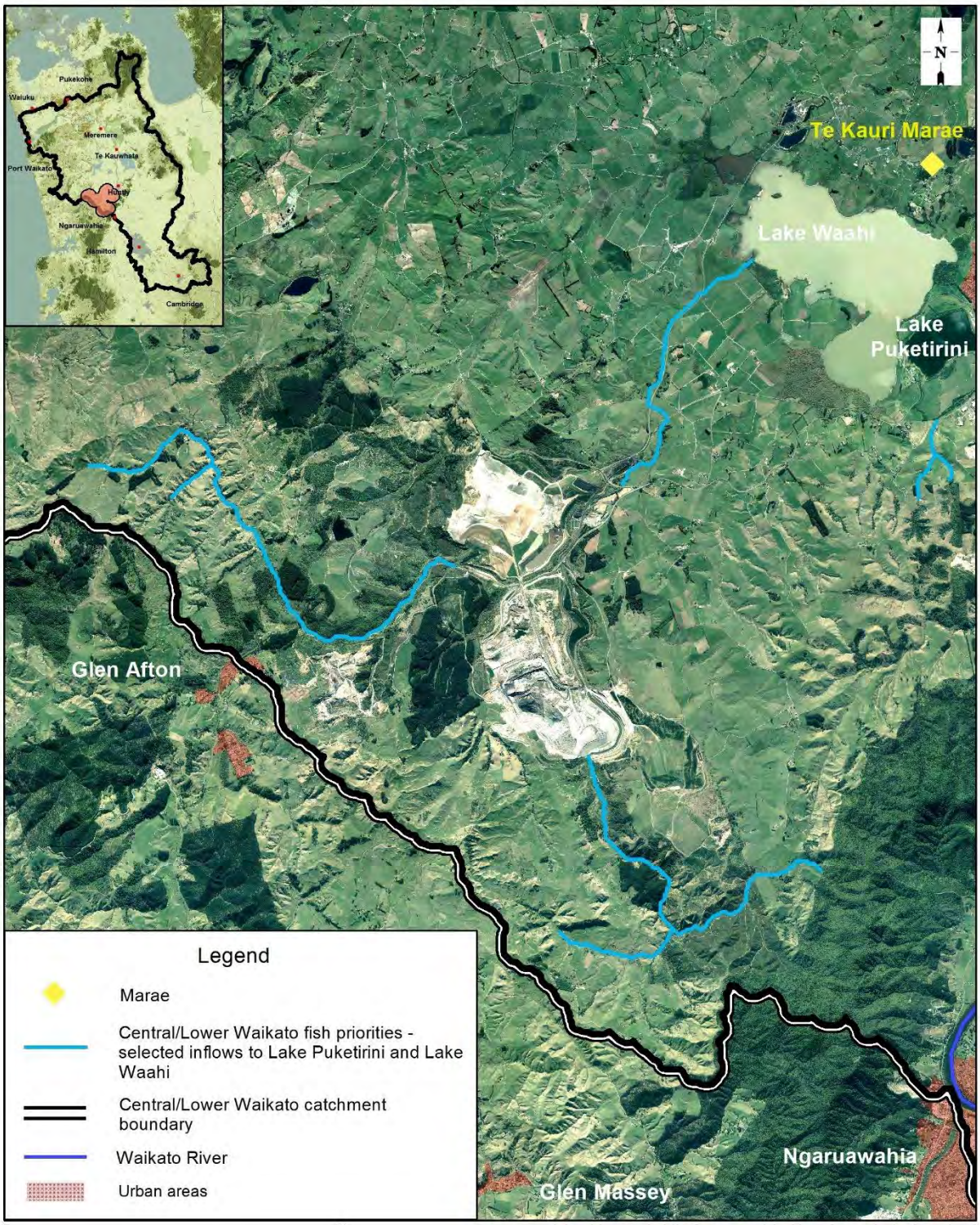
<table>
<tr><td>Impact on Vision & Strategy</td><td>In a restored condition these streams would have a high impact on giving effect to the Vision & Strategy at a central and lower Waikato catchment level.</td><td>VS = 40</td></tr>
<tr><td>Key threats to the feature that this project addresses</td><td><table>
<tr><th>Key threat</th><th>Impact on feature</th></tr>
<tr><td>Stock access to the stream</td><td>Reduced water quality and destruction of riparian vegetation.</td></tr>
<tr><td>Lack of riparian cover and associated fish habitat</td><td>Reduced habitat for adult fish.</td></tr>
<tr><td>Weed species</td><td>Compete with native plant communities and are a threat to agriculture.</td></tr>
<tr><td>Vegetation clearance</td><td>Reduced cover, habitat and food (invertebrates) for native fish species.</td></tr>
<tr><td>Culverts and crossings that are a barrier for native fish</td><td>Native fish unable to access upstream areas.</td></tr>
</table></td><td></td></tr>
<tr><td>Project goal/s</td><td>Within 7 years of project commencing:
- 100% of the waterways are fenced to exclude stock.
- On both sides of the stream there is a vegetated riparian margin (at least 5m wide) that provides stream shade and enhances habitat for adult native fish.
- There are no manmade barriers to native migratory fish. Barriers to pest fish are left in place.</td><td></td></tr>
<tr><td>Priority works for funding</td><td>Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This project could be undertaken as a whole, or in multiple smaller components.

Riparian management
Carry out riparian fencing with a minimum 5m setback from the top of the streambank (5 wire fence – 2 electric wires). Include adjoining wetland areas within the riparian fencing.
- Assume 50% (this equates to 23km in total, including both sides) requires fencing or fence upgrade/moving back ($184,000).

Undertake native riparian planting within the fenced area and associated weed control and maintenance for native plant establishment.
- Assume 50% (6ha) requires planting ($237,312)
- Additional weed control, using a knapsack, within fenced areas (23km long riparian area or 11.5ha) to assist in establishing plantings and promoting native regeneration. The estimated</td><td></td></tr>
</table>

	cost of this is $2800 per hectare per year ($96,600 over 3 years). **Remediation of fish barriers** Reduce the length of the culvert that flows under Rotowaro Road. Estimated cost $5000. Note: the weir located at the bottom of the catchment is in the process of being reinstated by NIWA to exclude pest fish from this catchment. **Project management/staffing/incidentals** Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include transport, office overheads, consumables and miscellaneous professional fees. This is estimated to be 25% of the direct project costs.	
Time lag for benefits to be realised	If works were implemented at an even pace over a 7-year period, it is estimated that the majority of the project benefits would be seen within 1 year of project completion.	L = 7.5
Effectiveness of works	The selected inflows to Lake Puketirini and Lake Waahi are currently in reasonable condition with some of the Vision & Strategy desired state aspects already being met, including being fishable. The Lake Waahi tributaries are considered to be in better condition than those of Puketirini. Overall, some improvement may be expected over the next 20 years even in the absence of this project. This is because catchment mining is expected to cease over this time. Works included here are expected to substantially increase the quality of fish habitat. Although it won't address catchment land use, the wide riparian setbacks should contribute to protecting and restoring water quality through shading, stock exclusion and reduction of nutrients and pathogens entering the streams. It is anticipated that if the project is fully completed, in 20 years' time the streams will be in good condition and closer to the Vision & Strategy state being achieved.	W = 0.075
Risk of technical failure	There is a low risk of project failure due to technical feasibility. Risks are mostly related to establishment of plantings.	F = 0.87
Adoptability	It is estimated that approximately three-quarters of landowners would adopt the works if they were fully incentivised. The extent of the fencing setbacks may provide some challenge in terms of uptake.	A = 0.75

<table>
<tr><td>Information quality</td><td>Good information – advice of local expert/s with a history of association to selected sites. Costings for most sites are largely based off aerial photography and local knowledge.</td><td></td></tr>
<tr><td>Knowledge gaps</td><td>It is unknown specifically how much fencing already exists. This would need to be established as part of the project planning. Location of fish barriers would need to be determined in the early stages of the project.</td><td></td></tr>
<tr><td>Socio-political risks</td><td>Very risk that the project will fail to meet its goals over the long term due to socio-political risks.</td><td>P = 0.97</td></tr>
<tr><td>Project duration (years)</td><td>7 years</td><td></td></tr>
<tr><td>Up-front cost – total for implementation phase/project duration</td><td><table>
<tr><th>Task</th><th>Cost ($)</th></tr>
<tr><td>Fencing (23km)</td><td>184,000</td></tr>
<tr><td>Planting (6ha)</td><td>237,312</td></tr>
<tr><td>Additional weed control within riparian area to promote native regeneration</td><td>96,600</td></tr>
<tr><td>Remediation of fish barriers</td><td>5000</td></tr>
<tr><td>Project management/staffing/incidentals (25% of project cost)</td><td>130,728</td></tr>
<tr><td>Total</td><td>653,640</td></tr>
</table></td><td>C = 0.65</td></tr>
</table>



Rehabilitation of banded kōkopu habitat in selected inflows to Lake Puketirini and Lake Waahi

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017
Status: Final
Request No.: N/A
File name: WWRRS.gws

0.0 0.5 1.0 1.5 2.0 2.5
Kilometers

Scale 1:70,000@A4 Portrait

A4

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Awaroa Stream showing unfenced riparian margin.

CLW 19 Priority: high	Upper Awaroa (Waahi) catchment hill country erosion protection and remediation	BCR value
Relevant Unit Goal(s)	Highly erodible land is effectively managed including through native or exotic reforestation and retirement of marginal lands. Sediment inputs to wetlands and waterbodies are reduced by 50%. The mauri/life supporting capacity of fresh water is protected and restored for aquatic species.	
Name of feature	Awaroa sub-catchment in the headwaters above Lake Waahi	
Brief description of feature	This is a relatively small catchment of 3536ha. It extends from the west at the catchment divide and goes northeast down to the confluence with the Te Wha Stream. From here it travels through the lower Awaroa and into Lake Waahi. Approximately 52% of the catchment is in pasture and 1227ha is estimated to be Land Use Capability (LUC) 6e in pasture. The predominant land use on this land is dry stock farming. Approximately 25% of the catchment is in either indigenous vegetation or plantation forestry. The main waterways in the catchment are the Mangakōtukutuku, the Awaroa and the Waitawhara streams. The catchment contains a series of current and rehabilitated open cast mines that lie west of Rotowaro. These include the township mine, Awaroa mine and Waipuna mine. The area was known for the gathering of bird life, fisheries and other taonga species for iwi and marae. The Hakarimata Range was regularly crossed by Māori to access the lakes and resources in the Awaroa catchment. There is little information on current soil conservation and riparian protection works in the catchment, however, there are only a small number of works that have been undertaken in partnership with Waikato Regional Council. There remains significant scope for soil conservation works here. Modelling undertaken in 2016 indicates that the upper Awaroa (Waahi) catchment is a high priority for hill country erosion management.	
Desired state to achieve Vision & Strategy	- A sub-catchment where land use matches capability and with a stable stream network that has a fenced and well vegetated riparian margin along its entire length (at least 5m wide). - Forest remnants and wetlands adjacent to streams are densely vegetated with native plant species, connected to riparian corridors and protected from stock grazing. - Native plant regeneration occurs naturally within the native bush remnants.	

<table>
<tr><td></td><td>- There are no manmade barriers to native migratory fish. Native fish are abundant and there is a wide diversity of species present.
- The streams are swimmable, fishable and have access for recreation.
- Iwi and community have a strong connection to the streams and are active in their use, protection and restoration.</td><td></td></tr>
<tr><td>Impact on Vision & Strategy</td><td>In a restored condition, Awaroa sub-catchment in the headwaters above Lake Waahi would have a high impact on giving effect to the Vision & Strategy at a central and lower Waikato catchment level.</td><td>VS = 50</td></tr>
<tr><td>Key threats to the feature that this project addresses</td><td><table><tr><th>Key threat</th><th>Impact on feature</th></tr><tr><td>Hill country erosion</td><td>Contributes significant sediment to the catchment streams, Lake Waahi and the lower Waikato River.</td></tr></table></td><td></td></tr>
<tr><td>Project goal/s</td><td>There is a 30% reduction in suspended sediment in the upper Awaroa streams within 15 years of project commencement.</td><td></td></tr>
<tr><td>Priority works for funding</td><td>Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This project could be undertaken as a whole, or in multiple smaller components.

Hill country soil conservation
- 153ha LUC 6e land managed with open space pole planting at $3000 per hectare
- 153ha LUC 6e land managed with plantation species (pine or mānuka) at $3000 per hectare
- 29km of fencing the managed LUC 6e land at $25 per metre (8-wire and batten)
- 7ha reducing sediment to waterways outside Class 6e, 7 and 8 land at $8000 per hectare (e.g. dewatering, retiring seepages, etc)
- 6km fencing existing indigenous forest cover at $25 per metre (8-wire and batten)
- 12 hunter days per year for 3 years of goat control while plantings on 6e land establish. Control carried out over a 1200ha area.

Project management/staffing/incidentals
Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include transport, office overheads, consumables and miscellaneous professional fees.</td><td></td></tr>
</table>

	This is estimated to be 25% of the direct project costs.	
Time lag for benefits to be realised	If works were implemented at an even pace over a 5-year period, it is estimated that the majority of the project benefits would be seen approximately 2-3 years after project completion.	L = 7.5
Effectiveness of works	The Awaroa sub-catchment is in moderate condition when compared to desired state, with few of the Vision & Strategy aspirations being met. It is expected that over the next 20 years there may be a deterioration in the condition of the catchment in the absence of this project. It is acknowledged that achieving the Vision & Strategy desired state will take a fuller range of initiatives and longer than the 20 year horizon used for the purposes of the Restoration Strategy. However, works included in this project address some of the key threats to the feature and it is anticipated that if the project is fully completed it would offset anticipated decline and make some headway with respect to achieving the Vision & Strategy state in 20 years' time. The project does not directly address all threats to the Awaroa, however, in addition to addressing land use matching capability, the proposed fencing and planting works would provide secondary benefits of reducing E. coli to waterways and improving fish habitat and biodiversity.	W = 0.2
Risk of technical failure	There is a low risk of project failure due to technical feasibility. Risks are mostly related to establishment of plantings or loss of works due to weather events/erosion.	F =0.87
Adoptability	It is estimated that approximately one third of landowners would adopt the works if they were fully incentivised. Uptake of management of LUC class 6e and 7 land may be low and we are not aware of significant similar works being undertaken recently in this catchment. Early community engagement, flexibility of approach and identifying key farmers will be very important for the success of this project.	A = 0.3
Information quality	Average – estimates are based on modelled information and input from catchment officers who are familiar with the sub-catchment.	
Knowledge gaps	Estimates of LUC class 6e come from a desktop exercise. Farm scale information will need to be gathered as part of this project.	
Socio-political risks	Low risk that the project will fail to meet its goals over the long term due to socio-political risks.	P = 0.85
Project duration (years)	5 years	

<table>
<tr>
<td>Up-front cost – total for implementation phase/project duration</td>
<td>
<table>
<tr><th>Task</th><th>Cost ($)</th></tr>
<tr><td>153ha LUC 6e managed with pole planting</td><td>459,000</td></tr>
<tr><td>153ha LUC 6e managed with plantation species</td><td>459,000</td></tr>
<tr><td>Fencing managed LUC 6e land (29km)</td><td>725,000</td></tr>
<tr><td>Erosion control outside LUC 6e, 7 and 8 (7ha)</td><td>56,000</td></tr>
<tr><td>Fencing existing indigenous vegetation (6km)</td><td>150,000</td></tr>
<tr><td>Goat control on treated 6e and 7</td><td>14,688</td></tr>
<tr><td>Project management/staffing/incidentals (25%)</td><td>465,922</td></tr>
<tr><td>Total</td><td>2,329,610</td></tr>
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<td>C = 2.33</td>
</tr>
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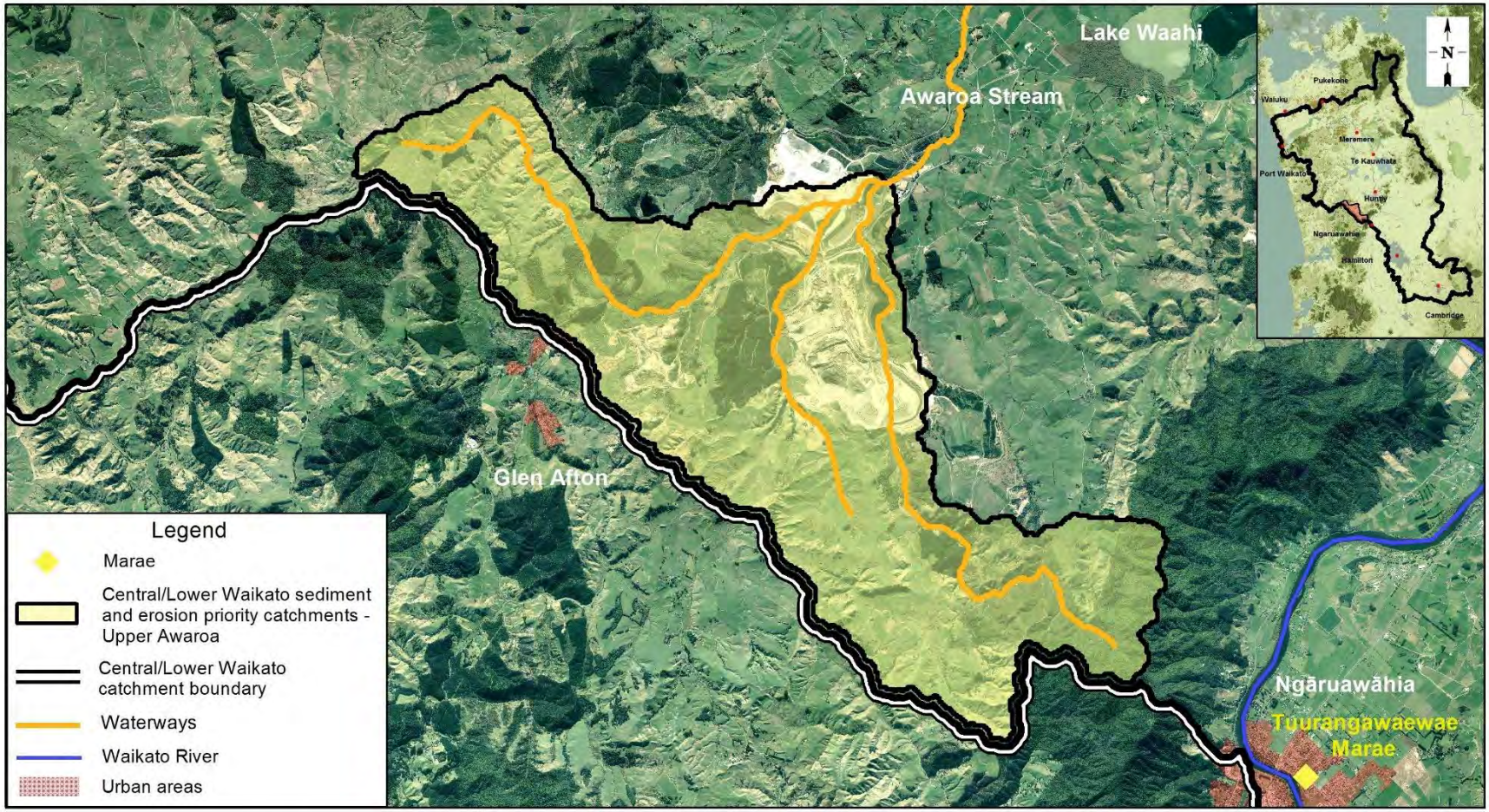

Upper Awaroa (Waahi) catchment hill country erosion protection and remediation

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017

Status: Final
Request No.: N/A
File name:WWRRS.gws

0.00 0.75 1.50 2.25 3.00 3.75
Kilometers

Scale 1:75,000@A4 Landscape

A4

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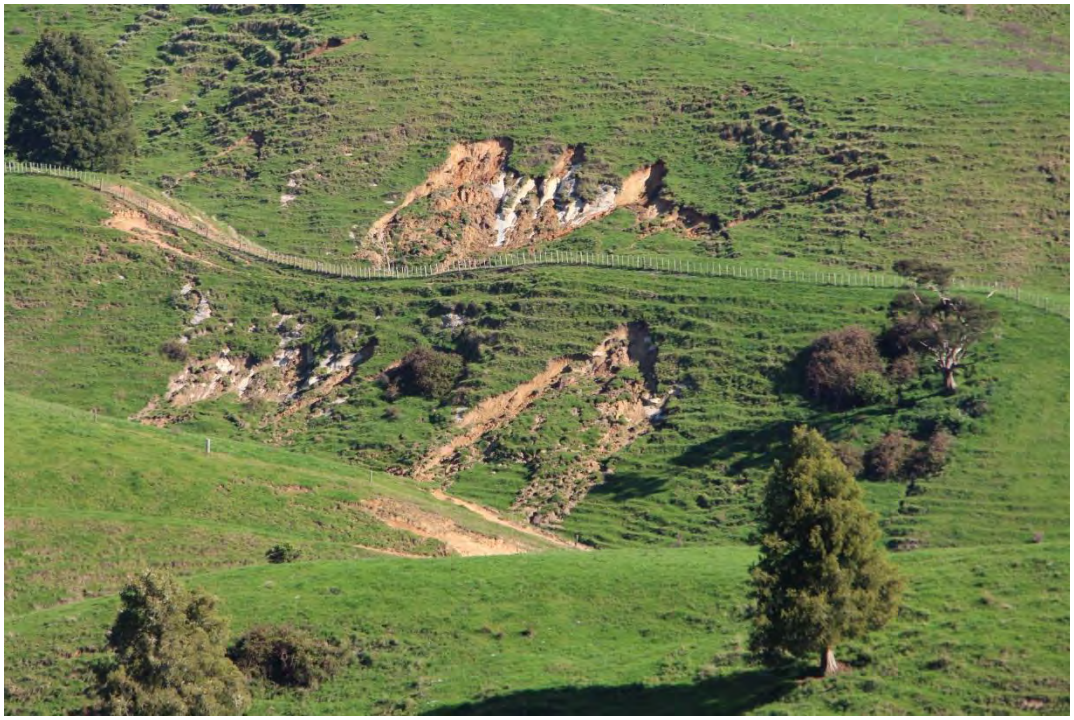

Hill country erosion following a large rain event.

