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Drury Quarry – Sutton Block

E5:9 Residual Effects Analysis Report: Stream and Wetland Offset

for: Stevenson Aggregates Limited

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EXECUTIVE SUMMARY

As part of the Sutton Block pit expansion, a full suite of ecology assessments, reports and plans have been developed (Table 1). A summary of each document, including its objectives and key findings are provided in this section. This table is provided at the start of each ecology document with the relevant document highlighted to improve navigation. This document is 5 of a series of 9 ecology documents (E5:9).

Table 1. Documents prepared as part of this project. The current document is highlighted.

Document name (abbreviated name)	Aspects covered
E1:9 Ecology Documents Guide and Summary	Summary of the whole project and guidance for navigating documents.
Ecological Impact and Management	
E2:9 Ecological Impact Assessment (EcIA)	Assessment of ecological values and impacts of the proposed Sutton Block on terrestrial and freshwater ecosystems, including regenerating and mature forest fragments, water courses and wetlands. Fauna values include common native invertebrates and birds, At Risk pipit, copper skinks, longfin eel and (potentially) threatened long-tailed bats. Recommendations are provided for avoiding, managing, offsetting and compensating for significant residual adverse effects.
E3:9 Ecological Management Plan (EMP)	Management of ecological impacts in accordance with the effects management hierarchy, prior to and during and following construction. Specific impacts and values addressed in this Plan include: a) Management of Vegetation Removal b) Avifauna Management Plan c) Long-Tailed Bats Management Plan d) Native Lizard Management Plan e) Edge Effects Management Plan f) Native Freshwater Fauna Management Plan g) Sutton Block Riparian Planting Plan
Residual Effects Analysis Reports (REAR)	
E4:9 REAR: Terrestrial Ecology (REAR-TE)	Residual effects on terrestrial ecosystems and fauna
E5:9 REAR: Stream and Wetland Loss (REAR-SW)	Residual effects on freshwater ecosystems
Net Gain Delivery Plans (NGDP)	
E6:9 NGDP: Planting Plan (NGDP:PP)	Terrestrial offset planting
E7:9 NGDP: Pest and Weed Control (NGDP:PWC)	Terrestrial offset pest and weed control
E8:9 NGDP: Wetland Planting (NGDP:WP)	Freshwater offset planting of wetlands.
E9:9 NGDP: Riparian Planting (NGDP:RP)	Freshwater offset planting of streams.

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1 INTRODUCTION

Stevenson Aggregates Limited (SAL) is proposing a new quarry pit and associated facilities ('the Project') to extend the life of its Drury (Auckland) Quarry operation. The new pit would be excavated within an area to the north-east of the existing pit, within an area known as the Sutton Block. The Sutton Block comprises approximately 108 ha of predominantly grazing pasture, with fragments of indigenous and exotic vegetation, permanent and intermittent stream and natural wetlands (Figure 1).

The ecological habitats, including aquatic habitats, within the Project area have been assessed and an assessment of the ecological effects of the proposed new pit and associated activities on the aquatic habitats has been provided in the Ecological Impact Assessment (EcIA) report for the Project (Bioresearches & JS Ecology, 2025a).

The EcIA provides recommendations to minimise unavoidable adverse effects on aquatic habitats where possible, including stream diversion rather than reclamation (where possible), riparian planting, fauna recovery and relocation, monitoring and flow augmentation for potential reduction in stream flow, and erosion and sediment control. Where adverse effects on aquatic habitats could not be reasonably minimised or remediated to a low level of effect, then the EcIA recommended, in accordance with the effects hierarchy, offset of residual adverse effects, and if offset is not possible then compensation.

As the expansion of quarry will include the removal of natural wetlands, and permanent and intermittent streams, the loss of these aquatic habitats was assessed as a significant residual adverse effect requiring offset or compensation.

This report follows the EcIA report, fulfilling the requirement within the EcIA for a separate freshwater effect offset report for the site to address these residual adverse effects on aquatic habitats that cannot be avoided or mitigated. This report specifically provides a summary of the approach, methodologies and analysis used to determine the wetland and stream ecological offset requirements for the Sutton Block expansion. Following this report, two additional reports address the planting requirements detailed in this report for riparian and wetland planting and enhancement.

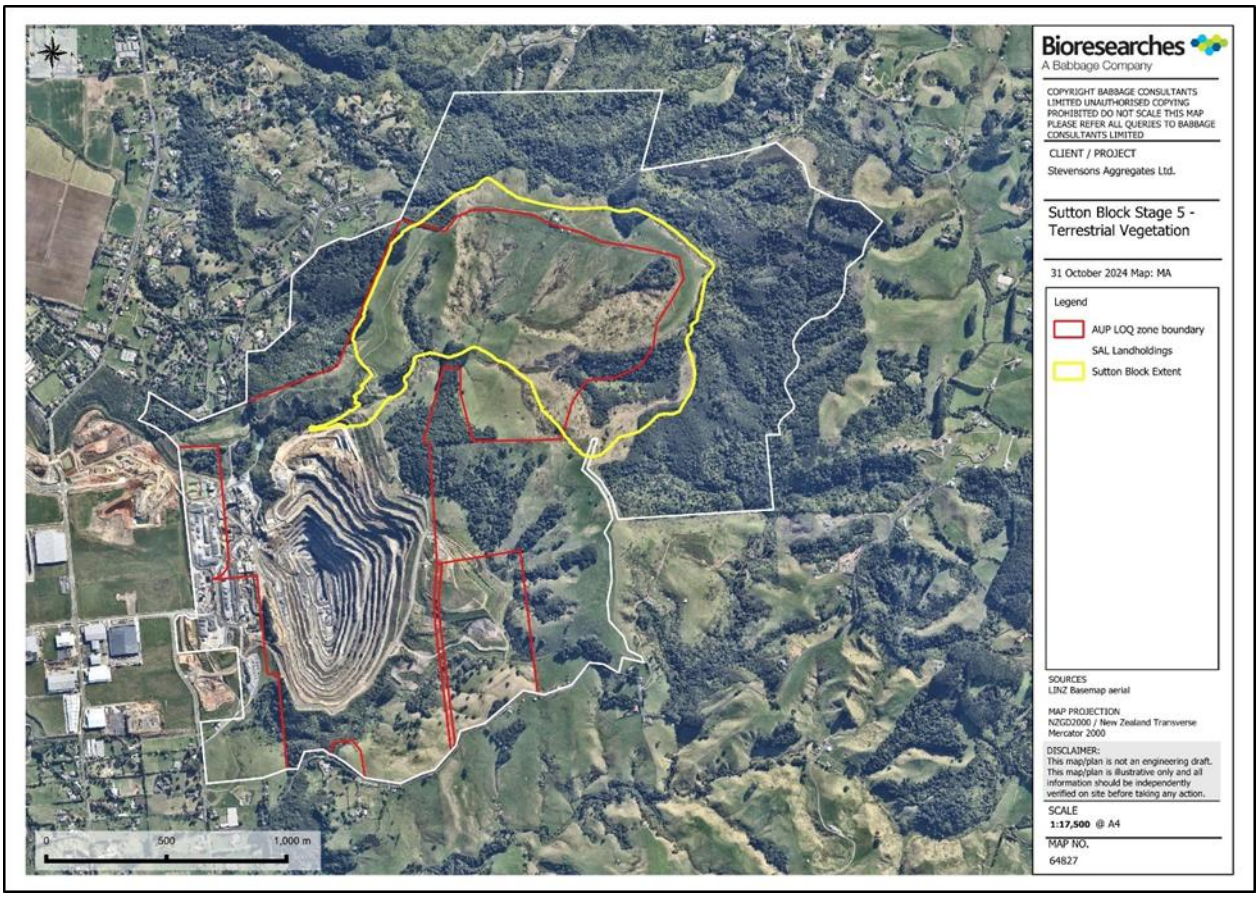


Figure 2. Drury Quarry and Sutton Block Expansion Area.