A soil slip following a heavy rain event.

CLW 20 Priority: very high	Rehabilitate fish habitat in streams flowing from Hakarimata Range to the Waikato River	BCR value
Relevant Unit Goal(s)	Aquatic habitats, including spawning grounds, are protected, enhanced, restored and accessible to native fish. The abundance of native fish, including Taonga species, in the catchment is restored and protected.	
Name of feature	Streams flowing from Hakarimata Range to Waikato River	
Brief description of feature	These are a selection of mostly short streams flowing from the steep forested headwaters of the Hakarimata Range to the Waikato River. They provide important habitat for native fish species such as shortfin eel, longfin eel, kōkopu and īnanga, and could be further enhanced to provide more extensive and better quality fish habitat. Not all of the streams are fully fenced to exclude stock and there are large sections that lack riparian vegetation. There are also known barriers (perched culverts and crossings) that prevent passage of native migratory fish. The Hakarimata Range and its peaks are recognised as children of Taupiri and Pirongia. The pae maunga (range) is culturally significant to Waikato-Tainui and marae. The Hakarimata is named as such in recognition of a significant event at Puke-i-ahua (Havelock Hill), which restored a disagreement between Maniapoto and Waikato. The food to celebrate the birth of a common mokopuna (grandchild) was so large it stretched from Puke-i-ahua to Te Huinga o ngā Wai (the point). However, it was not fully cooked, it was raw. The name Hākari (feast) - mata (raw) was then given to the mountain range.	
Desired state to meet Vision & Strategy	- Waterways are fenced to exclude stock from their entire length. - Waterways have riparian margins that are vegetated with native plants to provide stream shading and cover for fish. Vegetated riparian margins are at least 5m wide. - Native fish are abundant and there is a wide diversity of species present, including non-climbing native fish. - There are no manmade barriers to native migratory fish. - The streams are swimmable, fishable and have access for recreation. - Iwi and communities have a strong connection to the streams and are active in their use, protection and restoration.	
Impact on Vision & Strategy	In a restored condition the streams flowing from the Hakarimata Range to the Waikato River would have a high impact on giving	VS = 40

<table>
<tr><td></td><td>effect to the Vision & Strategy at a central and lower Waikato catchment level.</td><td></td></tr>
<tr><td>Key threats to the feature that this project addresses</td><td>
<table>
<tr><th>Key threat</th><th>Impact on feature</th></tr>
<tr><td>Stock access to the stream</td><td>Reduced water quality and destruction of riparian vegetation.</td></tr>
<tr><td>Lack of riparian cover and associated fish habitat</td><td>Reduced habitat for adult fish.</td></tr>
<tr><td>Weed species</td><td>Compete with native plant communities and are a threat to agriculture.</td></tr>
<tr><td>Vegetation clearance</td><td>Reduced cover, habitat and food (invertebrates) for native fish species.</td></tr>
<tr><td>Culverts and crossings that are a barrier for native fish</td><td>Native fish unable to access upstream areas.</td></tr>
</table>
</td><td></td></tr>
<tr><td>Project goal/s</td><td>Within 5 years of the project commencing:
- All of the waterways are 100% fenced to exclude stock.
- There is a planted riparian margin (at least 5 metres wide) that provides stream shade and enhances habitat for adult native fish.
- There are no manmade barriers to native migratory fish.</td><td></td></tr>
<tr><td>Priority works for funding</td><td>Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This project could be undertaken as a whole, or in multiple smaller components.

Riparian management
Carry out riparian fencing with a minimum 5m setback from the top of the streambank (5 wire fence – 2 electric wires). Include adjoining wetland areas within the riparian fencing.
- Assume 95% (18km of streambank) requires fencing or fence upgrade/moving at a cost of $8 per metre ($144,000).

Undertake native riparian planting (within appropriately fenced areas) and associated weed control and maintenance for native plant establishment.
- Assume 95% (17km of streambank/8.5ha) requires planting on both sides ($319,192).

Remedy of fish barriers
Determine the location and type of barriers to fish passage.

Cost estimates are based on remedying six barriers to native fish at $5000 each ($30,000). Remediation actions will depend on the type of barrier present but could include installation of mussel ropes, fish ramps, baffles and/or culvert reconstruction.</td><td></td></tr>
</table>

	Project management/staffing/incidentals Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include transport, office overheads, consumables and miscellaneous professional fees. This is estimated to be 25% of the direct project costs.	
Time lag for benefits to be realised	If works were implemented at an even pace over a 5-year period, it is estimated that the majority of the project benefits would be seen approximately 1-2 years after project completion.	L = 6.5
Effectiveness of works	When compared to the Vision & Strategy desired state, these streams currently vary from good condition near the forested headwaters to moderate condition in the lower reaches. Overall, there is not expected to be significant change in condition of these streams over the next 20 years in the absence of this project. Works included here are expected to substantially increase fish habitat availability and quality. Although they won't address catchment land use, the wide riparian setbacks should contribute to protection and restoring water quality through shading, stock exclusion and reduction of nutrients and pathogens entering the streams. It is anticipated that if the project is fully completed, in 20 years' time the streams will be in good to very good condition and closer to the Vision & Strategy state being achieved.	W = 0.15
Risk of technical failure	There is a low risk of project failure due to technical feasibility. Risks are mostly related to establishment of plantings.	F = 0.87
Adoptability	It is estimated that approximately three-quarters of landowners would adopt the works if they were fully incentivised. The extent of the fencing setbacks may provide some challenge in terms of uptake.	A = 0.75
Information quality	Poor – estimates for most sites are largely based off aerial photography and some local knowledge.	
Knowledge gaps	It is unknown specifically how much fencing already exists. This would need to be established as part of the project planning. If there is already a large amount of fencing close to the streambank (i.e. with a narrow riparian margin) landowners may be unwilling to move fences back to allow room for native planting.	
Socio-political risks	Very risk that the project will fail to meet its goals over the long term due to socio-political risks.	P = 0.97
Project duration (years)	5 years	

<table>
<tr>
<td>Up-front cost – total for implementation phase/project duration</td>
<td>
<table>
<tr><th>Task</th><th>Cost ($)</th></tr>
<tr><td>Fencing (18km)</td><td>144,000</td></tr>
<tr><td>Planting (8.5ha) including plant establishment</td><td>319,192</td></tr>
<tr><td>Remediation of barriers to native fish</td><td>30,000</td></tr>
<tr><td>Project management/staffing/incidentals (25% of project cost)</td><td>123,298</td></tr>
<tr><td>Total</td><td>616,490</td></tr>
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<td>C = 0.62</td>
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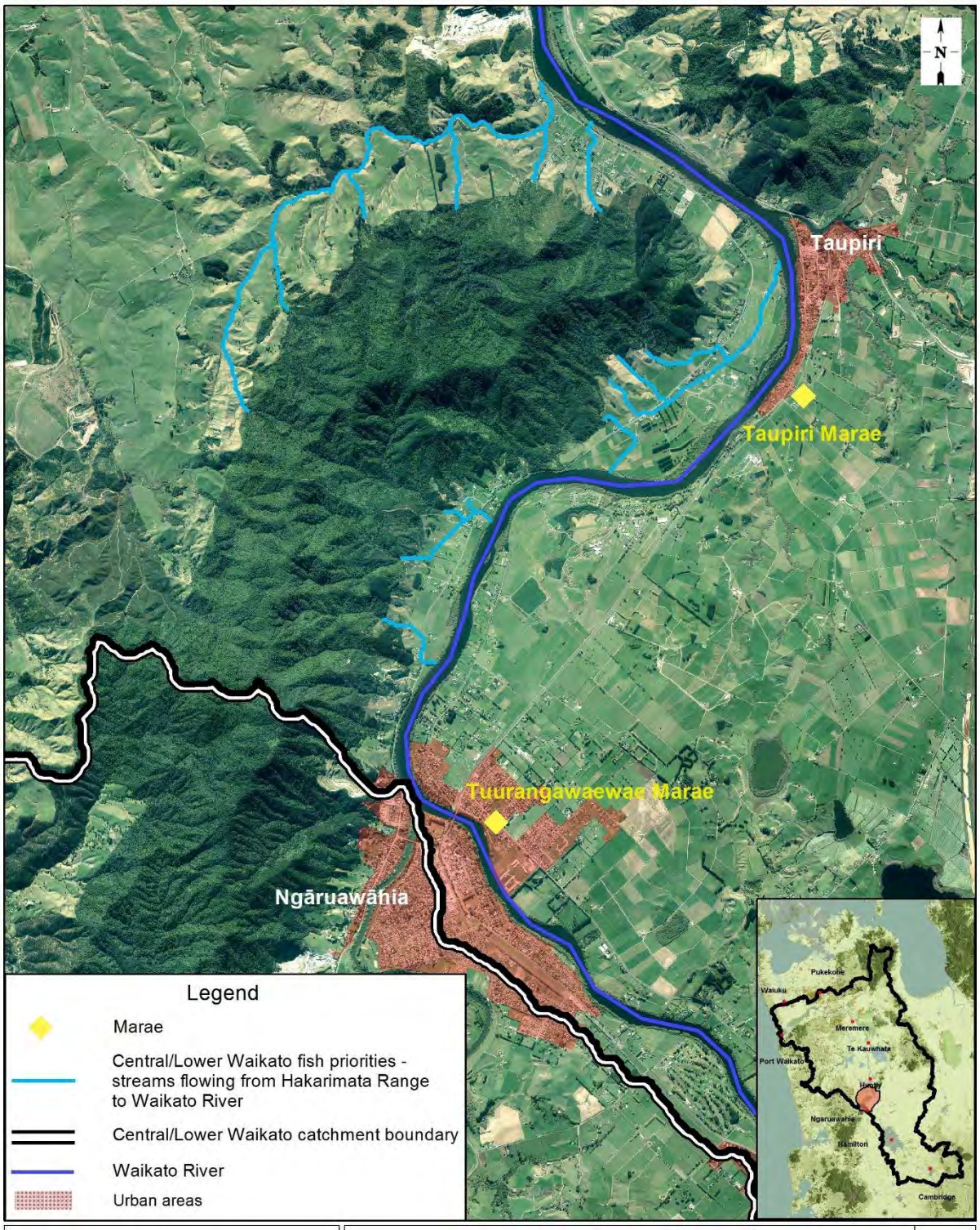

Rehabilitation of fish habitat in streams flowing from Hakarimata Range to Waikato River

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017
Status: Final
Request No.: N/A
File name: WWRRS.gws

0.0 0.4 0.8 1.2 1.6 2.0
Kilometers

Scale 1:50,000@A4 Portrait

A4

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The stream flowing through centre of this photo would benefit from fencing and planting.

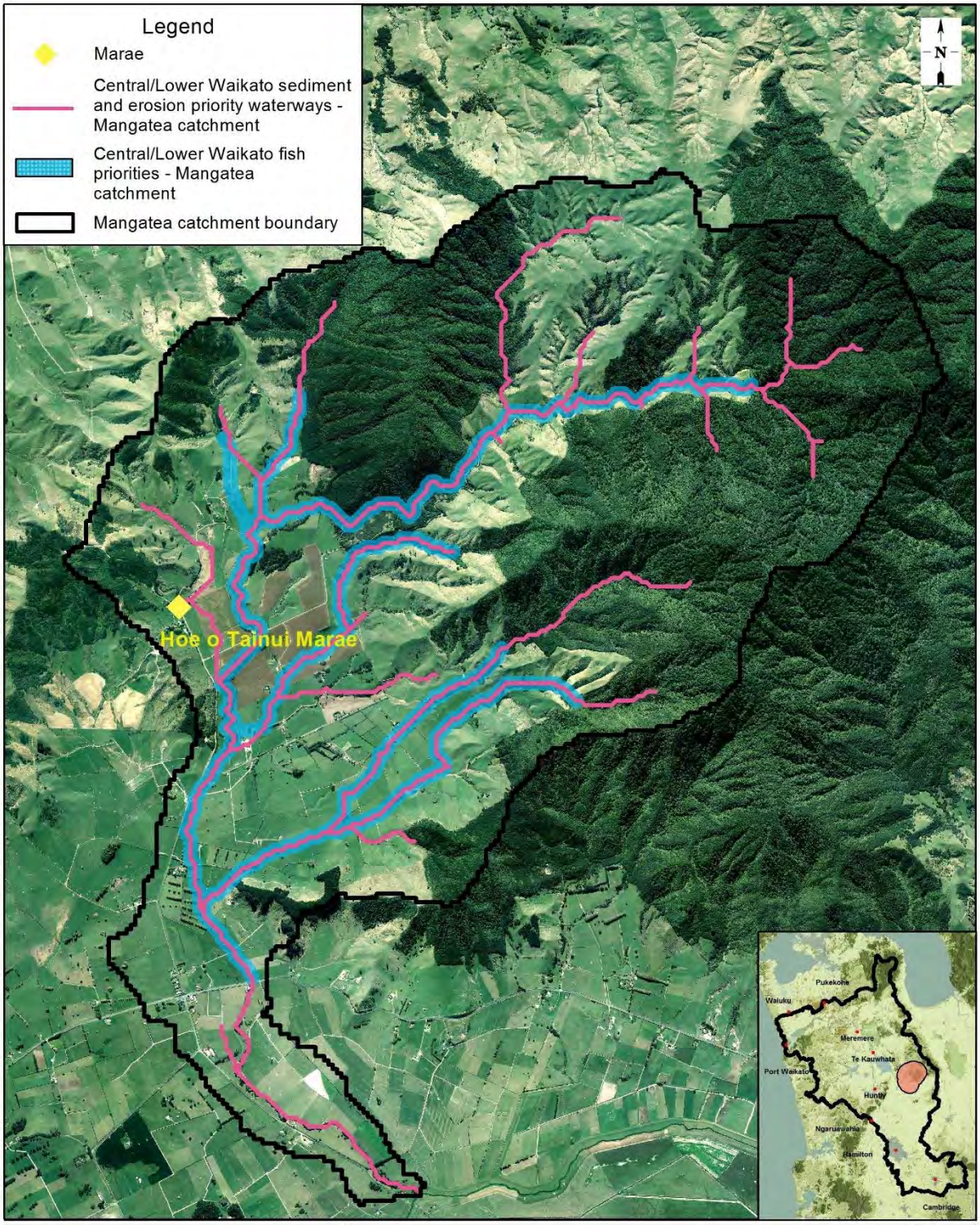
CLW 21 Priority: medium	Mangatea Stream integrated catchment programme	BCR value
Relevant unit goal(s)	Sediment inputs to wetlands and waterbodies are reduced by 50%. The mauri/life supporting capacity of fresh water is protected and restored for aquatic species. Aquatic habitats, including spawning grounds, are protected, enhanced, restored and accessible to native fish. The abundance of native fish, including taonga species, in the catchment is restored and protected.	
Name of feature	Mangatea sub-catchment	
Brief description of feature	The Mangatea catchment is a small (2086ha) catchment with the stream itself being a tributary to the Mangawara. The catchment headwaters are in indigenous vegetation. Of the approximately 36km stream network, 24km lie in pastoral areas. The catchment extends from the west of the Hapuakohe summit, downstream to its confluence with the Mangawara. Land use in the catchment is a mix of dairy and dry stock farming. There have been some historic willow and poplar plantings on the stream margins which have been successful in stabilising banks along planted reaches. However, there is significant bank instability where banks are de-vegetated and therefore scope remains to undertake similar works throughout. The stream has been identified through modelling as a priority for prevention and management of bank erosion. Fish experts have identified waterways within this catchment as being important habitat for native fish species (including īnanga, giant kōkopu, kōura, shortfin eel and longfin eel) and there are opportunities to increase native fish abundance by remediating barriers and providing increased and higher quality fish habitat. The Mangatea catchment, Hapuakohe Range and Mangawara Stream provided significant resources to marae, including kōura (freshwater crayfish), tuna (eels), kōkopu and bird species. There are many historic pā sites and marae within the area.	