2 AQUATIC HABITATS AND PROPOSED LOSS

2.1 Aquatic Habitats

All aquatic habitats within the Sutton Block pit (and immediately adjacent) were assessed. The aquatic habitats in the expansion area and immediately adjacent, are comprised of nine un-named streams and their tributaries, a mix of permanent and intermittent streams, all upper tributaries to the Hingaia Stream, and fourteen areas of wetland, all of which meet the definition of a Natural Inland Wetland in the NPS-FM. No additional AUP wetlands were determined. (Figure 1). The Sutton Block expansion area was redesigned in 2023 to be set back further from Kaarearea Paa, avoid significant additional reclamation, including further reclamation of Stream 4; avoid the loss of the southern boundary streams and wetlands; and then further redesigned in 2024 to avoid the approximately 550 m of stream and wetland system east of Stream 9.

The location of the aquatic habitats is illustrated in Figure 1. The ecological value and effects management of the streams are presented in Table 4; with Table 5 providing additional summary details of streams where significant adverse effects cannot be avoided or minimised, and therefore require offset, under the effects management hierarchy. Table 3 provides similar summary details for the wetlands.

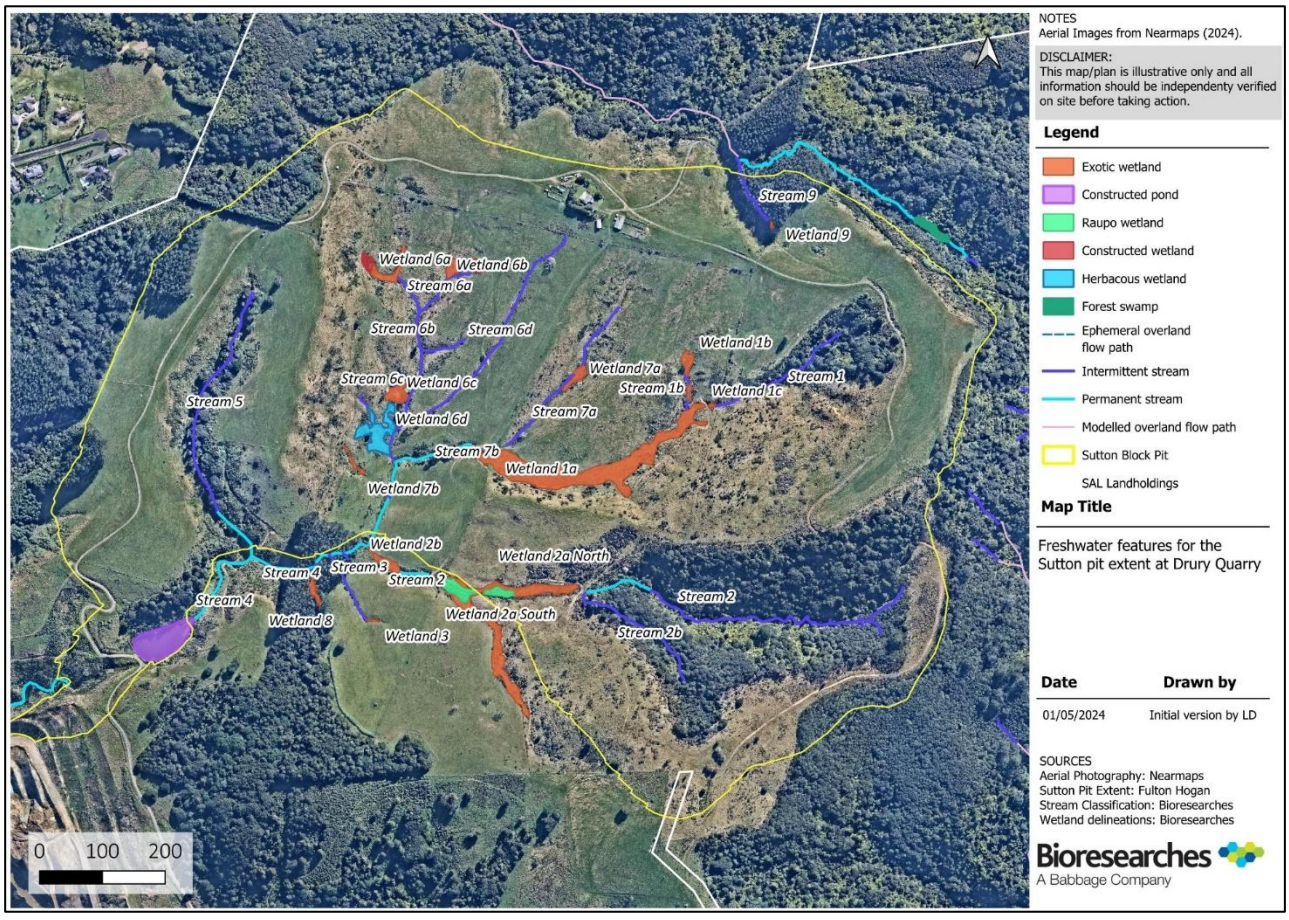


Figure 1. Freshwater ecological habitats within the proposed Sutton Block Pit.

A detailed assessment of the ecological effects of the proposed Sutton Block Pit on these aquatic habitats was provided in the EcIA report (E2:9, Bioresearches & JS Ecology, 2025a).

2.2 Stream and Wetland Loss

As detailed in the EcIA report, the proposed quarry construction and ancillary works will result in the infilling of 3,341 linear metres of intermittent and permanent stream, ranging from Moderate to Very Low ecological value.

The quarry works will be staged. Establishment of the infrastructure will occur within the first three years (approximate); then a quarry pit will be formed in the west of the site (Stage 2), expanding over about 30 years to the west and centre of the site (Stage 3); and finally the pit will expand further east to occupy the full footprint at about 50 years (Stages 4 and 5).

The staging of the quarry works will result in approximately 1,565 m of stream length and 4,587 m² of wetland habitat reclaimed within the first approximate 15 years, under Stages 1 and 2, most of which will occur under the temporary overburden area. The majority of aquatic habitat loss will occur under Stages 3 and 4, mostly at 20 years or more, with an additional 1,118 linear metres of stream and 14,171 m² of wetland extent reclaimed. The total stream length lost in the final Stage 5 pit at about 50 years will be 3,341 m, and the total wetland loss will be 18,758 m².

The EcIA report assessed:

- The magnitude of stream and wetland loss as 'Very high' due to the complete loss of these surface water systems, which is definitive and will have a direct impact.
- That the effects will be permanent and irreversible.
- That the majority of the stream and wetland reclamation cannot be minimised, and as the overall level of effect is 'Moderate' to 'High' (depending upon the ecological values of the habitats) the effects on streams and wetlands need to be offset or compensated.