<table>
<tr><td>Desired state to achieve Vision & Strategy</td><td>- A sub-catchment where land use matches capability and with a stable stream network that has a fenced and well vegetated riparian margin along its entire length (at least 5m wide) to assist in providing erosion protection, shade and shelter.
- Forest remnants and wetlands adjacent to streams are densely vegetated with native plant species, connected to riparian corridors and protected from stock grazing.
- Native plant regeneration occurs naturally within the native bush remnants.
- There are no manmade barriers to native migratory fish.
- Native fish are abundant and there is a wide diversity of species present, including non-climbing native fish.
- The stream is swimmable, fishable and has access for recreation.
- Iwi and community have a strong connection to the stream and are active in its use, protection and restoration.</td><td></td></tr>
<tr><td>Impact on Vision & Strategy</td><td>In a restored condition, the Mangatea sub-catchment would have a high impact on giving effect to the Vision & Strategy at a central and lower Waikato catchment level.</td><td>VS = 40</td></tr>
<tr><td>Key threats to the feature that this project addresses</td><td><table>
<tr><th>Key threat</th><th>Impact on feature</th></tr>
<tr><td>Riverbank erosion</td><td>Contributes significant sediment load to the Mangatea Stream, Mangawara Stream and lower Waikato River.</td></tr>
<tr><td>Stock access to the stream</td><td>Reduced water quality and destruction of riparian vegetation.</td></tr>
<tr><td>Lack of riparian cover and associated fish habitat</td><td>Reduced habitat for adult fish.</td></tr>
<tr><td>Weed species</td><td>Compete with native plant communities.</td></tr>
<tr><td>Vegetation clearance</td><td>Reduced cover, habitat and food (invertebrates) for native fish species.</td></tr>
<tr><td>Culverts and crossings that are a barrier for native fish</td><td>Native fish unable to access upstream areas.</td></tr>
</table></td><td></td></tr>
<tr><td>Project goal/s</td><td>Within 5 years of project commencement:
- The main channel and tributaries of the Mangatea Stream are stable and fenced to exclude stock with a minimum 5 wire (2 electric) fence.
- Native and exotic planting (and associated weed control) is established within areas of the riparian margin most susceptible to erosion.
- There are no manmade barriers to native fish on the Mangatea Stream or tributary streams.</td><td></td></tr>
</table>

Priority works for funding	Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This project could be undertaken as a whole, or in multiple smaller components. **Riparian management of rivers/streams in pasture for soil conservation purposes and fish habitat** Carry out riparian fencing with a minimum 5m setback from the top of the streambank (preferably 5 wire with 2 electric wires at $8 per metre) along an estimated 13km of streambank (6.5km of stream length). Include adjoining wetland areas within the riparian fencing. Undertake a mix of native and exotic soil conservation riparian planting within the fenced area (where it doesn't exist naturally), estimated to be 5ha of planting and associated weed control and maintenance. 1200 poplar poles are estimated to be required for river and stream erosion control. The main reach of the Mangatea is 10km long and it is estimated that erosion control structures would be required at a frequency of 2 per km of bank length ($10,000 per km of stream). **Remediation of fish barriers** Determine the location of barriers to fish passage (on the mapped watercourses as well as side tributaries) and carry out remediation work. It is estimated that there are at least 6 barriers (or partial barriers) to fish passage in the catchment. Field work associated with investigating the location of barriers to fish passage is covered as part of the project management costs. The cost estimates below allow for remediation of 6 fish barriers. - Remediation of 6 barriers at $5000 each ($30,000) **Project management/staffing/incidentals** Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include transport, office overheads, consumables and miscellaneous professional fees. This is estimated to be 20% of the direct project costs.	
Time lag for benefits to be realised	If works were implemented at an even pace over a 5-year period, it is estimated that the majority of the project benefits would be seen 2-3 years after project completion.	L = 7.5
Effectiveness of works	When compared to the Vision & Strategy desired state, the Mangatea sub-catchment is in a moderate condition with some of the Vision & Strategy aspirations already being partly met. There is not expected to be significant change in condition over the next 20 years in the absence of this project. Works included here address many of the threats to the feature and it is anticipated that if the	W = 0.1

	project is fully completed, the stream will be in good condition and closer to the Vision & Strategy state being achieved. The project does not address catchment land use, however the steepest parts of the catchment are already vegetated and the proposed fencing and planting works will assist in protecting and restoring water quality at this site.	
Risk of technical failure	There is a moderate risk of project failure due to technical feasibility. Risks are mostly related to establishment of plantings or loss of works due to flooding and/or erosion before they are established. This would be minimised by the fencing setbacks being at least 5m, and by planting sterile willow poles to stabilise banks while native plantings establish.	F = 0.82
Adoptability	It is estimated that approximately half of landowners would adopt the works if they were fully incentivised. The extent of the fencing setbacks may provide some challenge in terms of uptake, and some landowners may be concerned about maintenance of fences following floods. However, this should be minimised once plantings mature.	A = 0.5
Information quality	Average – estimates are based on modelled information, aerial photographs, Lower Waikato catchment riparian surveys and input from catchment officers who are familiar with the sub-catchment. Fish habitat enhancement recommendations are based on the judgement of a fish expert with some local knowledge. Quantities of work required are predominantly based on estimates made from aerial photographs.	
Knowledge gaps	It is unknown specifically how much fencing already exists. This would need to be established as part of the project planning. Location of fish barriers and location and design of instream woody debris structures would need to be determined in the early stages of the project.	
Socio-political risks	Low risk that the project will fail to meet its goals over the long term due to socio-political risks.	P = 0.85
Project duration (years)	5 years	

<table>
<tr>
<td>Up-front cost – total for implementation phase/project duration</td>
<td>
<table>
<tr><th>Task</th><th>Cost ($)</th></tr>
<tr><td>Riparian fencing (13km)</td><td>104,000</td></tr>
<tr><td>Riparian willow/poplar pole planting (1200 poles)</td><td>16,803</td></tr>
<tr><td>Native riparian planting (5ha)</td><td>187,760</td></tr>
<tr><td>Erosion control structures</td><td>100,000</td></tr>
<tr><td>Remediation of fish barriers</td><td>30,000</td></tr>
<tr><td>Project management/staffing/incidentals (20%)</td><td>87,712</td></tr>
<tr><td>Total</td><td>526,276</td></tr>
</table>
</td>
<td>C = 0.53</td>
</tr>
</table>



Mangatea Stream integrated catchment programme

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017
Status: Final
Request No.: N/A
File name: WWRRS.gws

0.00 0.25 0.50 0.75 1.00 1.25
Kilometers

Scale 1:35,000@A4 Portrait

A4

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Examples of erosion along the Mangatea Stream.

CLW 22 Priority: medium	Upper Mangawara integrated catchment programme	BCR value
Relevant unit goal(s)	Highly erodible land is effectively managed including through native or exotic reforestation and retirement of marginal lands. Sediment inputs to wetlands and waterbodies are reduced by 50%. The mauri/life supporting capacity of fresh water is protected and restored for aquatic species. Aquatic habitats, including spawning grounds, are protected, enhanced, restored and accessible to native fish. The abundance of native fish, including taonga species, in the catchment is restored and protected.	
Name of feature	Mangawara sub-catchment	
Brief description of feature	The upper Mangawara is a relatively small (3562ha) catchment lying at the southern end of the Hapuakohe Range and along the eastern boundary of the Lower Waikato catchment. The catchment is estimated to have an approximately 50km stream network including the Mangawara Stream itself. This stream heads south down the catchment turning west and through the much larger middle Mangawara before entering the Waikato River at the base of Taupiri mountain. The lower extent of the upper catchment is where the stream crosses under Tahuna Road. Catchment land use is predominantly a mixture of dry stock and dairy. Waikato Regional Council has undertaken some river stabilisation works in the upper Mangawara Stream, including willow and poplar planting, vegetation/rock groynes, fencing and weir construction. Fencing and retirement of bush blocks has also been undertaken by landowners. Modelling undertaken in 2016 indicates that the upper Mangawara catchment is a high priority for hill country and streambank erosion prevention and management. Fish experts have identified waterways within this catchment as being important habitat for native fish species (including īnanga, crans bully, kōura, shortfin eel and longfin eel) and there are opportunities to increase native fish abundance by remediating barriers and providing increased and higher quality fish habitat. The Mangatea catchment, Hapuakohe Range and Mangawara Stream provided significant resources to marae, including kōura (freshwater crayfish), tuna (eels), kōkopu and bird species. There are	

<table>
<tr><td></td><td>many historic pā sites and marae within the area. It is said that one of the hoe (paddles) of the Tainui waka sits near the top of the Mangawara.</td><td></td></tr>
<tr><td>Desired state to achieve Vision & Strategy</td><td>- Catchment where land use matches capability and with a stable stream network that has fenced and well vegetated riparian margins along their entire length (at least 5m wide).
- Forest remnants and wetlands adjacent to streams are densely vegetated with native plant species, connected to riparian corridors and protected from stock grazing.
- Native plant regeneration occurs naturally within the native bush remnants.
- There are no manmade barriers to native migratory fish.
- Native fish are abundant and there is a wide diversity of species present, including non-climbing native fish.
- The streams are swimmable, fishable and have access for recreation.
- Iwi and community have a strong connection to the streams and are active in their use, protection and restoration.</td><td></td></tr>
<tr><td>Impact on Vision & Strategy</td><td>In a restored condition, the Mangawara sub-catchment would have a high impact on giving effect to the Vision & Strategy at a central and lower Waikato catchment level.</td><td>VS = 50</td></tr>
<tr><td>Key threats to the feature that this project addresses</td><td><table>
<tr><th>Key threat</th><th>Impact on feature</th></tr>
<tr><td>Streambank erosion</td><td>Increased sediment in the catchment streams and loss of streambank vegetation, habitat for fish.</td></tr>
<tr><td>Hill country erosion</td><td>Contributes significant sediment to the catchment streams and to the lower Waikato River.</td></tr>
<tr><td>Stock access to the stream</td><td>Reduced water quality and destruction of riparian vegetation.</td></tr>
<tr><td>Lack of riparian cover and associated fish habitat</td><td>Reduced habitat for adult fish.</td></tr>
<tr><td>Weed species</td><td>Compete with native plant communities.</td></tr>
<tr><td>Vegetation clearance</td><td>Reduced cover, habitat and food (invertebrates) for native fish species.</td></tr>
<tr><td>Culverts and crossings that are a barrier for native fish</td><td>Native fish unable to access upstream areas.</td></tr>
</table></td><td></td></tr>
<tr><td>Project goal/s</td><td>- LUC class 7 soils are managed within their capabilities and are retired from heavy stock grazing.</td><td></td></tr>
</table>

	- Within 15 years of project commencement there is a 30% reduction in suspended sediment in the Mangawara Stream. - Within 10 years of project commencing, all of the waterways are 100% fenced to exclude stock, and a vegetated riparian margin provides stream shade and enhances habitat for adult native fish. - There are no manmade barriers to native migratory fish.	
Priority works for funding	Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This project could be undertaken as a whole, or in multiple smaller components. **Hill country soil conservation** - 124ha LUC 6e land managed with open space pole planting at $3000 per hectare - 124ha LUC 6e land managed with plantation species (pine or mānuka) at $3000 per hectare - 30km of fencing the managed LUC 6e land at $25 per metre (8-wire and batten) - 145ha LUC 7 land managed with plantation species (pine or mānuka at $3000 per hectare - 20km of fencing the managed LUC 7 land at $25 per metre (8-wire and batten) - 4ha reducing sediment to waterways outside LUC class 6e, 7 and 8 land at $8000 per hectare (e.g. dewatering, retiring seepages, etc) - 17km fencing existing indigenous forest cover at $25 per metre (8-wire and batten). **Riparian management of rivers/streams in pasture for soil conservation purposes and for fish habitat** *Costs for fencing are based on a 5-wire (2 electric) fence, however, in these flood prone streams a 3-wire electric fence would also be acceptable.* Carry out riparian fencing with a minimum 5m setback from the top of the streambank along an estimated 17km of streambank (8.5km of stream length). Include adjoining wetland areas within the riparian fencing. Undertake a mix of native and exotic soil conservation riparian planting within the fenced area (where it doesn't exist naturally), estimated to be 6ha of planting and associated weed control and maintenance. 1478 willow poles are estimated to be required for river and stream erosion control. It is estimated that a further 2km of main channel will require vegetation groynes at a frequency of 5 structures per km ($12,500 per km). These should be focused upstream of the regional council weirs. **Remediation of fish barriers** Determine the location of barriers to fish passage (on the mapped watercourses as well as side tributaries) and carry out remediation	

	work. It is estimated that there are at least 6 barriers (or partial barriers) to fish passage in the catchment. Field work associated with investigating the location of barriers to fish passage is covered as part of the project management costs. The cost estimates below allow for remediation of 6 fish barriers. - Remediation of 6 barriers at $5000 each ($30,000) **Project management/staffing/incidentals** Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include transport, office overheads, consumables and miscellaneous professional fees. This is estimated to be 30% of the direct project costs.	
Time lag for benefits to be realised	If works were implemented at an even pace over a 15-year period, it is estimated that the majority of the project benefits would be seen approximately 12-13 years after project commencement.	L = 12.5
Effectiveness of works	The upper Mangawara sub-catchment is in relatively poor condition compared with the desired state, with few of the Vision & Strategy aspirations currently being met. It is not expected to significantly decline or improve over the next 20 years in the absence of this project. It is acknowledged that achieving the Vision & Strategy desired state will take longer than the 20-year horizon used for the purposes of the Restoration Strategy. However, works included in this project address many of the threats to the feature and it is anticipated that if the project is fully completed it would make significant progress with respect to achieving the Vision & Strategy state in 20 years' time.	W = 0.3
Risk of technical failure	There is a moderate risk of project failure due to technical feasibility. Risks are mostly related to establishment of plantings or loss of works due to weather events/erosion.	F = 0.82
Adoptability	It is estimated that about a quarter of landowners would adopt the works if they were fully incentivised. Uptake of management of LUC class 6e and 7 land may be low and we are not aware of significant similar works being undertaken in this catchment recently. The extent of the fencing setbacks may also provide some challenge in terms of uptake. There are large sections of river that are erosive in nature and likely to flood on a regular basis. Landowners may be unwilling to erect fences in these locations due to the potential maintenance costs. Early community engagement, flexibility of approach and identifying key farmers will be very important for the success of this project.	A = 0.25

<table>
<tr><td>Information quality</td><td>Average – estimates are based on modelled information, aerial photographs, Lower Waikato catchment riparian surveys and input from catchment officers who are familiar with the sub-catchment. Fish habitat enhancement recommendations are based on the judgement of a fish expert with some local knowledge. Quantities of work required are predominantly based on estimates made from aerial photographs.</td><td></td></tr>
<tr><td>Knowledge gaps</td><td>Estimates of LUC classes 6e and 7 come from a desktop exercise. Farm scale information will need to be gathered as part of this project. It is unknown specifically how much riparian fencing already exists. This would need to be established as part of the project planning. Location of fish barriers would need to be determined in the early stages of the project.</td><td></td></tr>
<tr><td>Socio-political risks</td><td>Low risk that the project will fail to meet its goals over the long term due to socio-political risks.</td><td>P = 0.85</td></tr>
<tr><td>Project duration (years)</td><td>15 years</td><td></td></tr>
<tr><td>Up-front cost – total for implementation phase/project duration</td><td>
<table>
<tr><th>Task</th><th>Cost ($)</th></tr>
<tr><td>124ha LUC 6e managed with pole planting</td><td>372,000</td></tr>
<tr><td>124ha LUC 6e managed with plantation species</td><td>372,000</td></tr>
<tr><td>Fencing managed LUC 6e land (30km)</td><td>750,000</td></tr>
<tr><td>145ha LUC 7 managed with plantation species</td><td>435,000</td></tr>
<tr><td>Fencing managed LUC 7 land (20km)</td><td>500,000</td></tr>
<tr><td>Reducing sediment outside LUC 6e, 7 and 8 (4ha)</td><td>32,000</td></tr>
<tr><td>Fencing existing indigenous vegetation (17km)</td><td>425,000</td></tr>
<tr><td>Riparian fencing 5-wire, 2 –electric (17km)</td><td>136,000</td></tr>
<tr><td>Riparian willow/poplar pole planting (1478 poles)</td><td>20,692</td></tr>
<tr><td>Native riparian planting (6ha)</td><td>225,312</td></tr>
<tr><td>Erosion control structures</td><td>25,000</td></tr>
<tr><td>Remediation of fish barriers</td><td>30,000</td></tr>
<tr><td>Project management/staffing/incidentals (30%)</td><td>996,901</td></tr>
<tr><td>Total</td><td>4,319,905</td></tr>
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</td><td>C = 4.3</td></tr>
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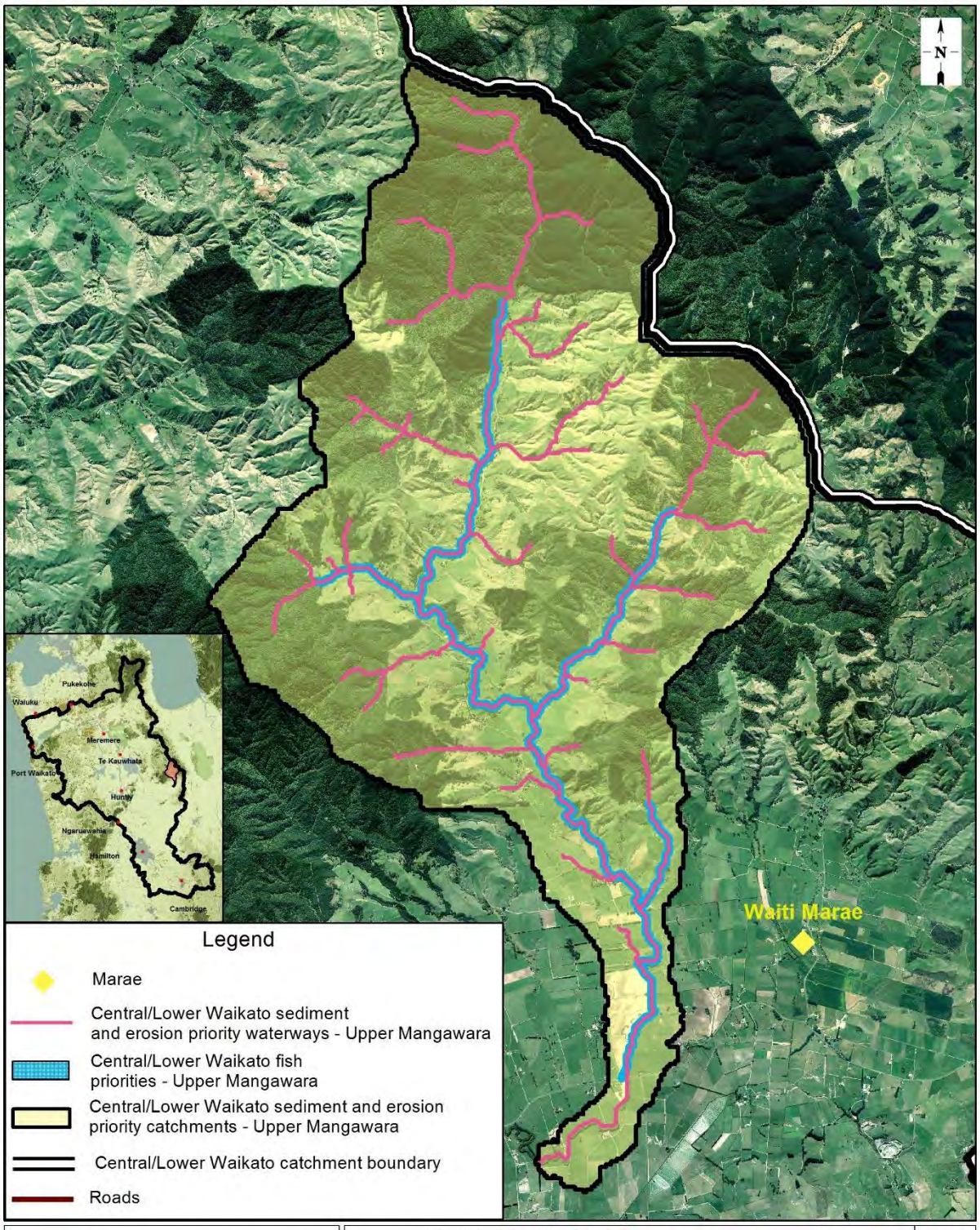

Upper Mangawara integrated catchment programme

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017
Status: Final
Request No.: N/A
File name: WWRRS.gws

0.0 0.4 0.8 1.2 1.6 2.0
Kilometers

Scale 1:55,000@A4 Portrait

A4

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Hill country in the upper Mangawara.

Erosion along the Mangawara Stream.

Streambank erosion along the Mangawara Stream.

CLW 23 Priority: very high	Water quality improvement in the middle Mangawara catchment	BCR value
Relevant Unit Goal(s)	Wetlands are protected, enhanced, created and able to perform their water purification role. The mauri/life supporting capacity of fresh water is protected and restored for aquatic species.	
Name of feature	Waterways in the middle Mangawara catchment	
Brief description of feature	The middle Mangawara Stream catchment covers 14,219ha and drains the Mangatea, upper Mangawara and Tauhei catchments. The stream itself eventually flows through the lower Mangawara and into the Waikato River at Taupiri. 90% of the catchment is in pastoral cover, with 8% still retaining native vegetation. The main waterways in the catchment are the Mangakawau Stream, Mangawara Stream (including Orini Canal), Sludge Creek and Paranui Drain. These are highly modified and maintained as part of the Mangawara Flood Protection Scheme. Waikato Regional Council water quality monitoring of the stream at Rutherford Road bridge indicates that levels of TN, TP and E. coli are unsatisfactory 100% of the time. Modelling undertaken in 2016 indicates that the middle Mangawara catchment is a high priority for actions that assist in nitrogen and E. coli reduction. The Mangatea catchment, Tauhei catchment, Hapuakohe Range and Mangawara Stream provided significant resources to marae, including kōura (freshwater crayfish), tuna (eels), kōkopu and bird species. There are many historic pā sites and marae within the area. Wāhi tapu are scattered within the project area.	
Desired state to achieve Vision & Strategy	- A sub-catchment where land use matches capability and with a stable stream network that has a fenced and well vegetated riparian margin along its entire length (at least 5m wide) to assist in providing erosion protection, shade and shelter. - Forest remnants and wetlands are densely vegetated with native plant species, connected to riparian corridors and protected from stock grazing. - Native plant regeneration occurs naturally within the native bush remnants. - There are no manmade barriers to native migratory fish. - Native fish are abundant and there is a wide diversity of species present, including non-climbing native fish. - The streams are swimmable, fishable and have access for recreation.	