Table 3 reproduced from the EcIA report summarises the effects management for the aquatic habitats and identifies the habitats where effects cannot be minimised and require to be offset.

Table 3. Summary of freshwater effects and proposed effects management

Surface water system	Ecological Value	Classification	Activity	Effects Management Offset[1]/Minimise
Stream 1	Moderate	Intermittent	Reclamation	Offset
Stream 1b	Low	Intermittent	Reclamation	Offset
Stream 2 headwaters	Moderate	Intermittent	Reclamation	Offset
Stream 2 upper	Moderate	Intermittent and permanent	Reclamation	Offset
Stream 2 lower	*Moderate*	*Permanent*	*Loss of catchment*	*Minimise*
Stream 2b	Moderate	Intermittent	Reclamation	Offset
Stream 4 upper & middle	*Moderate*	*Permanent*	*Loss of catchment*	*Minimise*
Stream 4 lower	*Moderate*	*Permanent*	*Diversion*	*Minimise*
Stream 5	Moderate	Intermittent and permanent	Reclamation	Offset

[1] Under the NPS-FM and the effects hierarchy, offset is the next step for reclamation of aquatic habitats, once Avoid, Remedy, Mitigate/Minimise have been addressed.

Stream 6 and tributaries	Low & Very Low	Intermittent	Reclamation	Offset
Stream 7 upper	Very Low	Intermittent	Reclamation	Offset
Stream 7 lower	Very Low	Permanent	Reclamation	Offset
Stream 9	Low	Intermittent	Reclamation	Offset
Wetland 1	Moderate	Exotic	Reclamation	Offset
Wetland 1b	Low	Exotic	Reclamation	Offset
Wetland 1c	Low	Exotic	Reclamation	Offset
Wetland 2a north exotic	Moderate	Exotic	Partial reclamation	Offset
Wetland 2a north raupō	Moderate	WL19	Partial reclamation	Offset
Wetland 2a south	*Low*	*Exotic*	*Loss of catchment*	*Minimise*
Wetland 2b	*Low*	*Exotic*	*Loss of catchment*	*Minimise*
Wetland 6	Low	Exotic	Reclamation	Offset
Wetland 6b	Low	Exotic	Reclamation	Offset
Wetland 6c	Low	Exotic	Reclamation	Offset
Wetland 6d	Low	Exotic	Reclamation	Offset
Wetland 7a	Low	Exotic	Reclamation	Offset
Wetland 7b	Low	Exotic	Reclamation	Offset
Wetland 9	Low	Exotic	Reclamation	Offset
Total Stream loss at Life of Quarry		3,341	1,704	Offset
Total Wetland loss at life of Quarry		-	18,758	Offset
Pond restoration to stream		128	tbc	Net positive gain

NB - Wetlands 3 and 8 are not included as there are no direct effects on the wetlands and they are separated from the works by Stream 4.

The classification, length, bed area, approximately timing of the works and current Stream Ecological Valuation (SEV) of streams within the Sutton pit expansion area that require offset, in accordance with the effects management hierarchy, are provided in Table 4, with Table 5 providing the extents and staging for the wetlands.

Table 4. Sutton Block - Stream Length Measurements & Extent of Bed Area of Aquatic Habitat

Stream	Classification	Total length (m)	Average width (m)	Bed area (m^2)	Current SEV	Activity	Indicative Activity Staging*
Stream 1a	Intermittent	241	0.68	164	*0.55*	Reclamation	Stage 4
Stream 1b	Intermittent	74	0.5	37	0.34	Reclamation	Stage 4
Stream 2 headwaters	Intermittent	367	0.43	158	0.54	Reclamation	Stage 5
Stream 2 upper	Intermittent & permanent	276	0.4	109	0.67	Reclamation	Stage 4
Stream 2b	Intermittent	241	0.28	67	0.46	Reclamation	Stage 4
Stream 5 upper	Intermittent	397	0.56	222	*0.53*	Reclamation	Stage 1 -2
Stream 5	Permanent	55	0.56	31	*0.53*	Reclamation	Stage 1
Stream 6 headwaters	Intermittent	207	0.3	62	*0.34*	Reclamation	Stage 1
Stream 6 lower	Intermittent	257	0.6	154	*0.4*	Reclamation	Stage 1

Stream 6 east branch	Intermittent	487	0.25	122	*0.34*	Reclamation	Stage 1
Stream 6 west branches	Intermittent	92	0.15	14	*0.34*	Reclamation	Stage 1
Stream 7 upper	Intermittent	292	0.53	155	*0.34*	Reclamation	Stage 3
Stream 7 lower	Permanent	270	1.38	373	*0.4*	Reclamation	Stage 3
Stream 9	Intermittent	85	0.36	31	0.51	Reclamation	Stage 1 & 4
Total stream loss		**3,341**	**-**	**1698**	**-**	**Reclamation**	**Stages 1 - 5**

Table 5. Sutton Block – Wetland extent

Wetland	Wetland Classification	Size m²	Activity*	Indicative Activity Staging and indicative timing	
Wetland 1	Exotic	10,730	Reclamation	Stage 3 & 4	30+ years
Wetland 1b	Exotic	492	Reclamation	Stage 4	> 30 years
Wetland 1c	Exotic	136	Reclamation	Stage 4	> 30 years
Wetland 2a north exotic	Exotic	1,780	Reclamation	Stage 4	> 30 years
Wetland 2a north raupō	WL19	506	Reclamation	Stage 4	> 30 years
Wetland 2a south	*Exotic*	*4,250*	*Loss of catchment*	*Stage 4*	*> 30 years*
Wetland 2b	*Exotic*	*604*	*Loss of catchment*	*Stage 4*	*> 30 years*
Wetland 3	*Exotic*	*51*	*No direct effects*	-	-
Wetland 6a	Exotic	693	Reclamation	Stage 2	3 - 15 years
Wetland 6b	Exotic	669	Reclamation	Stage 2	3 - 15 years
Wetland 6c	Exotic	768	Reclamation	Stage 2	3 - 15 years
Wetland 6d	Exotic	2,263	Reclamation	Stage 2	3 - 15 years
Wetland 7a	Exotic	487	Reclamation	Stage 3	> 15 years
Wetland 7b	Exotic	194	Reclamation	Stage 2	3 - 15 years
Wetland 8	*Exotic*	*373*	*No direct effects*	-	-
Wetland 9	Exotic	40	Reclamation	Stage 4	>30 years
Stage 1 wetland loss 0 -3 years		**0**			
Stage 2 wetland loss 3 - 15 years		**4,587**			
Stage 3 wetland loss 15 -30 years		**5,852**			
Stage 4 wetland loss 30 -40 years		**8,319**			
Stage 5 wetland loss 40 -50 years		**0**			
Total Wetland Loss		**18,758**			

*All wetland **reclamation** is assessed as loss requiring offset. The adverse effects of *Loss of catchment* will be mitigated, as discussed in the EcIA, and are not included as wetland loss.

2.3 Streams

The results of the detailed stream assessments and site characteristics at the Stream Ecological Valuation sites are summarised in Appendix B and briefly described below. More detailed descriptions of the streams within and associated with the Sutton Block expansion area are provided in the Ecological Impact Assessment (EcIA) report (E2:9 EcIA).

The ecological values of the Sutton Block streams were assessed as Low to Moderate, with Low to Moderate potential; the magnitude of the effect (i.e. total or occasionally partial loss) was assessed as Very High; resulting in a Moderate to High level of effect for the loss of the aquatic habitats within the final pit area.

The streams were a combination of soft muddy habitats and rocky habitats. All of the aquatic habitats were located within an active farm running stock, mostly unfenced, and dominated by pasture. Stock and exotic browsing animals had access to all the riparian areas and within areas where trees were present the understory was depauperate or damaged.

The stream beds were either soft sediment or rocky, and if dominantly rocky habitat, the stream had a high percentage of silt, on occasion entirely covering the rock. The upper reaches of the streams in the Significant Ecological Areas (SEAs), and a reach of Stream 6 showed a high degree of hydraulic variation with small shoots, runs, occasional waterfalls, riffles and pools. Within the pasture the streams mainly formed narrow runs with less hydrological variation.

Macroinvertebrates were dominated by amphipods or freshwater snails, with sandfly larvae and damselflies subdominant. A low range of taxa was recorded (11 to 18 taxa), which included seven EPT taxa and three taxa with individual MCI scores >8, which are typically sensitive to reduced water quality. The proportion of EPT[2] taxa was low ranging between 10% and 1%, and the MCI[3] scores were indicative of 'poor' to 'good' habitat (E2:9 EcIA).

The native fish confirmed to be present were longfin eels and shortfin eels, which were present in low densities. No other native fish were caught or were expected to be able to climb the large natural waterfall between the two dams downstream of the Sutton Block. No additional fish were detected from the three eDNA samples carried out in Stream 4. The presence of longfin eel (rated as 'at risk; declining'; Dunn *et al.,* 2018) elevated the value of the lower tributaries as habitat for aquatic biota.

Water quality parameters showed temperatures and dissolved oxygen concentrations were well within the range that is considered suitable for most benthic invertebrates. Conductivity levels were moderate to low, showing minimal signs of nutrient enrichment.

The current Stream Ecological Valuation (SEV) scores for the streams were mostly low to moderate (0.34 – 0.67), reflective of the land use, with the lowest values in the intermittent streams in the open pasture (0.34). The potential scores were moderate to high (0.49 – 0.72, Appendix D), with potential riparian planting and stock exclusion.

Table 6. Summary table of the ecological values of the Sutton Block streams

Stream	Value	Justification
Stream 1	Moderate	Permanent stream with upper reach located in the SEA_T_1177, which supports a large pastoral wetland downstream in the lower catchment. Stream is predominantly soft bottomed and dominated by silt substrates, reducing the quality of aquatic habitat. Stock access has degraded the channel banks and riparian yard with understory absent or damaged, bare ground and rank pasture grass are present throughout, however the indigenous canopy provides high shade to the stream. No native fish but kōura common. Current SEV score 0.55 and potential score 0.67.

[2] Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) (EPT). EPT are three orders of insects that are generally sensitive to organic or nutrient enrichment and are an indicator of the quality of the aquatic habitat.

[3] Macroinvertebrate Community Index (MCI), a score based on the average sensitivity score of individual taxa recorded and indicator of the quality of the aquatic habitat.

		Stream 1b, a small, shallow intermittent tributary in the Stream 1 catchment, located within the pasture with SEV scores comparable with Stream 7 upper tributaries, current 0.34 and potential 0.49.
Stream 2	Moderate	Intermittent then permanent stream reaches providing year-long aquatic habitat which supports longfin eel in the lower reaches. The headwaters are located within a good canopy cover, and form a flattened, shallow stream channel, which becomes more incised and narrow as the stream descends the catchment. The mid-stream has good flow and high shading. Stream 2 is mainly located within SEA_T_ 5323. Riparian vegetation provided good shading functions to the stream with a range of indigenous vegetation, however the understory is absent or damaged, with stock access. This reach is dominated by hard substrates with a diverse stream bank profile and high hydrological heterogeneity and aquatic habitat; however, sedimentation was present throughout. Downstream of the SEA the stream hydrologically supports several large natural wetlands. A small reach of stream is present in open pasture between the two wetlands downstream of a farm crossing. Headwaters reach in the SEA: Current SEV score 0.54 and potential score 0.67 Upper reach in the SEA: Current SEV score 0.67 and potential score 0.72 Lower reach between the two wetlands: Current SEV score 0.4 and potential 0.53. A second gully in the upper Stream 2 catchment supports an intermittent stream, Stream 2b. This reach is narrow, with low hydrological variation, a mix of hard and soft substrates and with a high degree of sedimentation. Although also located within the SEA, the dominant riparian vegetation was pasture grass, with shading from scattered small trees and tree ferns. Current SEV score 0.46 and potential 0.6.
Stream 3 (not in expansion area)	Very Low	Intermittent stream of the first order which predominantly flows through pastoral land. Stream is mostly soft bottomed with fine sediments present throughout and pugging impacts degrading the stream bank. Riparian vegetation of poor quality and largely consists of rank pasture grasses and some gorse providing little or no shade before transitioning to exotic pine forest. Current SEV score 0.43 and potential score 0.58.
Stream 4 (only the lower reach within the works area)	Moderate	Permanent stream, providing a permanent presence of aquatic habitat. Stream is mostly hard bottomed with good aquatic habitat supporting longfin eel, however high sediment loading present. The upper reach is located within an area of mature plantation pines, the middle reach (above the large pond) is open with the riparian areas dominated by pasture grass and gorse, and the lower reach, below the large pond is dominated by pasture grass. Although the lower reach below the pond is not included in the pit the upper section of this reach will be affected by the access roads into the pit. Upper reach in the pines: Current SEV score 0.6 and potential score 0.6 Middle reach (above the pond): Current SEV score 0.46 and potential score 0.6. Lower reach (below the pond): Current SEV score 0.42 and potential score 0.65
Stream 5	Moderate	Intermittent reach which transitions to permanent in the lower reaches. Stream banks impacted by stock access resulting in pugged and incised channel. Stream is naturally hard bottomed with a bed rock base, however with high sedimentation from the surrounding land use. High habitat variability. Riparian vegetation provided good shading functions to the stream with a diverse range of indigenous vegetation, however the understory is absent or damaged, with exotic pest vegetation present. Current SEV score 0.53 and potential 0.60
Stream 6	Low	Intermittent reaches with multiple intermittent tributaries draining down the gully. Channel contains incised banks and is a mix of soft and hard bottomed reaches with a moderate diversity of aquatic habitat however high sedimentation and pugging from surround pastoral land use present. Riparian vegetation of low quality due to

		dominance of rank pasture grasses and sparse mature trees to provide shade. Upper west branch: Current SEV score 0.34 and potential 0.49. Lower main branch (west): Current SEV score 0.4 and potential 0.53. East and minor west branches: Current SEV score 0.34 and potential 0.49
Stream 7	Very Low	Intermittent stream draining to a permanent stream at the base of gully. Channel contains incised banks and is soft bottom comprised of compacted clay with little aquatic habitat in the upper reach. Riparian vegetation low quality, comprised of pasture grasses and gorse. Current SEV scores 0.34 (upper) and 0.4 (lower) potential 0.49 (upper) and 0.53 (lower).
Stream 9		Intermittent stream reach within an area of pine plantation. Channel narrow and shallow, with flow comprised of shallow trickles and isolated shallow pooling. Substrate soft with high loading of sedimentation. Current SEV score 0.51 and potential 0.60

2.4 Wetlands

Ten wetlands, plus a branch of an eleventh wetland will be lost to the Sutton Block pit. The wetlands have moderate to low value, the majority of which will be lost in the later stages of the pit expansion after about 20 years (Table 5).