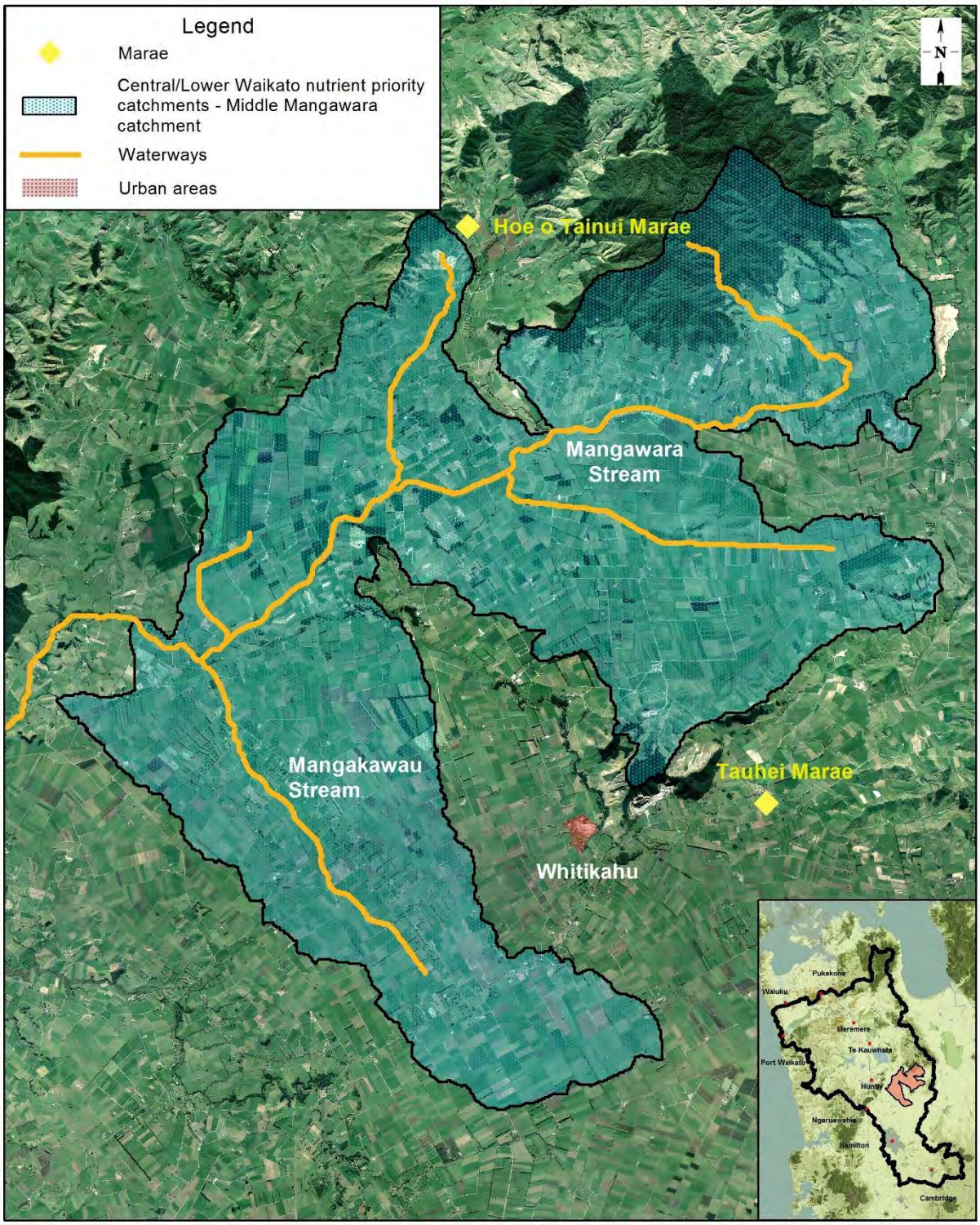
<table>
<tr><td></td><td>- Iwi and community have a strong connection to the catchment streams and are active in their use, protection and restoration.</td><td></td></tr>
<tr><td>Impact on Vision & Strategy</td><td>In a restored condition, the waterways in the middle Mangawara catchment would have a high impact on giving effect to the Vision & Strategy at a central and lower Waikato catchment level.</td><td>VS = 30</td></tr>
<tr><td>Key threats to the feature that this project addresses</td><td><table><tr><th>Key threat</th><th>Impact on feature</th></tr><tr><td>Stock access to the streams and wetlands</td><td>Reduced water quality and destruction of riparian and wetland vegetation.</td></tr></table></td><td></td></tr>
<tr><td>Project goal/s</td><td>100% of wetlands and seeps greater than 0.1ha are fenced to exclude stock within 5 years of project commencement.</td><td></td></tr>
<tr><td>Priority works for funding</td><td>Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This project could be undertaken as a whole, or in multiple smaller components.

Wetland and ephemeral stream protection
11km of fencing wetlands and seeps >0.1ha and ephemeral streams at $8 per metre. Fence should be 5 wire – 2 electric. The focus should be on wetlands that retain relatively natural hydrology, i.e. water is flowing in and out through the wetland (not via a drain through or around), water is held back and the wetland is functioning year round.

Project management/staffing/incidentals
Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include transport, office overheads, consumables and miscellaneous professional fees.

This is estimated to be 25% of the direct project costs.</td><td></td></tr>
<tr><td>Time lag for benefits to be realised</td><td>If works were implemented at an even pace over a 5-year period, it is estimated that the majority of the project benefits would be seen within a year following project commencement.</td><td>L = 5.5</td></tr>
<tr><td>Effectiveness of works</td><td>When compared with the Vision & Strategy desired state, the waterways and wetlands in the middle Mangawara sub-catchment are currently in a poor condition, with few of the Vision & Strategy aspirations being met. Water quality is poor and not safe for swimming and waterways are highly modified. It is anticipated that there may be a slight decline in state over the next 20 years in the absence of this project, due to further peat loss. The project encourages fencing wetlands/seeps and ephemeral streams and is expected to offset decline and contribute to slight improvement in overall condition. However, it is acknowledged that achieving the desired state will take longer than the 20 year horizon used for the</td><td>W = 0.03</td></tr>
</table>

<table>
<tr><td></td><td>purposes of the Restoration Strategy, and a fuller range of initiatives over the long term will be needed.</td><td></td></tr>
<tr><td>Risk of technical failure</td><td>There is a negligible risk of project failure due to technical feasibility. The project consists solely of fencing wetland areas.</td><td>F = 0.97</td></tr>
<tr><td>Adoptability</td><td>It is estimated that approximately half of landowners would adopt the works if they were fully incentivised. Some may be concerned by loss of marginal grazing areas. Although generally the benefits of avoiding loss of stock in wetlands and protection of nutrient attenuation areas are becoming better recognised, this kind of work has not yet become as widely supported as riparian protection.</td><td>A = 0.5</td></tr>
<tr><td>Information quality</td><td>Poor – estimates based on modelled information and examination of aerial photographs.</td><td></td></tr>
<tr><td>Knowledge gaps</td><td>Estimates of wetland location and perimeter come from a desktop exercise. It is uncertain how many wetlands and seeps retain natural hydrology. Farm scale information will need to be gathered as part of this project.</td><td></td></tr>
<tr><td>Socio-political risks</td><td>Moderate risk that the project will fail to meet its goals over the long term due to socio-political risks.</td><td>P = 0.62</td></tr>
<tr><td>Project duration (years)</td><td>5 years</td><td></td></tr>
<tr><td>Up-front cost – total for implementation phase/project duration</td><td><table><tr><th>Task</th><th>Cost ($)</th></tr><tr><td>Fencing wetlands and ephemeral streams (11km)</td><td>88,000</td></tr><tr><td>Project management/staffing/incidentals (25%)</td><td>22,000</td></tr><tr><td>Total</td><td>110,000</td></tr></table></td><td>C = 0.11</td></tr>
</table>



Water quality improvement in the Middle Mangawara catchment

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017

Status: Final
Request No.: N/A
File name: WWRRS.gws

0.00 0.75 1.50 2.25 3.00 3.75
Kilometers

Scale 1:100,000@A4 Portrait

A4

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An example of a seep in the Mangawara catchment that would be a candidate for re-establishing hydrology and fencing/retiring (Photo: Waikato RiverCare).

Wetland in the Mangawara catchment suitable for fencing and retiring (Photo: Waikato RiverCare).

Wetland in the Mangawara catchment that would be suitable for fencing and retiring (Photo: Waikato RiverCare).

CLW 24 Priority: high	Water quality improvement in the Tauhei catchment	BCR value
Relevant Unit Goal(s)	Wetlands are protected, enhanced, created and able to perform their water purification role. The mauri/life supporting capacity of fresh water is protected and restored for aquatic species.	
Name of feature	Waterways and wetlands within the Tauhei catchment	
Brief description of feature	The Tauhei catchment extends over 11,600ha from west of Morrinsville and drains into the Mangawara Stream at Orini. 94% of the catchment is in pastoral cover with the predominant land use being dairy farming. There is an estimated 162km stream network in pasture within the catchment. The Tauhei Stream itself is highly modified and stopbanked along much of its length. The catchment is largely peat and forms part of the Tauhei drainage scheme and flood protection scheme. Modelling undertaken in 2016 indicates that the Tauhei catchment is a high priority for actions that assist in nitrogen and E.coli reduction. The Tauhei area and the Mangawara Stream provided significant resources to marae, including kōura (freshwater crayfish), tuna (eels), kōkopu and bird species. There are many historic pā sites within the area, and existing marae.	
Desired state to achieve Vision & Strategy	- A sub-catchment where land use matches capability and with a stable stream network that has a fenced and well vegetated riparian margin along its entire length (at least 5m wide) to assist in providing erosion protection, shade and shelter. - Forest remnants and wetlands are densely vegetated with native plant species, connected to riparian corridors and protected from stock grazing. - Native plant regeneration occurs naturally within the native bush remnants. - There are no manmade barriers to native migratory fish. - Native fish are abundant and there is a wide diversity of species present, including non-climbing native fish. - The streams are swimmable, fishable and have access for recreation. - Iwi and community have a strong connection to the catchment streams and are active in their use, protection and restoration.	
Impact on Vision & Strategy	In a restored condition, waterways in the Tauhei catchment would have a high impact on giving effect to the Vision & Strategy at a central and lower Waikato catchment level.	VS = 30

<table>
<tr><td>Key threats to the feature that this project addresses</td><td><table><tr><th>Key threat</th><th>Impact on feature</th></tr><tr><td>Stock access to the streams and wetlands</td><td>Reduced water quality and destruction of riparian and wetland vegetation.</td></tr></table></td><td></td></tr>
<tr><td>Project goal/s</td><td>100 % of wetlands and seeps greater than 0.1ha are fenced to exclude stock within 5 years of project commencement.</td><td></td></tr>
<tr><td>Works required (by whom)</td><td>Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This project could be undertaken as a whole, or in multiple smaller components.

Wetland and ephemeral stream protection
8km of fencing wetlands and seeps >0.1ha and ephemeral streams at $8 per metre. Fence should be 5 wire – 2 electric. The focus should be on wetlands that retain relatively natural hydrology, i.e. water is flowing in and out through the wetland (not via a drain through or around), water is held back and the wetland is functioning year round.

Project management/staffing/incidentals
Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include transport, office overheads, consumables and miscellaneous professional fees.

This is estimated to be 25% of the direct project costs.</td><td></td></tr>
<tr><td>Time lag for benefits to be realised</td><td>If works were implemented at an even pace over a 5-year period, it is estimated that the majority of the project benefits would be seen approximately within 1 year following project commencement.</td><td>L = 5.5</td></tr>
<tr><td>Effectiveness of works</td><td>When compared with the Vision & Strategy desired state, the waterways and wetlands in the Tauhei sub-catchment are currently in a poor condition with few of the Vision & Strategy aspirations being met. Water quality is poor and not safe for swimming and waterways are highly modified. It is anticipated that there may be a slight decline in state over the next 20 years in the absence of this project due to further peat loss. The project encourages fencing wetlands/seeps and ephemeral streams and is expected to slightly offset decline. However it is acknowledged that achieving the desired state will take longer than the 20 year horizon used for the purposes of the Restoration Strategy, and a fuller range of initiatives over the long term will be needed.</td><td>W = 0.01</td></tr>
<tr><td>Risk of technical failure</td><td>There is a negligible risk of project failure due to technical feasibility. The project consists solely of fencing wetland areas.</td><td>F = 0.97</td></tr>
</table>

<table>
<tr><td>Works by private citizens – likelihood of adoption and adoption circumstances</td><td>It is estimated that approximately one quarter of landowners would adopt the works if they were fully incentivised. Some may be concerned by loss of marginal grazing areas. Although generally the benefits of avoiding loss of stock in wetlands and protection of nutrient attenuation areas are becoming better recognised, this kind of work has not yet become as widely supported as riparian protection.</td><td>A = 0.25</td></tr>
<tr><td>Information quality</td><td>Poor – estimates based on modelled information and examination of aerial photographs.</td><td></td></tr>
<tr><td>Knowledge gaps</td><td>Estimates of wetland location and perimeter come from a desktop exercise. It is uncertain how many wetlands and seeps retain natural hydrology. Farm scale information will need to be gathered as part of this project.</td><td></td></tr>
<tr><td>Socio-political risks</td><td>Very low risk that the project will fail to meet its goals over the long term due to socio-political risks.</td><td>P = 0.97</td></tr>
<tr><td>Project duration (years)</td><td>5 years</td><td></td></tr>
<tr><td>Up-front cost – total for implementation phase/project duration</td><td><table><tr><th>Task</th><th>Cost ($)</th></tr><tr><td>Fencing wetlands and ephemeral streams (8km)</td><td>64,000</td></tr><tr><td>Project management/staffing/incidentals (25%)</td><td>16,000</td></tr><tr><td>Total</td><td>80,000</td></tr></table></td><td>C = 0.08</td></tr>
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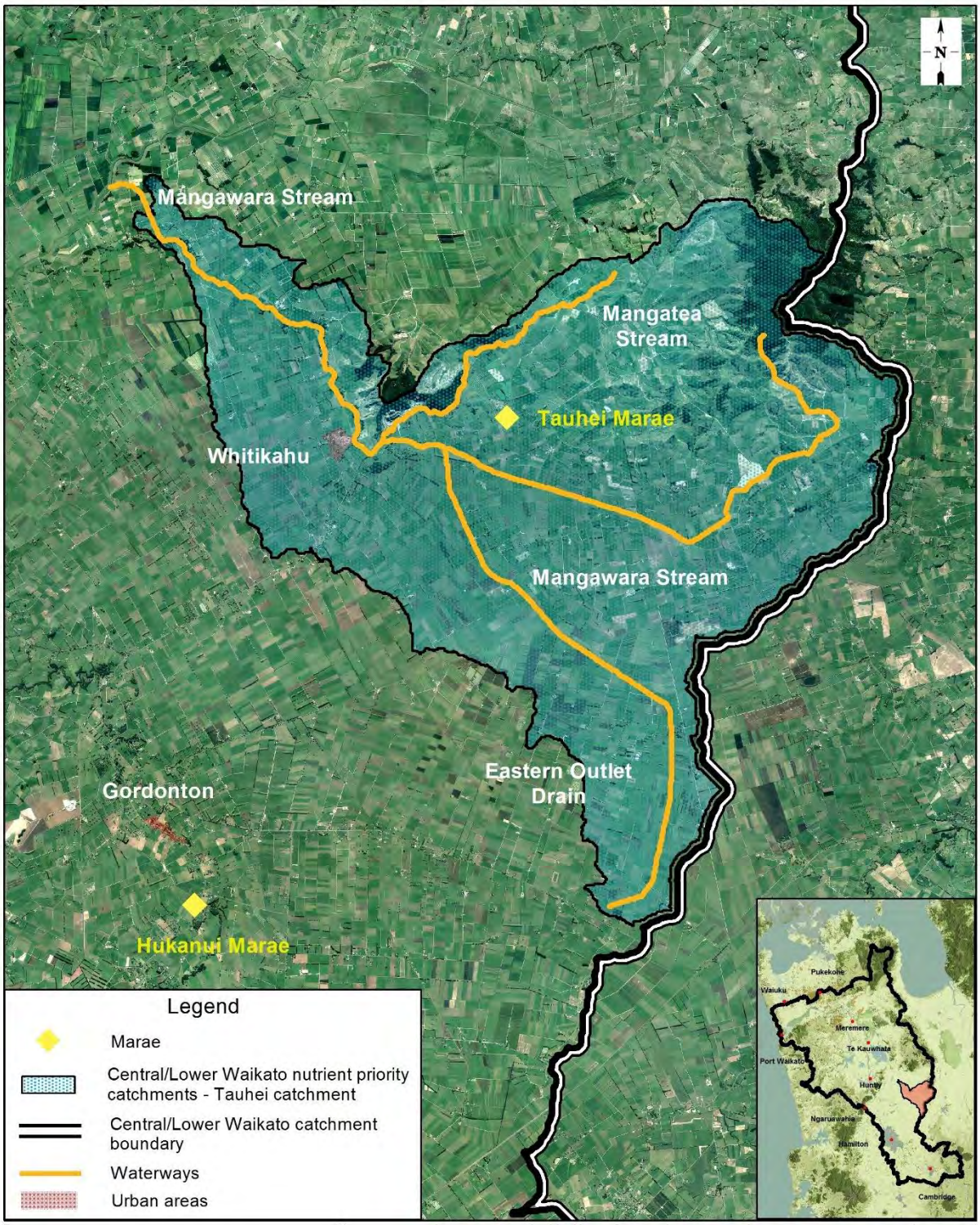

Water quality improvement in the Tauhei catchment

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017

Status: Final
Request No.: N/A
File name: WWRRS.gws

0.00 0.75 1.50 2.25 3.00 3.75
Kilometers

Scale 1:110,000@A4 Portrait

A4

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An example of a small wetland area that would be suitable for fencing and protecting.

CLW 25 Priority: high	Water quality improvement in the Kōmakorau and Mangatoketoke catchments	BCR value
Relevant Unit Goal(s)	Wetlands are protected, enhanced, created and able to perform their water purification role. The mauri/life supporting capacity of fresh water is protected and restored for aquatic species.	
Name of feature	Waterways and wetlands within the Kōmakorau and Mangatoketoke catchments	
Brief description of feature	This large catchment covering 19,143ha lies to the east of Hamilton and Ngāruawāhia and has streams entering the Waikato River at Taupiri. The land cover is more than 95% pastoral, and land use is predominantly dairy with a mix of lifestyle blocks. There are an estimated 247km of streams in pasture within this catchment. Many of the Horsham Downs peat lakes lie within the catchment, including lakes Whakatangi, Tunawhakaheke, Kaituna and Kainui. The key waterways are Kōmakorau and Mangatoketoke streams. This catchment sits on peat soils and contains the Kōmakorau and Freshfield drainage schemes, therefore many of the waterways are highly modified and regularly maintained with spraying or mechanical removal of silt and vegetation. This limits the ability to undertake riparian plantings so, before works are undertaken, consideration needs to be given to regulations that enable ongoing access for drain maintenance. The Kōmakorau Stream contains high numbers of indigenous fish, including black mudfish, banded kōkopu, giant kōkopu, shortfin eel and longfin eel. The Kōmakorau catchment and associated lakes historically provided significant resources to marae, including kōura (freshwater crayfish), tuna (eels), kōkopu, kāeo and bird species. The names of the lakes reflect the nature of their service to tangata whenua, i.e. to provide food with kupu (words) such as kai (food), tuna (eels) and kōmako (bellbird) in their historic names. Waikato Regional Council water quality monitoring of the Kōmakorau Stream at Henry Road indicates that levels of nitrogen, phosphorus and E. coli are unsatisfactory 100% of the time. Modelling undertaken in 2016 indicates that the Kōmakorau and Mangatoketoke catchment is a high priority for actions that assist in nitrogen, phosphorus and E. coli reduction.	

<table>
<tr><td>Desired state to achieve Vision & Strategy</td><td>- A sub-catchment where land use matches capability and with a stable stream network that has a fenced and well vegetated riparian margin along its entire length (at least 5m wide) to assist in providing erosion protection, shade and shelter.
- Forest remnants and wetlands are densely vegetated with native plant species, connected to riparian corridors and protected from stock grazing.
- Native plant regeneration occurs naturally within the native bush remnants.
- There are no manmade barriers to native migratory fish.
- Native fish are abundant and there is a wide diversity of species present, including non-climbing native fish.
- The streams are swimmable, fishable and have access for recreation.
- Iwi and community have a strong connection to the catchment streams and are active in their use, protection and restoration.</td><td></td></tr>
<tr><td>Impact on Vision & Strategy</td><td>In a restored condition, waterways within the Kōmakorau and Mangatoketoke catchments would have a high impact on giving effect to the Vision & Strategy at central and lower Waikato catchment level.</td><td>VS = 50</td></tr>
<tr><td>Key threats to the feature that this project addresses</td><td><table><tr><th>Key threat</th><th>Impact on feature</th></tr><tr><td>Stock access to the streams and wetlands</td><td>Reduced water quality and destruction of riparian and wetland vegetation.</td></tr></table></td><td></td></tr>
<tr><td>Project goal/s</td><td>100% of wetlands and seeps greater than 0.1ha are fenced to exclude stock within 15 years of project commencement.</td><td></td></tr>
<tr><td>Priority works for funding</td><td>Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This project could be undertaken as a whole, or in multiple smaller components.

Wetland and ephemeral stream protection
44km of fencing wetlands and seeps >0.1ha and ephemeral streams at $8 per metre. Fence should be 5 wire – 2 electric. The focus should be on wetlands that retain relatively natural hydrology, i.e. water is flowing in and out through the wetland (not via a drain through or around), water is held back and the wetland is functioning year round.

Project management/staffing/incidentals
Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include transport, office overheads, consumables and miscellaneous professional fees.

This is estimated to be 25% of the direct project costs.</td><td></td></tr>
</table>

<table>
<tr><td>Time lag for benefits to be realised</td><td>If works were implemented at an even pace over a 10-year period, it is estimated that the majority of the project benefits would be seen approximately 8 years after project commencement.</td><td>L = 8</td></tr>
<tr><td>Effectiveness of works</td><td>When compared with the Vision & Strategy desired state, the waterways and wetlands in these sub-catchments are currently in a poor condition, with few of the Vision & Strategy aspirations being met. Water quality is poor and not safe for swimming and waterways are highly modified. It is anticipated that there may be a decline in state over the next 20 years in the absence of this project due to further catchment peat loss. The project encourages fencing wetlands/seeps and ephemeral streams and is expected to offset decline in overall condition. However, it is acknowledged that achieving the desired state will take longer than the 20 year horizon used for the purposes of the Restoration Strategy, and a fuller range of initiatives over the long term will be needed.</td><td>W = 0.05</td></tr>
<tr><td>Risk of technical failure</td><td>There is a negligible risk of project failure due to technical feasibility. The project consists solely of fencing wetland areas.</td><td>F = 0.97</td></tr>
<tr><td>Adoptability</td><td>It is estimated that approximately one quarter of landowners would adopt the works if they were fully incentivised. Some may be concerned by loss of marginal grazing areas. Although generally the benefits of avoiding loss of stock in wetlands and protection of nutrient attenuation areas are becoming better recognised, this kind of work has not yet become as widely supported as riparian protection.</td><td>A = 0.25</td></tr>
<tr><td>Information quality</td><td>Poor – estimates based on modelled information and examination of aerial photographs.</td><td></td></tr>
<tr><td>Knowledge gaps</td><td>Estimates of wetland location and perimeter come from a desktop exercise. It is uncertain how many wetlands and seeps retain natural hydrology. Farm scale information will need to be gathered as part of this project.</td><td></td></tr>
<tr><td>Socio-political risks</td><td>Very low risk that the project will fail to meet its goals over the long term due to socio-political risks.</td><td>P = 0.97</td></tr>
<tr><td>Project duration (years)</td><td>10 years</td><td></td></tr>
<tr><td>Up-front cost – total for implementation phase/project duration</td><td><table><tr><th>Task</th><th>Cost ($)</th></tr><tr><td>Fencing wetlands and ephemeral streams (44km)</td><td>352,000</td></tr><tr><td>Project management/staffing/incidentals (25%)</td><td>88,000</td></tr><tr><td>Total</td><td>440,000</td></tr></table></td><td>C = 0.44</td></tr>
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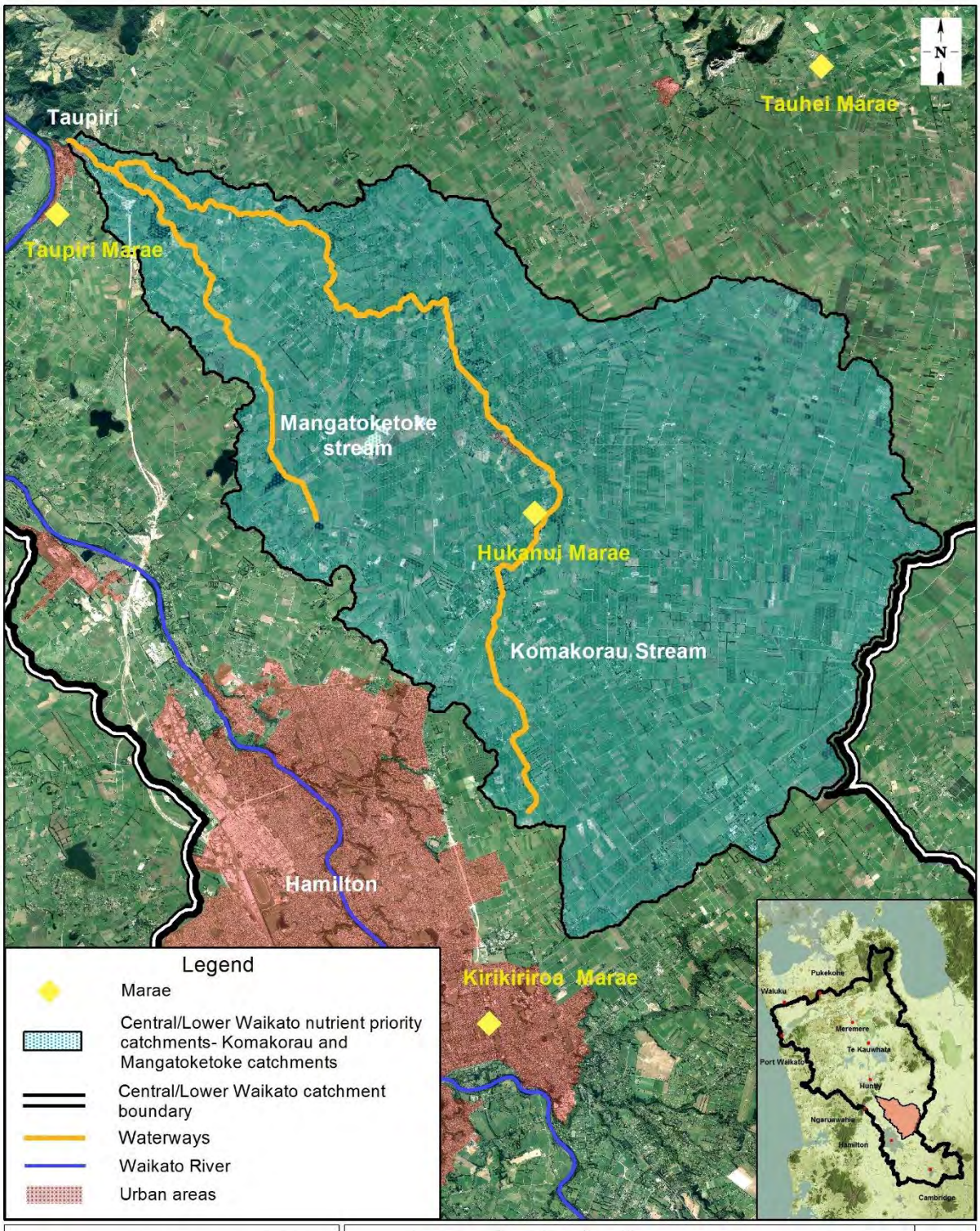

Water quality improvement in the Komakorau and Mangatoketoke catchments

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017

Status: Final
Request No.: N/A
File name: WWRRS.gws

0 1 2 3 4 5
Kilometers

Scale 1:120,000@A4 Portrait

A4

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An example of a wetland area that would be suitable for fencing and protecting.

CLW 26 Priority: medium	Biodiversity enhancement of Kukutaaruhe Stream and associated gully ecosystem	BCR value
Relevant Unit Goal(s)	Wetlands are protected, enhanced and where feasible expanded and re-established. Ecosystems, forest fragments and ecological corridors associated with aquatic environments are protected, enhanced and expanded. Connections between significant places are provided for. A platform for tourism along the river is created and connects to inland opportunities. Aquatic habitats, including spawning grounds, are protected, enhanced, restored and accessible to native fish. The abundance of native fish, including taonga species, in the catchment is restored and protected.	
Name of feature	Kukutaaruhe Stream and associated 23 hectare (ha) gully ecosystem (from Fairfield College to the Waikato River)	
Brief description of feature	The greater Kukutaaruhe Stream catchment is approximately 148ha with about 36ha of that being urban gully directly connected to the stream system. Kukutaaruhe Stream and associated gully ecosystem is approximately 23ha in total area. This comprises 6.2ha of gully in the upper reach which is owned and managed by Ministry of Education/Kukutaaruhe Trust, 12.4ha of Donny Park stream/park reserve (Hamilton City Council owned and managed) as well as adjoining privately owned gully areas (approximately 1.6ha). The Kukutaaruhe Stream and catchment are directly connected to the Waikato River and the stream is a confirmed spawning site for native fish species giant kōkopu. NIWA have been GPS tracking and monitoring native fish species here since the installation of a constructed fish passage in 2006. The stream is predominantly cobble and sandy bottomed, with partial riparian vegetation (predominantly weeds) providing some spawning and stream habitat shading and protection. The gully catchment now has resident tūī (at least 2 pairs), small remnant wetland areas and representative native gully vegetation species. Historically, gullies were an important resource for Māori providing food and medicinal herbs. In pre-European times the area was known to Māori as Kukutaruhe (pigeon flight) and the gully system had considerable significance to Ngāti Wairere. It was an important area for growing crops and renowned as an	

	area for hunting native pigeons. There was a number of significant pa and papakāinga settlements overlooking the gully (the largest being Te Tupari situated near what is now Waikato Diocesan School for Girls). A number of significant artefacts associated with pre-European Māori habitation of the area have been recovered from the gully and surrounding area (Source: Donny Park Operative Management Plan, 2004). The gully and stream have a public path from the river to the head of a gully arm near the school boundary. The gully is also connected to the Aratiatia marae bordering Fairfield College. This site was selected for inclusion in the Restoration Strategy due to its urban location, significance for fish spawning and opportunity for multiple outcomes including education, biodiversity, recreation and fish habitat enhancement.	
Desired state to achieve Vision & Strategy	- Streams have riparian buffers to provide habitat for native fish spawning and cooler waters (improved native fish habitat). These extend from the upper Kukutaaruhe catchment to the Waikato River. - The gully is predominantly weed free and vegetated with native species (ecological communities) characteristic of the local environment, including restored remnant wetlands, gully forest species and upland forest species. - There are no manmade barriers to native migratory fish. - Native fish are abundant and there is a wide diversity of species present, including non-climbing native fish. - The stream is swimmable, fishable and has access for recreation. - Iwi and communities have a strong connection to the stream and are active in its use, protection and restoration.	
Impact on Vision & Strategy	In a restored condition, the Kukutaaruhe Stream and associated gully would have a high impact on giving effect to the Vision & Strategy at a local level.	VS = 2

<table>
<tr>
<td>Key threats to the feature that this project addresses</td>
<td>
<table>
<tr><th>Key threat</th><th>Impact on feature</th></tr>
<tr><td>Riverbank erosion</td><td>Contributes to poor water quality and affects fish.</td></tr>
<tr><td>People become disconnected from the waterway</td><td>Waterway areas become more degraded and people see the area more as a wasteland than something that needs to be nurtured and cared for.</td></tr>
<tr><td>Weed species</td><td>Compete with native plant communities and are a threat to agriculture.</td></tr>
<tr><td>Land drainage</td><td>Lowers water levels, reduces the extent and/or quality of wetlands and causes adverse changes in ecosystems.</td></tr>
<tr><td>Vegetation clearance</td><td>Reduced cover, habitat and food (invertebrates) for native fish species.</td></tr>
</table>
</td>
<td></td>
</tr>
<tr>
<td>Project goal/s</td>
<td>Within 20 years of project commencement:
- The gully vegetation over the upper area of the gully (approximately 6ha) is restored back to native species, including a 0.5ha area of upland native forest being established to provide a complete topographic sequence example of the original native flora.
- The stream has a predominantly native vegetation riparian buffer for the entire stream length.
- Sites of cultural significance are protected.
- The stream continues to provide spawning habitat for giant kōkopu and has an abundance of native fish.</td>
<td></td>
</tr>
<tr>
<td>Priority works for funding</td>
<td>This project has been split into 3 areas:
- 6.2ha of gully upstream of Donny Park (managed by Kukutaaruhe Trust)
- 12.4ha Donny Park
- 1.6ha of private land.

The entire project has potential to be part of a wider project called the Fairfield Project. The Fairfield Project involves development of an ecological restoration centre and education programme at Fairfield College. It is envisaged that it will be recognised nationally as the face of environmental sustainability and restoration education. Implementation of this gully restoration project should also involve dialogue with the Fairfield Project.

Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This project could be undertaken as a whole, or in multiple smaller components.</td>
<td></td>
</tr>
</table>

Restoration plan
Developing a restoration plan will be essential. This project has opportunities to link with the Fairfield Project and be used as an open classroom for education, cultural development and research to connect the schools, marae and greater community with the stream, catchment and the Waikato River.

The restoration plan should detail the tasks required, timing, planting plan, weed management plan, monitoring plan and protocols for working and studying in the gully to ensure minimal impact on the surrounding environment. The plan should build on and connect with the Donny Park Reserves Act Management Plan (2004). The estimated cost of this is $25,000 (including a general ecological condition assessment of the gully and stream).

<u>Upstream of Donny Park (on Kukutaaruhe Trust managed land)</u>

Connecting pathways:

- Complete the remainder of the gully pathway from Donny Park to the Trust site (~250m gravel/boardwalk path). This will require design drawings suitable for resource consent as well as material and labour to build. There may be opportunity to include students as a training opportunity and community volunteers. The estimated cost of this is $37,500.

- Establish a knowledge trail with at least 6 interpretive signs identifying areas of ecological or cultural interest in the gully area. This will require material and labour to build and there is opportunity to include students as a training opportunity and community volunteers. The estimated cost of this is $10,000.

Weed removal (vegetation clearance)
Weed removal is required throughout the restoration areas. Weeds are mostly climbing or groundcover (e.g. honeysuckle, jasmine, convolvulus, *Tradescantia*) and will require multiple applications with herbicide and/or clearing equipment and labour. There is an opportunity to involve students in this work as a training opportunity and community volunteers.

A comprehensive weed control plan will be essential to ensure success of this project and should be undertaken as part of the management plan for the site.

	Exact costs associated with undertaking weed control are unknown but the following estimates have been made for the 6.2ha area: - $2800 per hectare 3 times per year over 2 years in order to establish weed free areas in preparation for native planting ($104,160). - Cost estimates for native planting allow for releasing of native plants and associated weed control for approximately 3 years following planting. Additional weed control following native plant establishment is estimated at $700 per hectare every year for 13 years ($58,420). **Native revegetation** Native revegetation is required over an area of approximately 6.2ha. The gully vegetation over the upper area of the gully (approximately 6ha) is already restored back to native species. There is opportunity to include students as a training opportunity and community volunteers. The estimated cost of native revegetation is $39,552 per hectare. This includes some site preparation, plant purchase, planting labour and 5 releasing events. Additional weed control will be required on top of this cost and this has been allowed for in the weed control section. - Native planting cost estimates are 6.2ha at $39,552 per hectare ($245,222). <u>Private land</u> **Native revegetation** Some native planting and weed control is required on private land within the gully. The total area of this land is approximately 1.6ha and it is estimated that 30% of the area requires native planting. The estimated cost of this work is $18,984. **Weed removal (vegetation clearance)** Weed control will be important for the success of this project. Exact costs associated with undertaking weed control are unknown but the following estimates have been made. - $2800 per hectare 3 times per year over 2 years in order to establish weed free areas in preparation for native planting ($26,880). - Cost estimates for native planting allow for releasing of native plants and associated weed control for approximately 3 years following planting. Additional weed control following native	

	plant establishment is estimated at $700 per hectare every year for 13 years ($700 x 1.6ha x 13 years is $14,560). <u>Donny Park</u> Within the Donny Park area, Hamilton City Council have made recommendations for riparian planting along Kukutaaruhe Stream and remediation of barriers to native fish. Some of these recommendations have come from the development of a Stormwater Master Plan that also includes potential projects to improve stormwater management within the city. A summary of the riparian and fish passage remediation recommendations are as follows: **Donny Park riparian improvement** - Undertake native planting along a 1000m length of Kukutaaruhe Stream to provide a 5m wide riparian margin (0.5ha in total). Riparian planting should be ecologically sensitive, reflecting ecological district and historical vegetation. The estimated cost of native planting is $19,776 (including plant purchase, planting labour, 5 releasing events). - A comprehensive weed control programme will also be required within the 0.5ha planted area. It is estimated that 3 weed control events will be required per year over a period of 3 years ($7500 per year x 3 years is $22,500) **Fish passage remediation** A partial fish barrier exists on Kukutaaruhe Stream at Wymer Terrace (twin culvert). This should be remediated through redesign of the culvert or installation of appropriate remediation measures (e.g. spat rope, fish ladders, low flow channels, fish baffles). The remediation measures adopted should follow the recommendation of an experienced fish ecologist. - A cost estimate of $5,000 has been provided for this work. **Animal pest control** Possum control may be required during native plant establishment (over a 3 year period). Costs are based on using A12 Goodnature kill traps at a rate of one trap per hectare (across 20ha) - $175 per hectare for set up ($3500) - $90 per hectare each year for three years thereafter ($5400) This site would benefit from mustelid and rat control to protect and enhance native bird populations. This work has not been	

	costed as ongoing because animal pest control is out of scope for the restoration strategy. **Project management/staffing/incidentals** Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include transport, office overheads, consumables and miscellaneous professional fees. This is estimated to be 30% of the direct project costs. Project implementers are also encouraged to work closely with the Fairfield Project, students, community and experts to establish baseline and ongoing monitoring protocols and collect data to measure the success of the restoration project.	
Time lag for benefits to be realised	If works were implemented at an even pace over a 15-year period, it is estimated that the majority of the project benefits would be seen approximately 10-11 years after project commencement.	L = 10.5
Effectiveness of works	Kukutaaruhe Stream and its associated gully ecosystem are currently in a moderate condition when compared to desired state. The stream retains some very good native fish values and the location is used by the local community for recreation. Condition is not expected to substantially change over the next 20 years in the absence of this project. If this project is successfully completed, then it is expected that the feature will move closer to Vision & Strategy desired state across many of the aspirations, with the proposed work addressing some key threats. Condition is therefore expected to be very good in 20 years' time if this work is undertaken.	W = 0.3
Risk of technical failure	There is a moderate risk of project failure due to technical feasibility. Risks are mostly related to weed control. There is a high risk of project failure due to technical feasibility if weed control isn't well planned and a focus given to key high priority weeds that can be managed to very low levels until native plants dominate.	F = 0.82
Adoptability	A community group is already operating in this area and has a strong interest in this project. They have recently taken on the lease for a large part of the land covered by this project. There is some uncertainty around adoptability on private land.	A = 0.6
Information quality	Good – information about the site and estimates of works have come from a local expert and examination of aerial photography.	