All of the wetlands are impacted by farming activities, with stock access currently directly accessing the wetlands. All of the wetlands are limited to low growing plants (herbs, grasses and rushes) and have a high proportion of pasture grasses. With the exception of an area of Wetland 2a, all the wetlands are palustrine wetlands dominated by low growing exotic pastoral species, grasses, occasional herbaceous wetland plants and rushes. A patch in the lower part of Wetland 2a is a raupō reedland (WL19).

The extent of the wetlands that will be lost to the Sutton Block pit and a summary of the ecological values, effect of the Sutton Block works and level of effect is presented in Table 7.

Table 7. Magnitude of effect and level of effect of the proposed works upon the Sutton Block wetlands.

Wetland and indicative staging	Ecological value	Effect description	Magnitude of effect and justification	Level of effect
Wetland 1a (Stage 3 and Stage 4)	Moderate	• Total loss of 10, 730 m^2 of wetland habitat • Mortality or harm to aquatic life	**Very High** The construction of the project will result in the complete loss of all wetland habitat within its footprint. The likelihood of this effect occurring is definite and will have a direct (rather than indirect) impact on the wetland habitat. The loss of the wetland habitat will be permanent and irreversible. Potential loss, mortality or harm to indigenous freshwater fauna, including 'At Risk' species	**High**
Wetlands 1b-c (Stage 4)	Low	• Total loss of 628 m^2 of wetland habitat • Mortality or harm to aquatic life		**Moderate**
Wetland 9 (Stage 4)	Low	• Total loss of 40 m^2 of wetland habitat		**Moderate**
Wetland 6a-d (Stage 2)	Low	• Total loss of 4,393 m^2 of wetland habitat		**Moderate**

		• Mortality or harm to aquatic life		
Wetland 7a (Stage 3), Wetland 7b (Stage 2)	Low	• Total loss of 681 m^2 of wetland habitat • Mortality or harm to aquatic life		**Moderate**
Wetland 2a north (Stage 4)	Moderate	• Reclamation of 2,286 m^2 of wetland habitat. • Sedimentation • Mortality or harm to aquatic life	**Very High** The construction of the project will result in the partial loss of all wetland habitat within its footprint. The likelihood of this effect occurring is definite and will have a direct (rather than indirect) impact on the wetland habitat. The loss of the wetland habitat will be permanent and irreversible.	**High**

The EIANZ Guidelines require effects management to be undertaken where the level of effect is moderate or greater. As the level of effect is 'moderate' or 'high' for the loss of all of the wetlands, which combined comprise 18,758 m^2 of wetland habitat within the Sutton Block, effects management is required. Minimisation of effects can be applied to some of the effects on the wetlands, but as the project will involve the total loss of wetland values for Wetlands 1a-c, 2a in part, 6a-d, 7a-b and Wetland 9, offsetting is required to manage the effects to these wetlands.

3 AQUATIC OFFSETTING

3.1 Freshwater Habitat Loss

Where adverse effects on aquatic habitats could not be reasonably avoided, remedied, minimised or remediated to a low level of effect, then the EcIA recommended, in accordance with the effects hierarchy, offset of residual adverse effects, and if offset is not possible then compensation.

The proposed use of the Sutton Block for quarrying aggregate will result, over about 50 years, in the loss of 3,341 lineal metres of permanent and intermittent stream reaches, plus wetlands totalling 1.88 ha, which cannot be avoided, remedied or mitigated on the Sutton Block.

3.2 Principles of Aquatic Offsetting

The loss of the 3,341 m of streams and the 1.88 ha of wetland to the 50-year Sutton pit is considered:

- A significant residual adverse effect under the AUP;
- A High Level of effect under the EcIA guidelines (Roper-Lindsay et al., 2018); and
- Would require aquatic offset.

Guidance on, and the principles for, good practice aquatic biodiversity offsetting is provided in the AUP, Ministry for the Environment *et al.* (2014), and in Appendix 6 of the NPS-FM, and have been applied in this assessment.

In summary the offsetting restoration and enhancement documents recommend:

a) The site be located as close as possible to the subject site;
b) Be 'like-for-like';
c) Preferably achieve no net loss;
d) Consideration of the use of biodiversity offsetting; and
e) The use of Storey *et al*. (2011), Appendix 8 (AUP Operative in part, 2016) and Ministry for the Environment *et al.* (2014) for guidance.

The eleven principles for aquatic offsetting (NPS-FM):

1. Adherence to effects management hierarchy;
2. When aquatic offsetting is not appropriate;
3. No net loss and preferably a net gain;
4. Additionality;
5. Leakage;
6. Long-term outcomes;
7. Landscape context;
8. Time lags;
9. Science and mātaurana Māori;
10. Tangata whenua or stakeholder participation; and
11. Transparency.

The NPS-FM requires that the applicant has complied with Offset principles 1 to 6, and has regard to the remaining principles, as appropriate.

3.3 Stream Loss Offset - Environmental Compensation Ratio (ECR) Methodology

Storey *et al.* (2011) provides the Stream Ecological Valuation (SEV) methodology combined with the calculation of the Environmental Compensation Ratio (ECR) for stream offset. It is a transparent, well-recognised methodology for calculating the quantum of offset required for stream loss, including both stream length and value. Although the methodology was originally developed in Auckland, it has been reviewed by NIWA for use in Wellington, Hawke's Bay and Southland, and is considered applicable without modification to most stream and river types in those regions. (Storey *et al.,* 2011).

The SEV methodology (Storey *et al.,* 2011) enables the overall function of the streams to be assessed and compared to the quality of other streams in the region. The SEV procedure involves the collection of habitat data (e.g. stream depth, substrate type, riparian cover), and sampling of fish communities and macroinvertebrates (e.g. insect larvae, snails), the latter being recognised indicators of habitat quality. SEV data are then entered into a SEV calculator to calculate an averaged SEV value.

For permanent and intermittent streams, SEV scores can be utilised to calculate environmental compensation (stream offset) for any loss or modification to natural stream habitat by using the Environmental Compensation Ratio (ECR; Storey *et al.*, 2011). The ECR considers the SEV values of both the affected or impacted stream/s and the proposed restoration site stream/s, and determines any differential between the scores to provide a ratio for offset which will result in "no net loss of area weighted stream function" (Storey *et al*., 2011). The SEV score used in the ECR calculation does not include two biotic functions relating to fish and macroinvertebrates due to the difficulty of predicting changes to these communities (Storey *et al*., 2011).

The ECR equation is calculated as follows:

$$ECR = [(SEVi\text{-}P – SEVi\text{-}I) / (SEVm\text{-}P – SEVm\text{-}C)] \times 1.5$$

Where:

- SEVi-P and SEVi-I are the potential SEV value and SEV value after impact, respectively, for the site to be impacted.
- SEVm-C and SEVm-P are the current and potential SEV values, respectively, for the site where the environmental compensation (offset) works are to be applied.
- 1.5 is a multiplier that allows for the delay in achieving offset benefits.