<table>
<tr><td>Knowledge gaps</td><td>Further work is required to determine the specific quantities of planting and weed control required. This should be undertaken in the early stages of project planning.</td><td></td></tr>
<tr><td>Socio-political risks</td><td>Low risk that the project will fail to meet its goals over the long term due to socio-political risks.</td><td>P= 0.85</td></tr>
<tr><td>Project duration (years)</td><td>15 years</td><td></td></tr>
<tr><td>Up-front cost – total for implementation phase/project duration</td><td>
<table>
<tr><th>Task</th><th>Cost ($)</th></tr>
<tr><td>Restoration Plan</td><td>25,000</td></tr>
<tr><td>Upstream of Donny Park (on Kukutaaruhe Trust managed land)</td><td></td></tr>
<tr><td>- Construct 250m pathway</td><td>37,500</td></tr>
<tr><td>- Signage</td><td>10,000</td></tr>
<tr><td>- Weed removal</td><td>162,580</td></tr>
<tr><td>- Native revegetation</td><td>245,222</td></tr>
<tr><td>Private Land</td><td></td></tr>
<tr><td>- Native revegetation</td><td>18,984</td></tr>
<tr><td>- Weed removal</td><td>41,440</td></tr>
<tr><td>Donny Park</td><td></td></tr>
<tr><td>- Riparian planting and weed control</td><td>42,276</td></tr>
<tr><td>- Remediation of fish barrier</td><td>5000</td></tr>
<tr><td>Animal pest control</td><td>8900</td></tr>
<tr><td>Project management/staffing/incidentals (30% of project cost)</td><td>179,071</td></tr>
<tr><td>Total</td><td>775,973</td></tr>
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</td><td>C = 0.78</td></tr>
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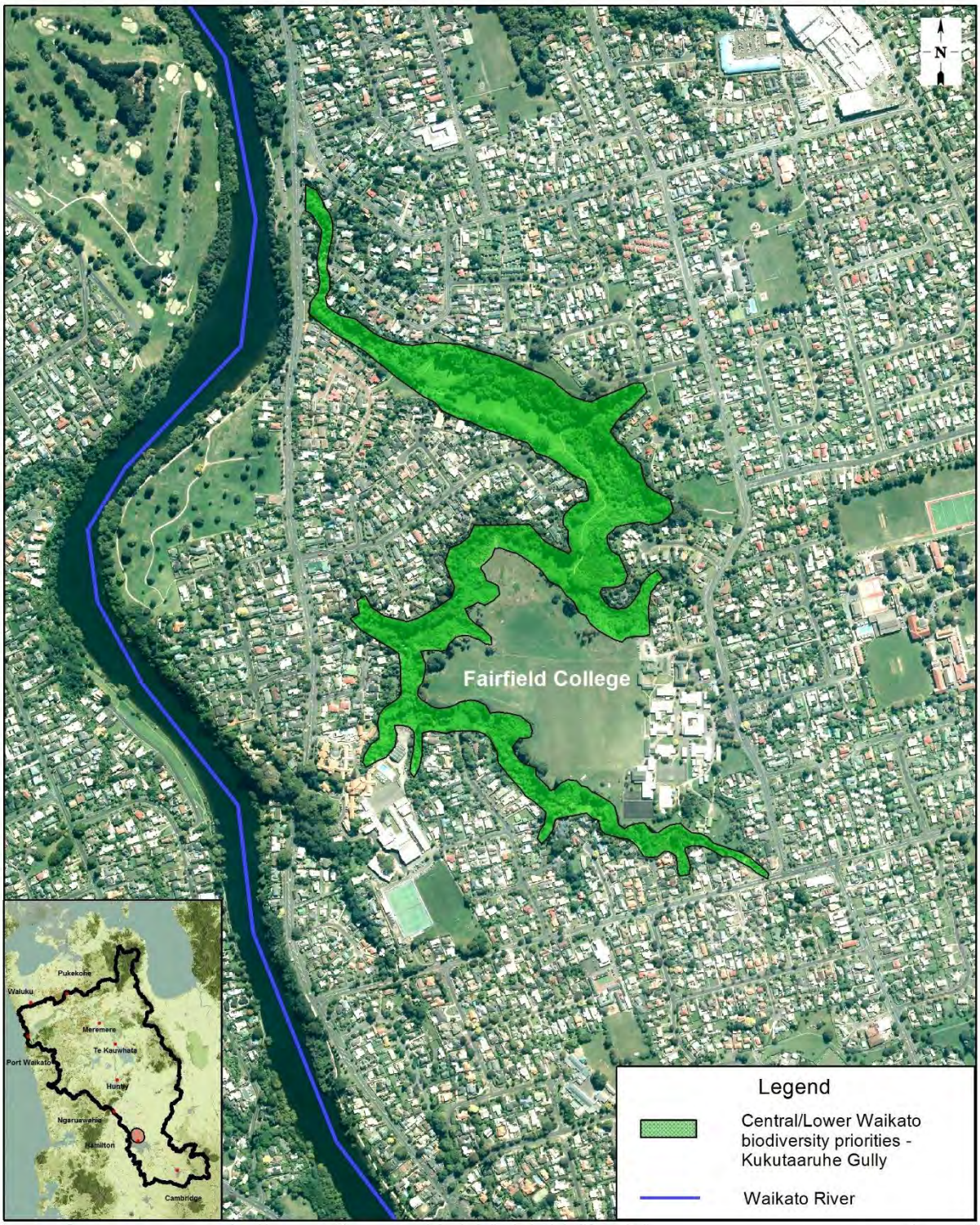

Biodiversity enhancement of Kukutaaruhe Stream and associated gully ecosystem

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017

Status: Final
Request No.: N/A
File name: WWRRS.gws

0.0 0.1 0.2 0.3 0.4
Kilometers

Scale 1:10,000@A4 Portrait

A4

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Cobble stream bed in the upper gully catchment.

Remnant native vegetation with weeds in the upper gully.

Remnant native vegetation with weeds in the upper gully.

The uncompleted path through the gully that links the Kukutaaruhe Trust site and Donny Park.

This significant natural area shows a native raupō swamp area with some willow infestation.

CLW 27 Priority: very high	Water quality improvement in the lower Mangaonua Stream catchment	BCR value
Relevant unit goal(s)	Wetlands are protected, enhanced, created and able to perform their water purification role. The mauri/life supporting capacity of fresh water is protected and restored for aquatic species.	
Name of feature	Mangaonua sub-catchment streams and wetlands	
Brief description of feature	The Mangaonua is an 11,346ha catchment that lies southeast of Hamilton city. The lower catchment makes up 6615ha of this. 86% of this lower catchment is pastoral and there is only 2% indigenous vegetation cover remaining. Approximately 73km of streams run through pastoral areas. This catchment contains a number of drainage schemes including the Fencourt scheme. Through historic land development practices the natural Mangaonua Stream channel has been altered to facilitate land drainage. Therefore segments of the stream in the middle-lower reaches are formed in straight drain configurations. After flowing through intensively farmed areas the stream enters a large gully network prior to flowing into the Waikato River on the south fringe of Hamilton city at Riverlea. The Mangaonua Stream was well known for its tuna (eels) and was a mahinga kai (food resource) of the local iwi. A historic track alongside the stream was taken by local iwi into Te Au o Waikato, which is now known as the Piako district. There are old pā and mahinga kai sites within the area. Karipukahu was once a forest of mainly kahikatea trees and was populated with kererū. Wetland restoration projects are currently underway in the Mangaonua catchment, particularly through the work of Ngāti Hauā Mahi Trust. However, scope remains for further work. Modelling undertaken in 2016 indicates that the lower Mangaonua catchment is a high priority for actions that assist in nitrogen and E.coli reduction.	
Desired state to achieve Vision & Strategy	- A sub-catchment where land use matches capability and with a stable stream network that has a fenced and well vegetated riparian margin along its entire length (at least 5m wide) to assist in providing erosion protection, shade and shelter. - Forest remnants and wetlands adjacent to streams are densely vegetated with native plant species, connected to riparian corridors and protected from stock grazing. Native	

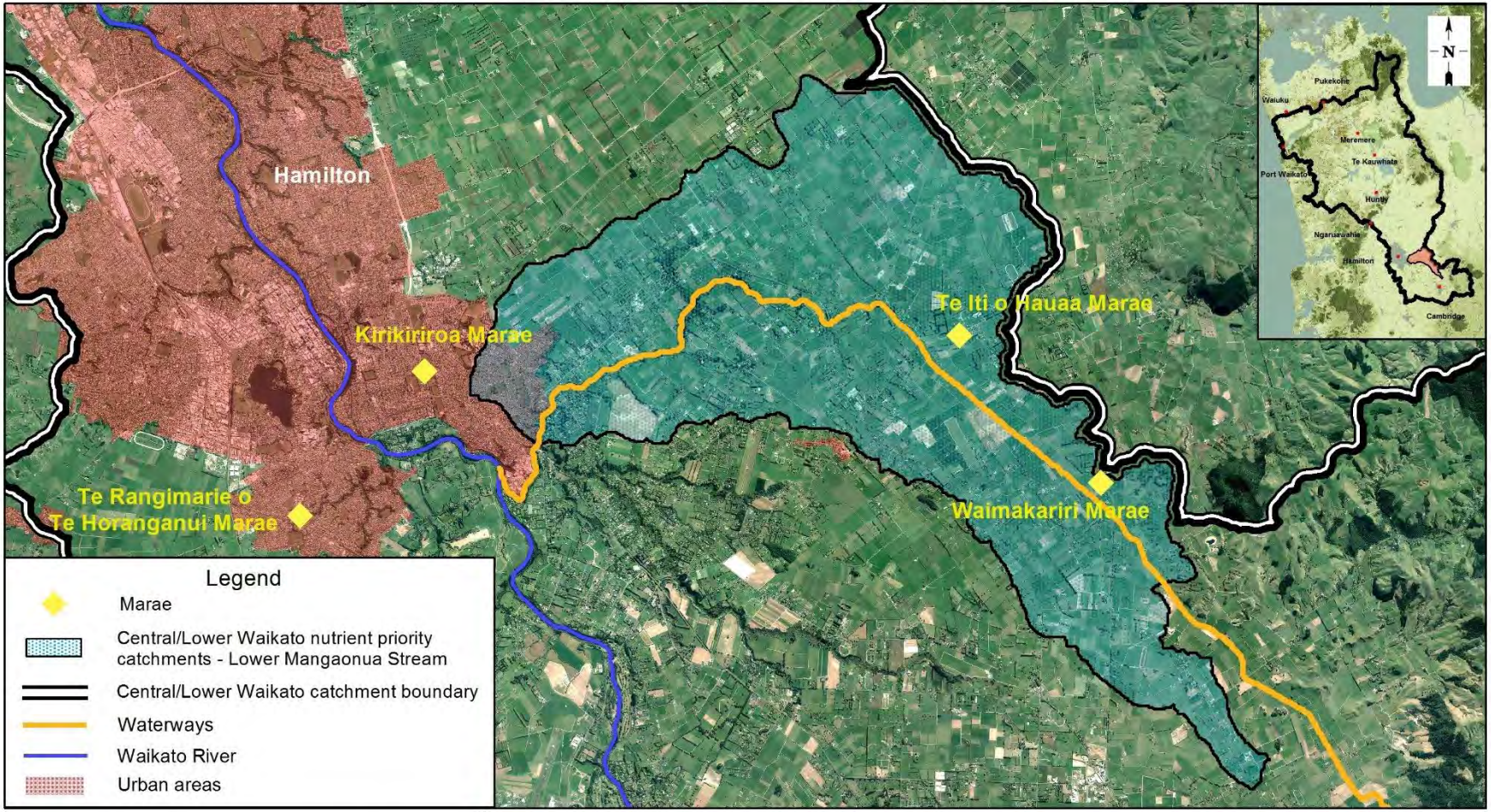
<table>
<tr><td></td><td>plant regeneration occurs naturally within the native bush remnants.
- There are no manmade barriers to native migratory fish.
- Native fish are abundant and there is a wide diversity of species present, including non-climbing native fish.
- The streams are swimmable, fishable and have access for recreation.
- Iwi and community have a strong connection to the stream and are active in its use, protection and restoration.</td><td></td></tr>
<tr><td>Impact on Vision & Strategy</td><td>In a restored condition, the Mangaonua sub-catchment streams and wetlands would have a high impact on giving effect to the Vision & Strategy at a central and lower Waikato catchment level.</td><td>VS = 30</td></tr>
<tr><td>Key threats to the feature that this project addresses</td><td><table><tr><th>Key threat</th><th>Impact on feature</th></tr><tr><td>Stock access to the streams and wetlands</td><td>Reduced water quality and destruction of riparian and wetland vegetation.</td></tr></table></td><td></td></tr>
<tr><td>Project goal/s</td><td>100% of wetlands and seeps greater than 0.1ha are fenced to exclude stock within 10 years of project commencement.</td><td></td></tr>
<tr><td>Priority works for funding</td><td>Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This project could be undertaken as a whole, or in multiple smaller components.

Wetland and ephemeral stream protection
24km of fencing wetlands and seeps >0.1ha and ephemeral streams at $8 per metre. Fence should be 5 wire – 2 electric. The focus should be on wetlands that retain relatively natural hydrology, i.e. water is flowing in and out through the wetland (not via a drain through or around), water is held back and the wetland is functioning year round.

Project management/staffing/incidentals
Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include transport, office overheads, consumables and miscellaneous professional fees.

This is estimated to be 25% of the direct project costs.</td><td></td></tr>
<tr><td>Time lag for benefits to be realised</td><td>If works were implemented at an even pace over a 5-year period, it is estimated that the majority of the project benefits would be seen within a year after project completion.</td><td>L = 5.5</td></tr>
</table>

<table>
<tr><td>Effectiveness of works</td><td>When compared with desired state, the waterways and wetlands in the Mangaonua sub-catchment are currently in a poor to moderate condition with few of the Vision & Strategy aspirations being met. Condition is not expected to change significantly in the next 20 years in the absence of this project. The project encourages fencing wetlands/seeps and ephemeral streams and is expected to facilitate improvement in condition. However, it is acknowledged that achieving the overall desired state will take longer than the 20 year horizon used for the purposes of the Restoration Strategy, and a fuller range of initiatives over the long term will be needed.</td><td>W = 0.05</td></tr>
<tr><td>Risk of technical failure</td><td>There is a negligible risk of project failure due to technical feasibility. The project consists solely of fencing wetland areas.</td><td>F = 0.97</td></tr>
<tr><td>Adoptability</td><td>It is estimated that approximately one-third of landowners would adopt the works if they were fully incentivised. Some may be concerned by loss of marginal grazing areas. Although generally the benefits of avoiding loss of stock in wetlands and protection of nutrient attenuation areas are becoming better recognised, this kind of work has not yet become as widely supported as riparian protection.</td><td>A = 0.3</td></tr>
<tr><td>Information quality</td><td>Below average – based on modelled information and some local knowledge.</td><td></td></tr>
<tr><td>Knowledge gaps</td><td>Estimates of wetland location and perimeter come from a desktop exercise. Farm scale information will need to be gathered as part of this project. It is uncertain how many wetlands and seeps retain natural hydrology.</td><td></td></tr>
<tr><td>Socio-political risks</td><td>Very low risk that the project will fail to meet its goals over the long term due to socio-political risks.</td><td>P = 0.97</td></tr>
<tr><td>Project duration (years)</td><td>5 years</td><td></td></tr>
<tr><td>Up-front cost – total for implementation phase/project duration</td><td><table><tr><th>Task</th><th>Cost ($)</th></tr><tr><td>Fencing wetlands and ephemeral streams (23km)</td><td>184,000</td></tr><tr><td>Project management/staffing/incidentals (25%)</td><td>46,000</td></tr><tr><td>Total</td><td>230,000</td></tr></table></td><td>C = 0.23</td></tr>
</table>



Water quality improvement in the Lower Mangaonua Stream catchment

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017

Status: Final
Request No.: N/A
File name:WWRRS.gws

0 1 2 3 4 5
Kilometers

Scale 1:100,000@A4 Landscape

A4

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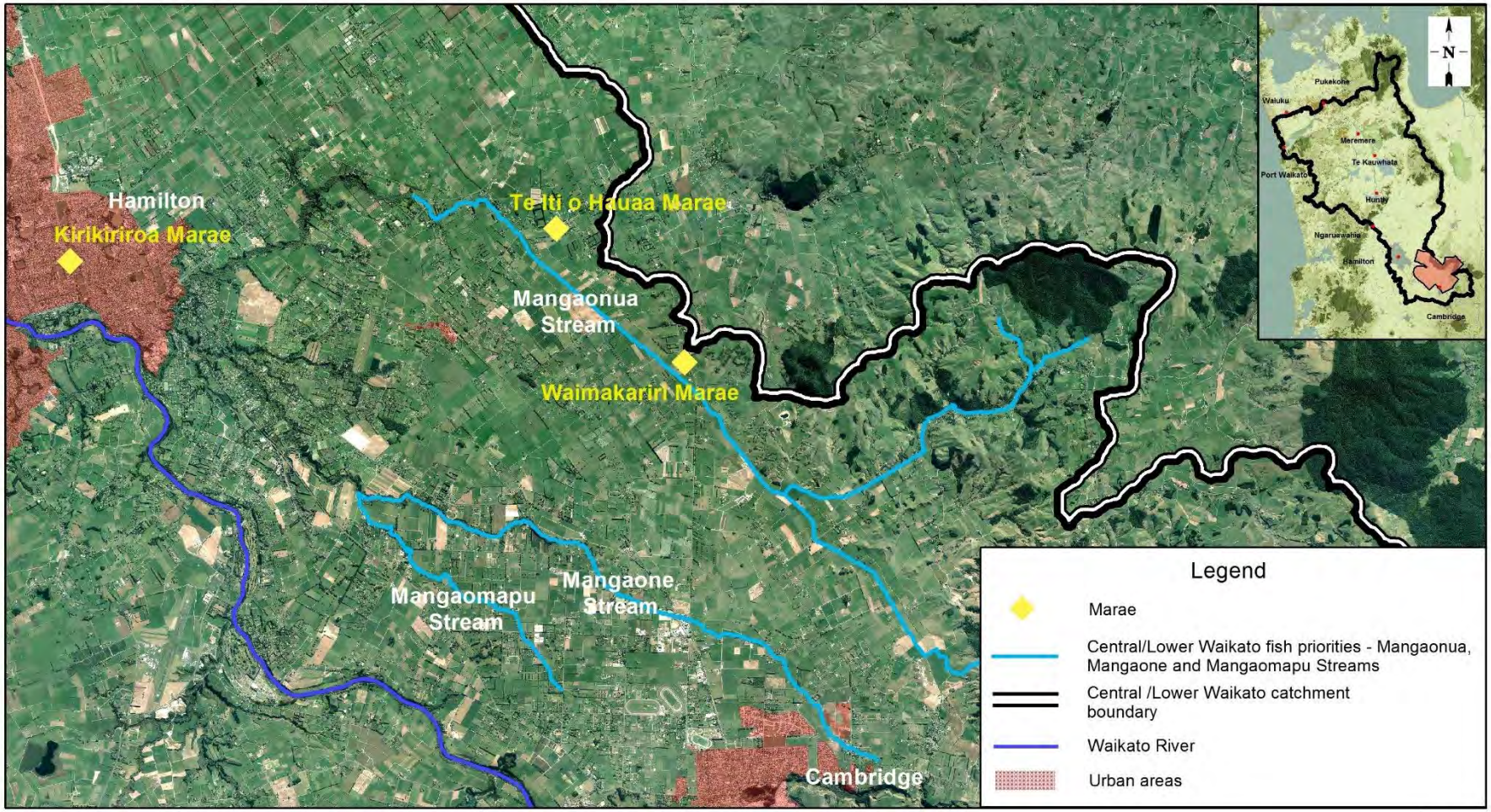
CLW 28 Priority: medium	Rehabilitation of fish habitat in the Mangaonua, Mangaone and Mangaomapu streams	BCR value
Relevant unit goal(s)	Aquatic habitats, including spawning grounds, are protected, enhanced, restored and accessible to native fish. The abundance of native fish, including taonga species, in the catchment is restored and protected.	
Name of feature	Mangaonui, Mangaone and Mangaomapu streams	
Brief description of feature	The total length of streams covered by this project is 50km. Mangaonoua Stream: This project includes the reach of Mangaonua Stream upstream of State Highway 1B near Matangi (approximately 22km) and a 7km tributary. The stream originates in the steep semi-forested headwaters near Te Miro and flows through lifestyle properties and intensively farmed pasture. It enters a gully system near State highway 1B and flows out to the Waikato River at Riverlea. The middle reaches of the stream are highly modified, having been straightened and managed for land drainage purposes. Mangaomapu Stream: This project includes the Mangaomapu Stream between Racecourse Road (near Cambridge), downstream to its confluence with Mangaone Stream, approximately 7km in length. The headwaters of the stream are a network of artificial drains in the Hautapu/Cambridge area. A more natural stream channel then meanders through intensively farmed pasture for approximately 3.5km before entering a gully system and flowing for another 3.5km to join the Mangaone Stream near Tamahere. Mangaone Stream: This project includes 14km of the Mangaone Stream from its headwaters near St Kilder, Cambridge, to the confluence with Mangaomapu Stream near Tamahere. The stream flows through a highly modified channel through lifestyle blocks and farmland before entering a gully system near its confluence with Mangaomapu Stream at Tamahere. All of the waterways appear to be well fenced from stock but are sparsely vegetated and there are likely to be barriers to fish migration in the form of incorrectly installed culverts and crossings. These waterways are important habitat for native fish species (including īnanga, giant kōkopu, banded kōkopu and smelt) and there are opportunities to increase native fish	

<table>
<tr><td></td><td>abundance by remediating barriers and providing increased and higher quality fish habitat.

These streams were well known for their tuna (eels) and birds and were a mahinga kai (food resource) of iwi. Alongside the streams there are old travelled paths to old pā sites – they can scarcely be identified but reflect the significance of the area to tangata whenua.</td><td></td></tr>
<tr><td>Desired state to achieve Vision & Strategy</td><td>The streams are fenced to exclude stock from its entire length. They have a vegetated riparian margin (at least 5m wide) to provide stream shading and cover for fish.
There are no manmade barriers to native migratory fish. Native fish are abundant and the full range of species expected to be found in the waterway can be found there, e.g. kōkopu, kōura, īnanga, tuna.</td><td></td></tr>
<tr><td>Impact on Vision & Strategy</td><td>In a restored condition, these streams would have a very high impact on giving effect to the Vision & Strategy at a local level.</td><td>VS = 15</td></tr>
<tr><td>Key threats to the feature that this project addresses</td><td><table><tr><th>Key threat</th><th>Impact on feature</th></tr><tr><td>Lack of riparian cover and associated fish habitat</td><td>Reduced habitat for adult fish.</td></tr><tr><td>Vegetation clearance</td><td>Reduced cover, habitat and food (invertebrates) for native fish species.</td></tr><tr><td>Culverts and crossings that are a barrier for native fish</td><td>Native fish unable to access upstream areas.</td></tr></table></td><td></td></tr>
<tr><td>Project goal/s</td><td>Within 10 years of project commencing:
- Streams are 100% fenced to exclude stock.
- Streams have a riparian margin that is a minimum of 5m wide and vegetated with plant species that provide stream shade and enhance habitat for adult native fish.
- There are no manmade barriers to native migratory fish.</td><td></td></tr>
<tr><td>Priority works for funding</td><td>Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This project could be undertaken as a whole, or in multiple smaller components.
The project manager will need to work closely with Waikato Regional Council to ensure planting does not negatively impact land drainage. Resource consent will be required where planting is undertaken within drainage districts. $5000 has been estimated for resource consent costs.
This project could be undertaken as a whole, or in components.</td><td></td></tr>
</table>

	Riparian management Carry out or upgrade riparian fencing so that it has a minimum 5m setback from the top of the streambank (5 wire fence – 2 electric wires). Include adjoining wetland areas within the riparian fencing. - Assume 70% (68km) requires fencing or fence upgrade/relocation at an estimated cost of $8 per metre ($544,000). Undertake native riparian planting and carry out associated weed control and maintenance for native plant establishment. - Assume 80% (78km) of streambanks require native planting with a 5m wide margin (39ha) at a cost of $37,552 per hectare ($1,464,528). **Remediation of barriers to native migratory fish** Determine the location and type of barriers to fish passage. Cost estimates allow for the remediation of 6 barriers (at $5000 per barrier) to native migratory fish on these waterways ($35,000). **Project management/staffing/incidentals** Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include transport, office overheads, consumables and miscellaneous professional fees. This is estimated to be 30% of the direct project costs.	
Time lag for benefits to be realised	If works were implemented at an even pace over a 10-year period, it is estimated that the majority of the project benefits would be seen approximately 1 year before project completion.	L = 9
Effectiveness of works	When compared to the Vision & Strategy desired state, these streams are currently in poor to moderate condition. Overall, there may be some improvement along some stretches over the next 20 years even in the absence of this project. This is due to fencing and planting work that has recently been undertaken in places. Works included here are expected to substantially increase fish habitat availability and quality. Although it won't address catchment land use, the wide riparian setbacks should contribute to protecting and restoring water quality through shading, stock exclusion and reduction of nutrients and pathogens entering the streams. It is acknowledged that achieving the Vision & Strategy desired state will take longer than the 20 year horizon used for the purposes of the Restoration	W = 0.13

<table>
<tr><td></td><td>Strategy. However, works included in this project address some of the key threats to the feature and it is anticipated that if the project is fully completed it would contribute to making progress towards achieving the Vision & Strategy state in 20 years' time.</td><td></td></tr>
<tr><td>Risk of technical failure</td><td>There is a low risk of project failure due to technical feasibility. Risks are mostly related to establishment of plantings.</td><td>F = 0.87</td></tr>
<tr><td>Adoptability</td><td>It is estimated that approximately 70% of landowners would adopt the works if they were fully incentivised. The extent of the fencing setbacks may provide some challenge in terms of uptake and if there is already fencing close to the streambank in places (i.e. with a narrow riparian margin) landowners may be unwilling to move fences back to allow room for native planting. However, there are already good examples of this type of work along these streams and they provide a good example of what can be achieved with larger riparian margins.</td><td>A = 0.7</td></tr>
<tr><td>Information quality</td><td>Average – recommendations are based on the judgement of fish experts with some local knowledge. Quantities of work required are predominantly based on estimates made from aerial photographs.</td><td></td></tr>
<tr><td>Knowledge gaps</td><td>It is unknown specifically how much fencing and planting already exists. This would need to be established as part of the project planning. Location of fish barriers would need to be determined in the early stages of the project.</td><td></td></tr>
<tr><td>Socio-political risks</td><td>Low risk that the project will fail to meet its goals over the long term due to socio-political risks.</td><td>P = 0.97</td></tr>
<tr><td>Project duration (years)</td><td>10 years</td><td></td></tr>
<tr><td>Up-front cost – total for implementation phase/project duration</td><td><table><tr><th>Task</th><th>Cost ($)</th></tr><tr><td>Riparian fencing (68km)</td><td>544,000</td></tr><tr><td>Riparian planting (93ha)</td><td>1,464,528</td></tr><tr><td>Remediation of fish barriers</td><td>35,000</td></tr><tr><td>Resource consent</td><td>5000</td></tr><tr><td>Project management/staffing/incidentals (30% of total works cost)</td><td>614,559</td></tr><tr><td>Total</td><td>2,663,086</td></tr></table></td><td>C = 2.7</td></tr>
</table>



Rehabilitation of fish habitat in the Mangaonua, Mangaone and Mangaomapu Streams

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017

Status: Final
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0 1 2 3 4 5
Kilometers

Scale 1:110,000@A4 Landscape

A4

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The Mangaomapu Stream where riparian fencing and planting is recommended.

Mangaone Stream where riparian planting and fencing is recommended

Mangaone Stream where riparian planting is recommended, along with some fence relocation to make space for the planting.

Mangaone Stream where riparian planting is recommended, along with some fence relocation to make space for the planting.

CLW 29 Priofity: medium	Upper Mangaonua catchment hill country erosion protection and remediation	BCR value
Relevant unit goal(s)	Highly erodible land is effectively managed including through native or exotic reforestation and retirement of marginal lands. Sediment inputs to wetlands and waterbodies are reduced by 50%. The mauri/life supporting capacity of fresh water is protected and restored for aquatic species.	
Name of feature	Mangaonua sub-catchment	
Brief description of feature	The Mangaonua is an 11,346ha catchment that lies southeast of Hamilton city. The upper Mangaonua makes up around 40% of the total catchment and contains the Pukemoremore and Te Miro areas. Approximately 82% of this catchment is in pasture with the remainder being native vegetation. 1678ha of this catchment is 6e in pasture. Through historic land development practices the natural Mangaonua Stream channel has been altered to facilitate land drainage. Therefore segments of the stream in the middle reaches are formed in straight drain configurations. After flowing through intensively farmed areas the stream enters a large gully network prior to flowing into the Waikato River on the south fringe of Hamilton city at Riverlea. The Mangaonua Stream was well known for its tuna (eels) and was a mahinga kai (food resource) of the local iwi. Alongside the stream, an old track took local iwi into Te Au o Waikato, which is now known as the Piako district. There are old pā and mahinga kai sites in the area. Karipukahu was once a forest of mainly kahikatea trees and was populated with kererū. Pukemoremore is also of significance to the Ngāti Hauā iwi. Modelling undertaken in 2016 indicates that the upper Mangaonua is a high priority for erosion and sediment management.	
Desired state to achieve Vision & Strategy	- A sub-catchment where land use matches capability and with a stable stream network that has a fenced and well vegetated riparian margin along its entire length (at least 5m wide). - Forest remnants and wetlands adjacent to streams are densely vegetated with native plant species, connected to riparian	

<table>
<tr><td></td><td>corridors and protected from stock grazing. Native plant regeneration occurs naturally within the native bush remnants.
- There are no manmade barriers to native migratory fish. Native fish are abundant and there is a wide diversity of species present, including non-climbing native fish.
- The stream is swimmable, fishable and has access for recreation.
- Iwi and community have a strong connection to the stream and are active in its use, protection and restoration.</td><td></td></tr>
<tr><td>Impact on Vision & Strategy</td><td>In a restored condition, the Mangaonua sub-catchment would have a very high impact on giving effect to the Vision & Strategy at a central and lower Waikato catchment level.</td><td>VS = 100</td></tr>
<tr><td>Key threats to the feature that this project addresses</td><td><table><tr><th>Key threat</th><th>Impact on feature</th></tr><tr><td>Hill country erosion</td><td>Contributes significant sediment to the central/lower Waikato River, impacting on both the water quality in Mangaonua Stream and the Waikato River. Soil is lost from farmland.</td></tr></table></td><td></td></tr>
<tr><td>Project goal/s</td><td>There is a 20% reduction in suspended sediment in the upper Mangaonua Stream within 10 years of project commencement.</td><td></td></tr>
</table>

Priority works for funding	Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This project could be undertaken as a whole, or in multiple smaller components. **Hill country soil conservation** - 210ha LUC 6e land managed with open space pole planting at $3000 per hectare - 210ha LUC 6e land managed with plantation species (pine or mānuka) at $3000 per hectare - 40km of fencing the managed LUC 6e land at $25 per metre (8-wire and batten) - 13km fencing existing indigenous forest cover at $25 per metre (8-wire and batten). **Project management/staffing/incidentals** Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include transport, office overheads, consumables and miscellaneous professional fees. This is estimated to be 25% of the direct project costs.	
Time lag for benefits to be realised	If works were implemented at an even pace over a 10-year period, it is estimated that the majority of the project benefits would be seen at project completion.	L = 10
Effectiveness of works	The upper Mangaonua sub-catchment is in moderate condition compared with the desired state, with few of the Vision & Strategy aspirations currently being met. Condition is not expected to significantly change over the next 20 years in the absence of this project. It is acknowledged that achieving the Vision & Strategy desired state will take longer than the 20 year horizon used for the purposes of the Restoration Strategy, and a fuller range of initiatives of the longer term needed. However, works included in this project address some key threats to the feature and it is anticipated that if the project is fully completed it would contribute to progress towards achieving the Vision & Strategy state in 20 years' time.	W = 0.05
Risk of technical failure	There is a low risk of project failure due to technical feasibility. Risks are mostly related to establishment of plantings or loss of works due to weather events/erosion.	F = 0.87
Adoptability	It is estimated that almost half of landowners would adopt the works if they were fully incentivised. Uptake of management of	A = 0.45

<table>
<tr><td></td><td>LUC class 6e land may be low and we are not aware of significant similar works being undertaken recently in this catchment. Early community engagement, flexibility of approach and identifying key farmers will be very important for the success of this project.</td><td></td></tr>
<tr><td>Information quality</td><td>Average – estimates are based on modelled information, central Waikato riparian surveys and input from catchment officers who are familiar with the sub-catchment.</td><td></td></tr>
<tr><td>Knowledge gaps</td><td>Estimates of LUC class 6e come from a desktop exercise. Farm scale information will need to be gathered as part of this project.</td><td></td></tr>
<tr><td>Socio-political risks</td><td>Low risk that the project will fail to meet its goals over the long term due to socio-political risks.</td><td>P = 0.85</td></tr>
<tr><td>Project duration (years)</td><td>10 years</td><td></td></tr>
<tr><td>Up-front cost – total for implementation phase/project duration</td><td><table>
<tr><th>Task</th><th>Cost ($)</th></tr>
<tr><td>210ha LUC 6e managed with pole planting</td><td>630,000</td></tr>
<tr><td>210ha LUC 6e managed with plantation species</td><td>630,000</td></tr>
<tr><td>Fencing managed LUC 6e land (40km)</td><td>1,000,000</td></tr>
<tr><td>Fencing existing indigenous vegetation (13km)</td><td>325,000</td></tr>
<tr><td>Project management/staffing/incidentals (25%)</td><td>646,250</td></tr>
<tr><td>Total</td><td>3,231,250</td></tr>
</table></td><td>C = 3.2</td></tr>
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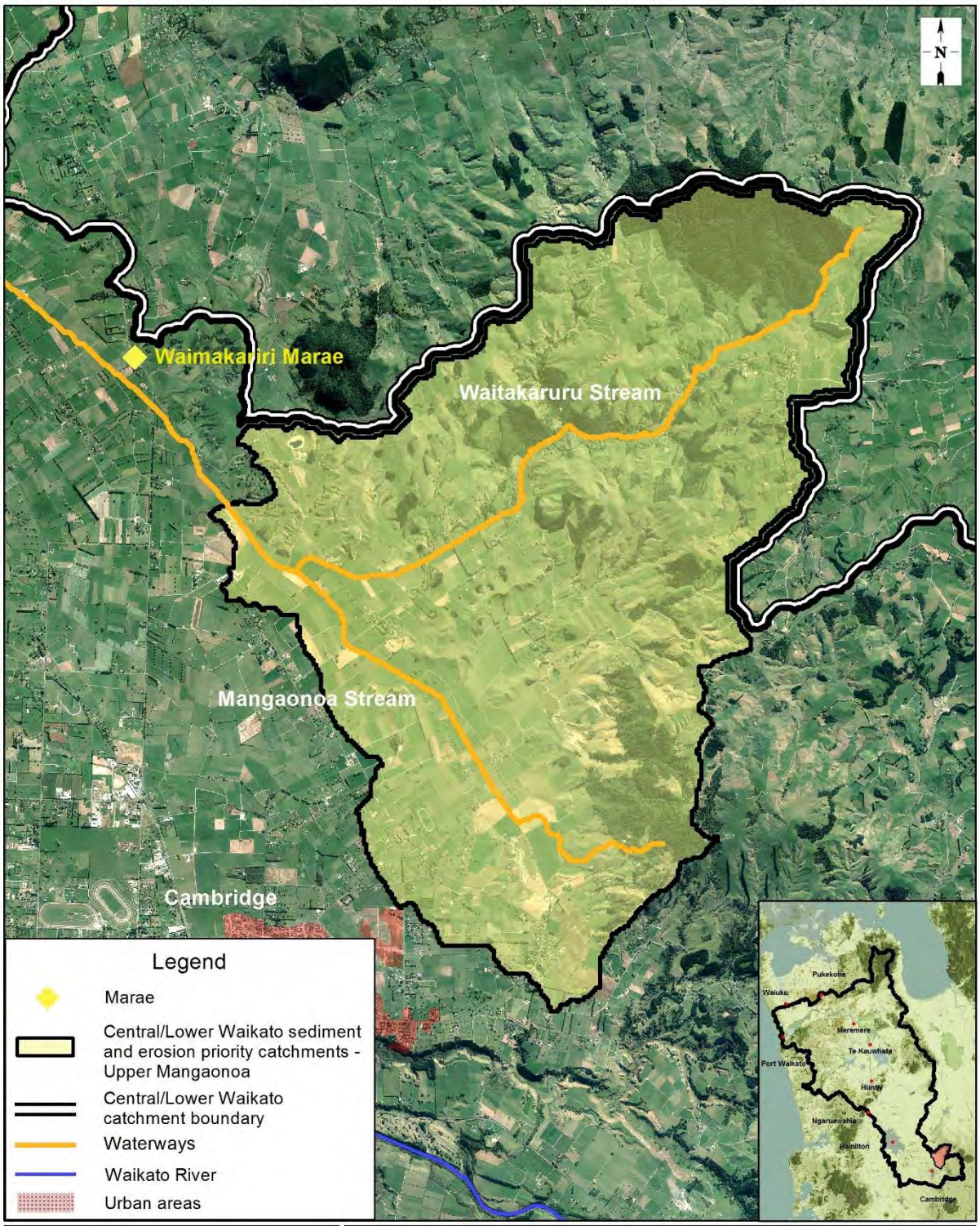

Upper Mangaonoa catchment hill country erosion protection and remediation

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017
Status: Final
Request No.: N/A
File name: WWRRS.gws

0.0 0.5 1.0 1.5 2.0 2.5
Kilometers

Scale 1:65,000@A4 Portrait

A4

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Waikato Regional Council
Te Kaunihera ā Rohe o Waikato

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Hill country in the upper Mangaonua.

CLW 30 Priority: medium	Karāpiro catchment hill country and streambank erosion protection and remediation	BCR value
Relevant unit goal(s)	Highly erodible land is effectively managed including through native or exotic reforestation and retirement of marginal lands. Sediment inputs to wetlands and waterbodies are reduced by 50%. The mauri/life supporting capacity of fresh water is protected and restored for aquatic species.	
Name of feature	Karāpiro catchment	
Brief description of feature	The Karāpiro is an 8920ha catchment with an approximately 150km stream network within it. According to Waikato Regional Council data, 81% of the catchment is in pasture, 9% is indigenous vegetation and 5% forestry. The pastoral area includes approximately 3985ha of Land Use Capability (LUC) 6e and 7. Headwaters for this catchment arise southeast of Cambridge in the vicinity of Whitehall, extending northward toward Te Miro. Predominant land use in the upper catchment is a mix of dry stock farming and dairying, with rural lifestyle blocks common through the lower part of the catchment. The topography is moderately steep to rolling in the upper reaches to undulating flats in the lower reaches. Water for the Karāpiro Stream mostly originates from natural groundwater systems in the upper catchment areas. Flows progressively increase as the stream travels through to the confluence with the Waikato River at Cambridge. Karāpiro is very significant to the Ngāti Hauā and Ngāti Koroki Kahukura iwi. Known as 'Te rohe o te Tuna', or the area renowned for eel abundance, it was a rich source of food for tangata whenua. There are many historic pā, wāhi tapu and mahinga kai sites within the project area. The catchment has previously been subject to a range of hill country, riparian and river protection and enhancement works and this work continues up to the present time. Modelling undertaken in 2016 indicates that the Karāpiro catchment is a high priority for erosion and sediment management from both hill country and streambanks.	

<table>
<tr><td>Desired state to achieve Vision & Strategy</td><td>- A sub-catchment where land use matches capability and with a stable stream network that has a fenced and well vegetated riparian margin along its entire length (at least 5m wide) to assist in providing erosion protection, habitat and shade.
- Forest remnants and wetlands adjacent to streams are densely vegetated with native plant species, connected to riparian corridors and protected from stock grazing.
- There are no manmade barriers to native migratory fish.
- Native fish are abundant and there is a wide diversity of species present, including non-climbing native fish.
- The stream is swimmable, fishable and has access for recreation.
- Iwi and community have a strong connection to the stream and are active in its use, protection and restoration.</td><td></td></tr>
<tr><td>Impact on Vision & Strategy</td><td>In a restored condition, the Karāpiro sub-catchment would have a very high impact on giving effect to the Vision & Strategy at a central and lower Waikato catchment level.</td><td>VS = 150</td></tr>
<tr><td>Key threats to the feature that this project addresses</td><td><table><tr><th>Key threat</th><th>Impact on feature</th></tr><tr><td>Hill country erosion</td><td>One of the largest contributors of sediment to the central Waikato River, impacting on both the water quality in Karāpiro Stream and the Waikato River. Soil is lost from farmland.</td></tr><tr><td>Riverbank erosion</td><td>Increased sediment in the catchment streams and within the central and lower reaches of the Waikato River.</td></tr><tr><td>Stock access to the streams</td><td>Reduced water quality and destruction of riparian and wetland vegetation.</td></tr></table></td><td></td></tr>
<tr><td>Project goal/s</td><td>- LUC class 7 soils are managed within their capabilities and are retired from heavy stock grazing.
- There is a 30% reduction in suspended sediment in the Karāpiro Stream within 20 years of project commencement.</td><td></td></tr>
<tr><td>Priority works for funding</td><td>Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This project could be undertaken as a whole, or in multiple smaller components.