The ECR calculations are, unavoidably, carried out using a number of assumptions. The 'Potential' SEV scores are calculated by altering parameter scores assuming best practice riparian restoration of the stream has taken place and is well established to a level providing at least 70% shade to the stream bed.
The streams within the Sutton Block quarry expansion area mostly have little riparian cover. Calculation of the 'Potential' score for the impact sites has generally assumed native riparian restoration of a 20m margin (10m either side of the watercourse). Calculation of the 'Impact' SEV scores would assume an outcome as proposed, with the full length of the stream being lost to the works.
Following calculation of the ECR, the area of stream impacted (based on length and width of the stream) is multiplied by this value to determine the stream area required for remediation works.

A detailed restoration planting plan and weed management plan[4] will be prepared for the offset stream riparian site by a qualified plant ecologist to ensure good quality native habitat is created. A minimum of a five-year

[4] Bioresearches (2025b) Net Gain Delivery Plan: Wetland Planting. Report for Stevensons Aggregates Limited.

defects and maintenance contract would be required for the restoration planting to ensure cover is achieved, weed control is maintained, and to ensure the proposed offset is achieved over the medium term.

For the streams that will be lost more than 15 years after the start of the initial pit (i.e. Streams 1, 2 and 7), the 1.5 multiplier is still applied even though there will be no delay in achieving the offset benefits (Table 4). This was left in as part of the calculation to provide additionality to the offset for the stream loss, and to add surety to the final outcome.

3.4 Wetland Offset Calculations and Biodiversity Compensation Model

The wetland offset calculations are based on the primary attributes of the wetlands, which have been assigned in accordance with nationally and regionally accepted reference documents, including Johnson and Gerbeaux (2004) as published by the Department of Conservation and the Ministry for the Environment and Singers *et al.* (2017) as published by Auckland Council; as well as the EIANZ guidelines for assigning ecological values.

The values were tabulated with each assessment criteria or measurement unit compared across each impact site and the restoration site, to determine the degree of Uplift in Ecological Value / Importance to the Site (EIANZ Guidelines). Overall EIANZ attributes to be considered when assigning ecological value or importance to a site or area of vegetation / habitat / community for the wetland enhancement site at 10 years, were Representativeness / naturalness; Rarity / distinctiveness; Diversity and Pattern; and Ecological Context, and were calculated in accordance with the EcIA guidelines methodologies for determining net gain.

The Biodiversity Offset Accounting Model (BOAM) was not used to calculate wetland offset, as an appropriate benchmark[5] example of a kahikatea-forested swamp was not able to be located. Singers & Rogers (2018) describes these habitats as lost to fire in the post-settlement period, and does not accommodate their description within their classification of New Zealand's terrestrial ecosystems. Therefore, to add surety to the offset methodology for the wetlands the Biodiversity Compensation Model (BCM) for New Zealand (Baber *et al.,* 2021a, b), user guide and excel calculator tool was used to provide additional confidence of Net Gain of biodiversity at the site.

3.5 Offset Sites

3.5.1 Potential Offset Sites

Stream and wetland offset sites were first investigated on SAL holdings at Drury Quarry, the downstream catchment, and the immediate areas surrounding the Sutton Block. Potential offset areas downstream and in immediately surrounding areas were very limited as they were either Drury South Development land, or set aside by Drury South for future offset (Peach Hill Road sites) or currently covered in bush (the land north and west of the Sutton Block). Onsite streams on the SAL holdings at Drury Quarry were maximised for offset (Peach Hill Road and Davies Road), but a significant quantum of offset for both stream and wetlands was required offsite.

[5]Appropriate benchmarks are integral to the BOAM. A benchmark provides a reference measure of condition from which to compare biodiversity condition at an impact and offset site, and a benchmark is a state that reflects a 'natural' or 'pristine' ecological condition and quality. (Maseyk *et al*, 2015).

3.5.2 SAL Holdings Drury Quarry Offset Sites

The sites (streams and wetlands) on SAL holdings at Drury Quarry are located immediately north of Peach Hill Road and immediately west of Davies Road and south of Quarry Road (Figure 2). The two offset sites are on the same property, located close to the Sutton Block (under 2 km), are like-for-like both in terms of position in the landscape and the stream and wetland attributes. Both the Peach Hill Road streams and the Davies Road streams and wetlands provide excellent opportunities for aquatic offset and because of proximity to the works area, located in the immediately adjacent catchment, and similarity in form and function of the habitats. These sites were prioritised for the aquatic offsetting, with the remaining offset to be provided on an off-site offset site.

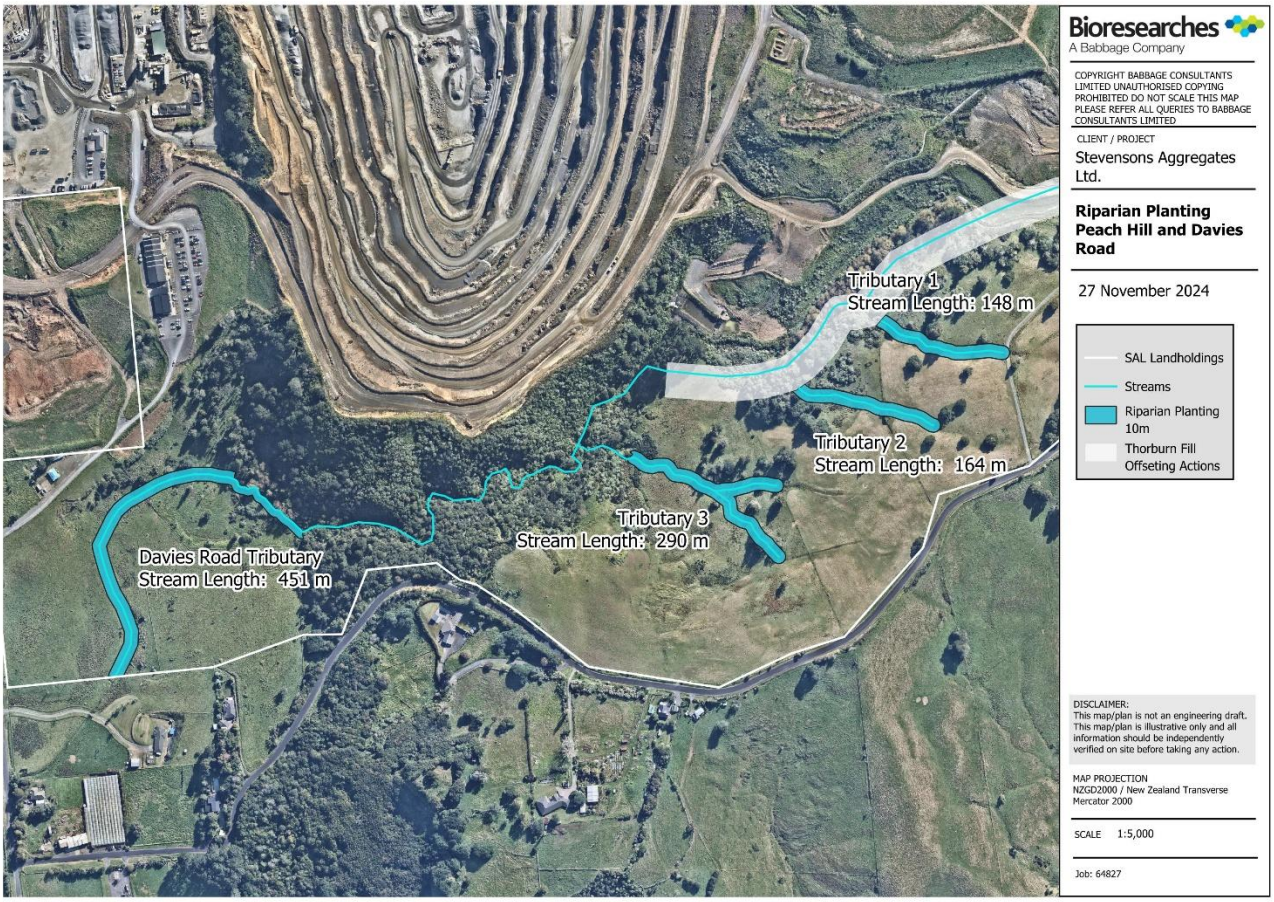


Figure 2. SAL potential offset sites at Drury Quarry. Peach Hill Road (east), Davies Road (west).

3.5.3 Potential Off-site Offset Sites

A detailed scoping exercise was made using GRIP property information maps and the Auckland Council GeoMaps to identify sites that had sufficient stream length and /or wetland areas that were suitable for use as aquatic offset areas. Sites were constrained by land owner access and numerous landowners through which a potential offset site for streams or wetlands might be located. The ideal site was considered to be a large site that could be enhanced or restored but with a single land owner (or at the most two landowners), reducing the complications of reaching agreements with multiple land owners, the exponential risk of restrictions on future access, the risk of fragmentation if one land owner pulls out, and therefore the risk of future alterations to the protection of offset areas.

Four sites were short-listed, and after further due diligence, two sites were investigated further, 2487 Hunua Road, Papakura, "Camp Adair"; and 86 Friedlander Road, Tuakau (hereafter referred to as the Tuakau Site). Camp Adair was not pursued further as it the site was constrained by existing use, current riparian restoration activity, and it did not provide sufficient stream length or wetland habitat.

Three additional sites, a Jesmond Road development site; Hingaia Stream west of 120 Flanagan Road; and Nga Motu o Hingaia revegetation of islands and saltmarsh, were proposed by Ngāti Te Ata and Ngāti Tamaoho. Each of these proposed sites were investigated and variously eliminated as Jesmond Road site had insufficient stream habitat on the site; 120 Flanagan was already under development pressure by both Kiwi Properties and Waka Kotahi (NZ Transport Agency), including stream enhancements; and enhancement of salt marsh and terrestrial revegetation of the islands would default directly to compensation, for freshwater aquatic habitats.

3.5.4 Tuakau offset site

The Tuakau Site was identified as the preferred site as the site offers significant opportunities for restoration, enhancement, and reinstatement of aquatic habitats, both in terms of degree of uplift and extent of area. Although not hydrologically connected to the Drury site, the site lies only 16km south of Drury Quarry (Figure 3).

The Tuakau Site drains south to the Waikato River, rather than west to the Manukau Harbour (Drury Quarry), but both waterbodies flow to the West Coast only separated by the Awhitu Peninsula. Approximately 2.3 km of the Tutaenui Stream, which originates in the Auckland Region in Pukekohe, flows along the boundary of the site, the lower 680 m of which has been straightened, prior to flowing to the Waikato River (Figure 4). Numerous drains running through the site have potential for naturalisation, creating functioning streams.

Much of the lower site near the Waikato River has good potential for restoration as wetlands and although the current land use on the wider site is either farming or sand mining, the land is wetted pasture and with modification of the drains has excellent potential for restoration and enhancement as indigenous wetlands. Excluding the potential rehabilitation opportunities of the sand mining area, the wetted pasture extends over more than 70 ha of the site, with almost all of that area suitable for wetland creation, restoration or enhancement. In particular wetland restoration adjacent to and extending the stand of kahikatea trees set back from the Waikato River would have significant ecological benefits including protecting and enhancing the area for the native long-tailed bats (Threatened, Nationally Critical; O'Donnell *et al.*, 2018) that are currently seen moving between the trees. The primary ecological values of wetlands as "the kidneys" of the aquatic ecosystem, providing filtration and improvements in water quality; and the provision of habitat for plants and animals adapted to wet conditions are the same at both the Drury Quarry site and the Tuakau Site. The Sutton block streams (RMA rivers) dominantly provide the hydrology for the wetlands on the Sutton Block, with an occasional seepage wetland; the Waikato River will be providing the dominant hydrology for the offset wetlands. Similarly, to the Sutton Block wetlands, flow paths can be easily formed within the proposed offset wetland.

Although the proposed offset site is only 16km south of Drury Quarry and located adjacent to Auckland infrastructure (Pukekohe Wastewater Treatment Plant), it lies just outside of the Auckland Council Boundary (Waikato). To ensure that the site was considered suitable for further investigation by Auckland Council in principle, discussions were held with Auckland Council. Their key concern was making sure the site is secured

and that the applicants were able to demonstrate to a high level of certainty they either already owned the offset site, or had a sufficient degree of control over it to provide the offset.

The ecological assessments were then carried out. The site was assessed as having excellent and extensive potential for aquatic enhancement and restoration works and therefore suitable for offset or biodiversity compensation. The applicant then met the primary concern expressed by Auckland Council over control of the proposed offset site and purchased the 86 Friedlander Road site in June 2023.