Hill country soil conservation
- 460ha LUC 6e land managed with open space pole planting at $3000 per hectare
- 460ha LUC 6e land managed with plantation species (pine or mānuka) at $3000 per hectare
- 80km of fencing the managed LUC 6e land at $25 per metre (8-wire and batten)</td><td></td></tr>
</table>

	- 303ha LUC 7 land managed with plantation species (pine or mānuka) at $3000 per hectare - 40km of fencing the managed LUC 7 land at $25 per metre (8-wire and batten) - 4ha reducing sediment to waterways outside LUC class 6e, 7 and 8 land at $8000 per hectare (e.g. dewatering, retiring seepages, etc) - 20km fencing existing indigenous forest cover at $25 per metre (8-wire and batten) **Riparian management of rivers/streams in pasture for soil conservation purposes** Carry out riparian fencing with a minimum 5m setback from the top of the streambank (at least 5-wire with 2 electric wires at $8 per metre) along an estimated 52km of streambank (26km of stream length). Include adjoining wetland areas within the riparian fencing. Undertake a mix of native and exotic soil conservation riparian planting within the fenced area (where it doesn't exist naturally), estimated to be 19ha of planting and associated weed control and maintenance. 5528 poplar poles are estimated to be required for river and stream erosion control. It is estimated that approximately 2km of main channel still requires soft and hard erosion control structures at a cost of $20,000 per km. **Project management/staffing/incidentals** Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include transport, office overheads, consumables and miscellaneous professional fees. This is estimated to be 30% of the direct project costs.	
Time lag for benefits to be realised	If works were implemented at an even pace over a 20-year period, it is estimated that the majority of the project benefits would be seen approximately 15 years after project commencement.	L = 15
Effectiveness of works	The Karāpiro sub-catchment is in moderate condition when compared to the Vision & Strategy desired state. It is not considered safe for swimming due to high levels of E. coli and low water clarity. Over the next 20 years it is expected that some aspects will deteriorate and some improve in the absence of this project. Works included here address several threats to the feature and it is anticipated that if the project is fully completed, the catchment will move measurably closer to the Vision & Strategy desired state in areas such as land use meeting	W = 0.15

	capability and streambank stability. The project will assist in protecting and improving water quality, facilitate a reduction in sediment in waterways and have benefits for native fisheries. It is, however, acknowledged that achieving the Vision & Strategy desired state will take longer than the 20 year horizon used for the purposes of the Restoration Strategy, and a fuller range of initiatives over the long term will be needed.	
Risk of technical failure	There is a low risk of project failure due to technical feasibility. Risks are mostly related to establishment of plantings or loss of works due to weather events/erosion.	F = 0.87
Adoptability	It is estimated that almost half of landowners would adopt the works if they were fully incentivised. Uptake of management of LUC class 6e and 7 land may be low and we are not aware of significant similar works being undertaken recently in this catchment. Early community engagement, flexibility of approach and identifying key farmers will be very important for the success of this project.	A = 0.45
Information quality	Average – estimates are based on modelled information, Central Waikato riparian surveys and input from catchment officers who are familiar with the sub-catchment.	
Knowledge gaps	Estimates of LUC classes 6e and 7, and stream lengths come from a desktop exercise. Farm scale information will need to be gathered as part of this project.	
Socio-political risks	Low risk that the project will fail to meet its goals over the long term due to socio-political risks.	P = 0.85
Project duration (years)	20 years	

<table>
<tr>
<td>Up-front cost – total for implementation phase/project duration</td>
<td>
<table>
<tr><th>Task</th><th>Cost ($)</th></tr>
<tr><td>460ha LUC 6e managed with pole planting</td><td>1,380,000</td></tr>
<tr><td>460ha LUC 6e managed with plantation species</td><td>1,380,000</td></tr>
<tr><td>Fencing managed LUC 6e land (80km)</td><td>2,000,000</td></tr>
<tr><td>303ha LUC 7 managed with plantation species</td><td>909,000</td></tr>
<tr><td>Fencing managed LUC 7 land (40km)</td><td>1,000,000</td></tr>
<tr><td>Reducing sediment outside LUC 6e, 7 and 8 (4ha)</td><td>32,000</td></tr>
<tr><td>Fencing existing indigenous vegetation (20km)</td><td>500,000</td></tr>
<tr><td>Riparian fencing (52km)</td><td>416,000</td></tr>
<tr><td>Riparian willow/poplar pole planting (5528 poles)</td><td>77,387</td></tr>
<tr><td>Native riparian planting (19ha)</td><td>713,418</td></tr>
<tr><td>Stream erosion protection structures</td><td>40,000</td></tr>
<tr><td>Project management/staffing/incidentals (30%)</td><td>2,534,341</td></tr>
<tr><td>Total</td><td>10,982,146</td></tr>
</table>
</td>
<td>C = 11</td>
</tr>
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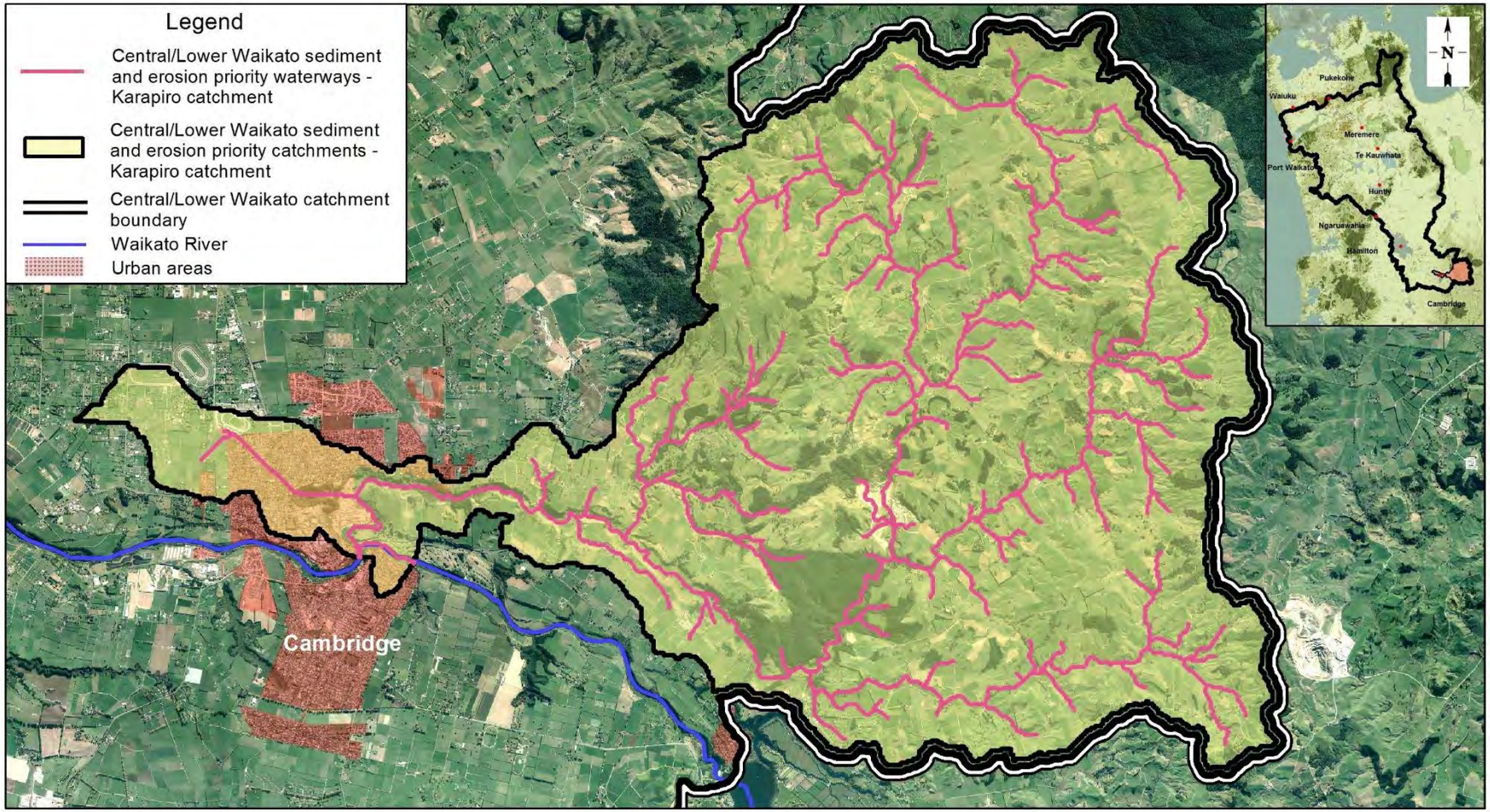

Karapiro catchment hill country and stream bank erosion protection and remediation

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017

Status: Final
Request No.: N/A
File name:WWRRS.gws

0.00 0.75 1.50 2.25 3.00 3.75
Kilometers

Scale 1:78,500@A4 Landscape

A4

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Active erosion in the Karāpiro catchment.

Areas of steep land and an unfenced waterway in the Karāpiro catchment.

An example of a wetland/seep outside of LUC 6e/7 that would benefit from fencing.

Erosion prone sites adjacent to a stream that could be fenced and planted.

Steep erosion prone land in the Karāpiro catchment.

CLW 31 Priority: medium	Water quality improvement in the Mangakōtukutuku catchment	BCR value
Relevant unit goal(s)	Wetlands are protected, enhanced, created and able to perform their water purification role. The mauri/life supporting capacity of fresh water is protected and restored for aquatic species.	
Name of feature	Streams and wetlands within the Mangakōtukutuku catchment	
Brief description of feature	The 2644ha Mangakōtukutuku catchment lies south of Hamilton city, originating in agricultural land before entering the suburbs of Glenview, Bader, Melville, Sunnyhills and Fitzroy. The majority of the catchment (78%) is pastoral (dairy and lifestyle) whilst only 2% retains indigenous vegetation. Most of the remainder of the catchment is residential. Much of the pastoral land within this catchment sits on peat soils that have been heavily drained. The main waterway in the catchment is the Mangakōtukutuku Stream which enters the Waikato River opposite Hamilton Gardens. There are three main tributaries to this stream. Significant riparian fencing and planting and gully restoration has already been undertaken in this catchment by landowners, Hamilton City Council and the Mangakōtukutuku Care Group. Ten species of indigenous fish are known to live in the Mangakōtukutuku Stream, including threatened giant kōkopu and longfin eel. Waikato Regional Council water quality monitoring of the stream at Peacock Road indicates that levels of nitrogen, phosphorus and E. coli are unsatisfactory 100% of the time. Modelling undertaken in 2016 indicates that the Mangakōtukutuku Stream catchment is a high priority for actions that assist in nitrogen and E. coli reduction.	
Desired state to achieve Vision & Strategy	- A sub-catchment where land use matches capability and with a stable stream network that has a fenced and well vegetated riparian margin along its entire length (at least 5m wide) to assist in providing erosion protection, shade and shelter. - Forest remnants and wetlands are densely vegetated with native plant species, connected to riparian corridors and protected from stock grazing. Native plant regeneration occurs naturally within the native bush remnants. - There are no manmade barriers to native migratory fish.	

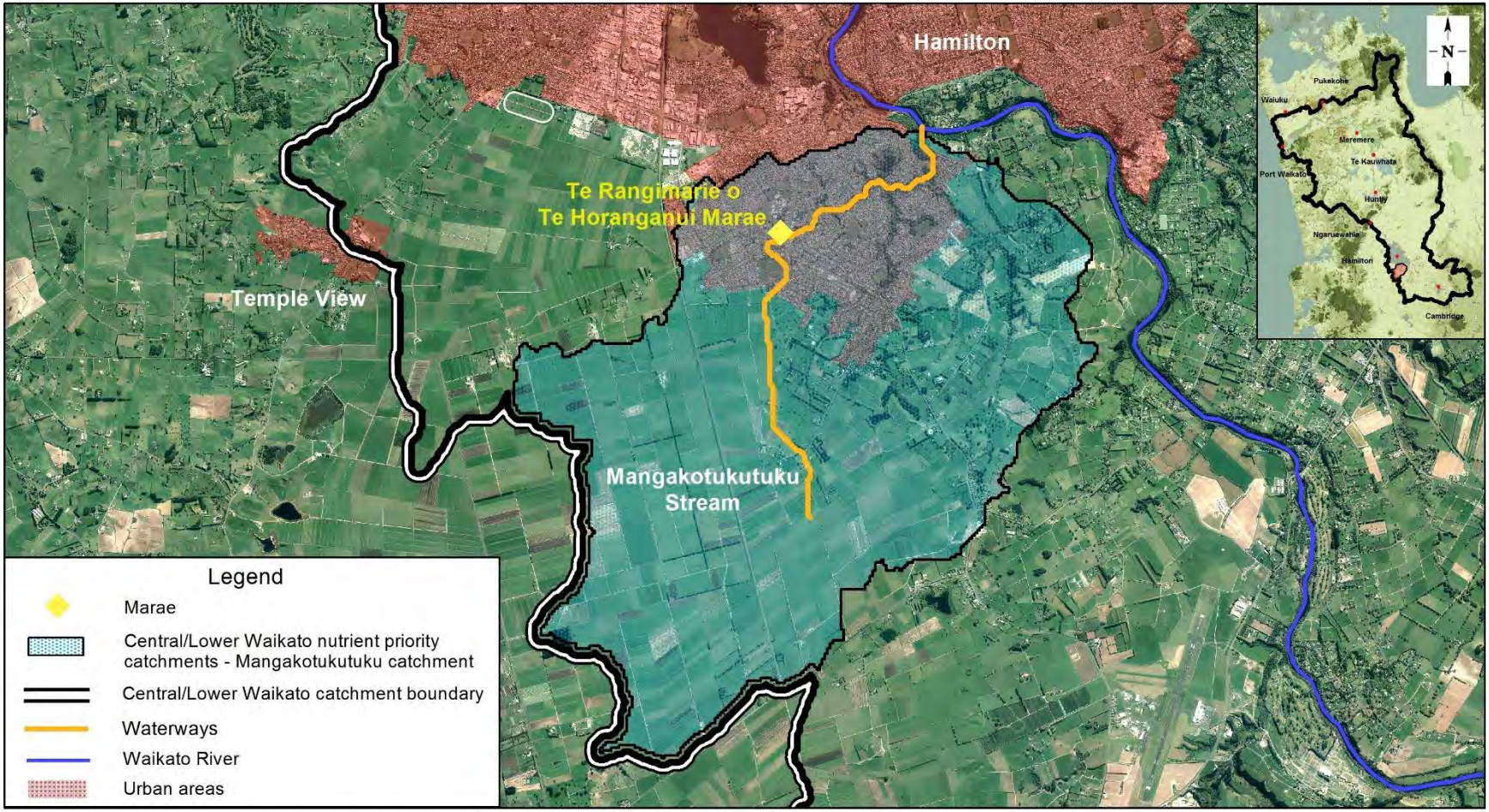
<table>
<tr><td></td><td>- Native fish are abundant and there is a wide diversity of species present, including non-climbing native fish.
- The stream is swimmable, fishable and has access for recreation.
- Iwi and community have a strong connection to the catchment streams and are active in their use, protection and restoration.</td><td></td></tr>
<tr><td>Impact on Vision & Strategy</td><td>In a restored condition, the streams and wetlands within the Mangakōtukutuku sub-catchment would have a very high impact on giving effect to the Vision & Strategy at a local level.</td><td>VS = 8</td></tr>
<tr><td>Key threats to the feature that this project addresses</td><td><table><tr><th>Key threat</th><th>Impact on feature</th></tr><tr><td>Stock access to the streams and wetlands</td><td>Reduced water quality and destruction of riparian and wetland vegetation.</td></tr></table></td><td></td></tr>
<tr><td>Project goal/s</td><td>100% of wetlands and seeps greater than 0.1ha are fenced to exclude stock within 5 years of project commencement.</td><td></td></tr>
<tr><td>Priority works for funding</td><td>Suggested works could be implemented either by an organisation or private citizens (using contractors or their own labour). This project could be undertaken as a whole, or in multiple smaller components.

Wetland and ephemeral stream protection
6km of fencing wetlands and seeps >0.1ha and ephemeral streams at $8 per metre. Fence should be 5 wire – 2 electric. The focus should be on wetlands that retain relatively natural hydrology, i.e. water is flowing in and out through the wetland (not via a drain through or around), water is held back and the wetland is functioning year round.

Project management/staffing/incidentals
Staff to carry out landowner liaison, iwi engagement, Health and Safety requirements, negotiate agreements, inspect works, manage parts of the work as required (e.g. fencing or planting), project reporting and financial management. Incidentals include transport, office overheads, consumables and miscellaneous professional fees.

This is estimated to be 25% of the direct project costs.</td><td></td></tr>
<tr><td>Time lag for benefits to be realised</td><td>If works were implemented at an even pace over a 3-year period, it is estimated that the majority of the project benefits would be seen approximately 1-2 years after project completion.</td><td>L = 4.5</td></tr>
<tr><td>Effectiveness of works</td><td>The waterways and wetlands in the Mangakōtukutuku sub-catchment are currently in a poor to moderate condition with few of the Vision & Strategy desired state aspects being met. It is</td><td>W = 0.01</td></tr>
</table>

<table>
<tr><td></td><td>anticipated that there may be decline in state over the next 20 years in the absence of this project. The project encourages fencing wetlands/seeps and ephemeral streams and is expected to very slightly offset decline. However, it is acknowledged that achieving the desired state will take longer than the 20 year horizon used for the purposes of the Restoration Strategy, and a fuller range of initiatives over the long term will be needed.</td><td></td></tr>
<tr><td>Risk of technical failure</td><td>There is a negligible risk of project failure due to technical feasibility. The project consists solely of fencing wetland areas.</td><td>F = 0.97</td></tr>
<tr><td>Adoptability</td><td>It is estimated that about half of landowners would adopt the works if they were fully incentivised. Some may be concerned by loss of marginal grazing areas, however, generally the benefits of avoiding loss of stock in wetlands are becoming well recognised.</td><td>A = 0.5</td></tr>
<tr><td>Information quality</td><td>Below average – estimates are based on modelled information and some local knowledge.</td><td></td></tr>
<tr><td>Knowledge gaps</td><td>Estimates of wetland location and perimeter come from a desktop exercise. Farm scale information will need to be gathered as part of this project. It is uncertain how many wetlands and seeps retain natural hydrology.</td><td></td></tr>
<tr><td>Socio-political risks</td><td>Low risk that the project will fail to meet its goals over the long term due to socio-political risks.</td><td>P = 0.97</td></tr>
<tr><td>Project duration (years)</td><td>3 years</td><td></td></tr>
<tr><td>Up-front cost – total for implementation phase/project duration</td><td><table>
<tr><th>Task</th><th>Cost</th></tr>
<tr><td>Fencing wetlands and ephemeral streams (6km)</td><td>48,000</td></tr>
<tr><td>Project management/staffing/incidentals (25%)</td><td>12,000</td></tr>
<tr><td>Total</td><td>60,000</td></tr>
</table></td><td>C = 0.06</td></tr>
</table>



Water quality improvement in the Mangakotukutuku catchment

WWRRS Project Map

Created by: Tane Desmond
Projection: NZTM
Date: December 2017

Status: Final
Request No.: N/A
File name:WWRRS.gws

0.0 0.6 1.2 1.8 2.4 3.0
Kilometers

Scale 1:60,000@A4 Landscape

A4

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