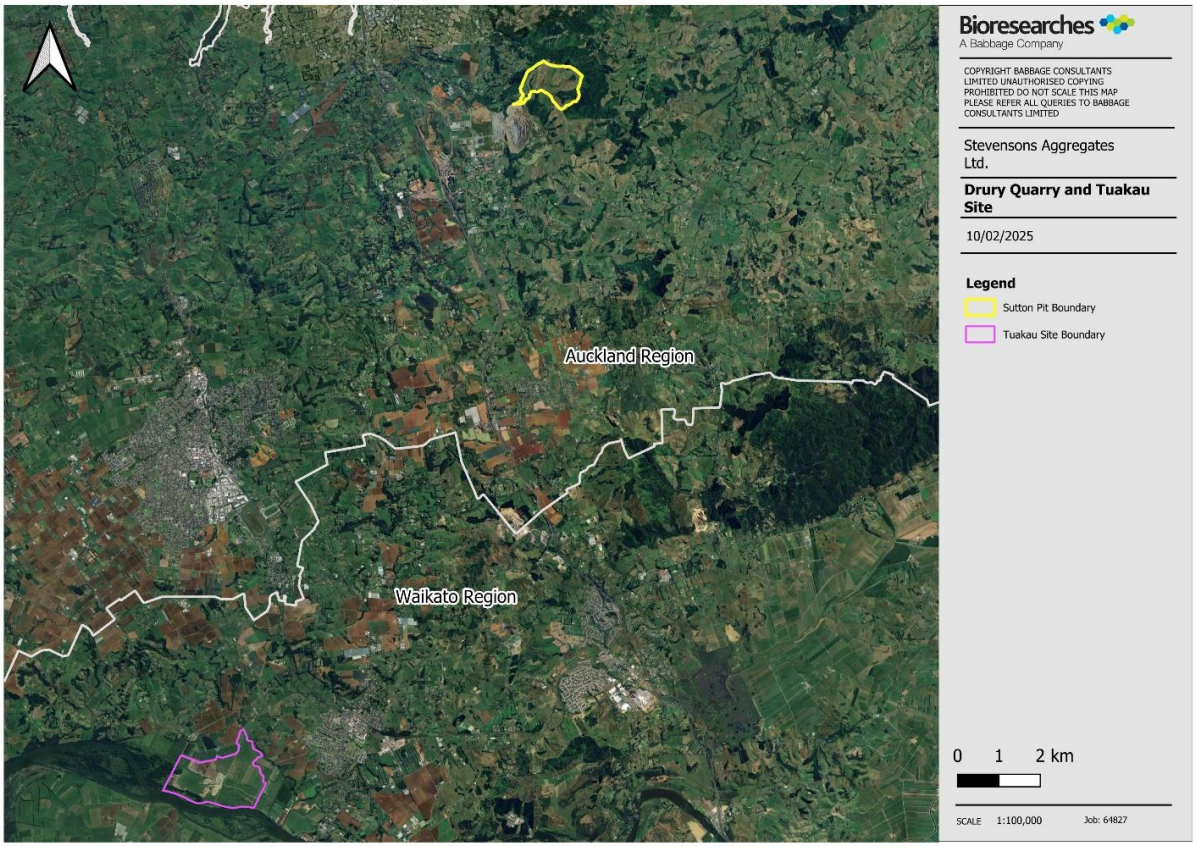


Figure 3. Sutton Block (pink polygon) and proposed stream offset site (yellow polygon).

The preferred location of the aquatic habitats suitable for offset on the Tuakau Site were constrained by the current land use on the site (sand mining and farming), and potential use. Two permanent streams were identified for the stream offset, in areas where no sand mining was proposed in the future. While the proposed offset is like-for-like with regard to offsetting stream loss with streams, stream loss at the impact site included intermittent streams, and narrower streams than at the offset site.

Aside from the transport and connection with water, the primary ecological values of streams are associated with habitat provision for fauna. Many insects are dependent upon streams for the larval stage of their lifecycle, which forms large part of the macroinvertebrate fauna in streams. The leafy and woody inputs to streams from their riparian yards and connection with upstream habitats provides substrate, shelter and food for the macroinvertebrates (leaf shedders and scrapers), food and habitat for native fish. Some intermittent streams can provide for the same stream values of macroinvertebrates, macrophytes, leaf litter, fish and fish habitat, but it is by definition only intermittently, and some, as significant lengths on the Sutton Block, for only very short periods of the year. Permanent streams on the other hand usually provide all of these ecological values

plus more, often including deeper refuges (pools, undercut banks), larger woody habitat, habitat for a greater variety of native fish and macroinvertebrates, and most importantly habitat (water) all year.

Stream loss of permanent and intermittent streams with offset with only permanent streams, provides additional ecological values over and above the intermittent stream habitat (as outlined above), but in addition, one of the conditions of the SEV/ECR methodology for stream offset is that length of the stream to be enhanced should not be less the length of the stream loss, which results in a much greater bed area (aquatic habitat) being included in the offset.

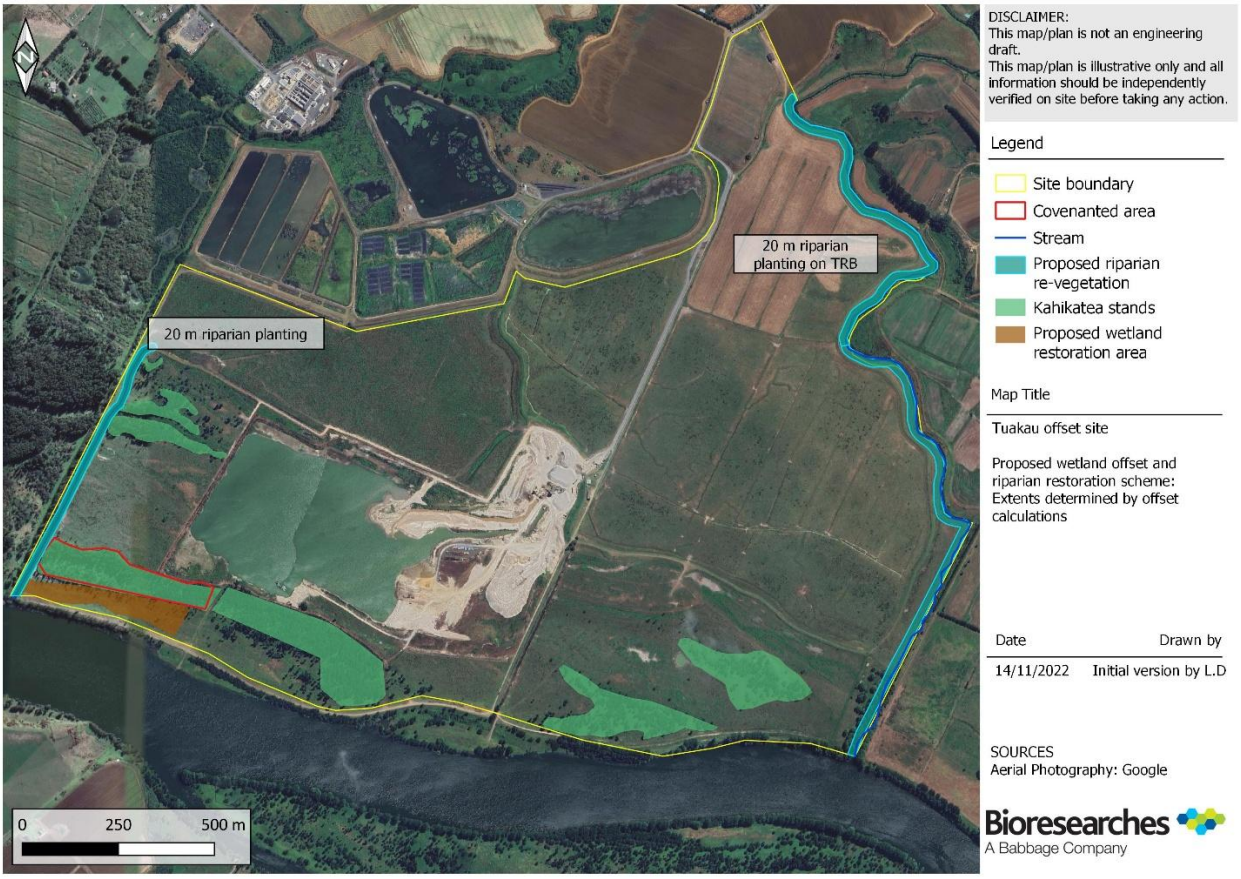


Figure 4. Stream and Wetland Offset Opportunity Areas - Tutaenui Stream (east), un-named stream (west) and potential wetland offset area on the Tuakau Site.

4 STREAM OFFSET METHODOLGY AND CALCULATIONS

4.1 Peach Hill Road Stream Offset site – current

Immediately west of Peach Hill Road, on SAL holding Drury Quarry farmland, three intermittent tributaries available for stream offset. The tributaries flow west to the mainstem tributary draining the catchment (Figure 5). The mainstem tributary has a riparian setback as part of the consent for the Thorburn fill site located further up the catchment.

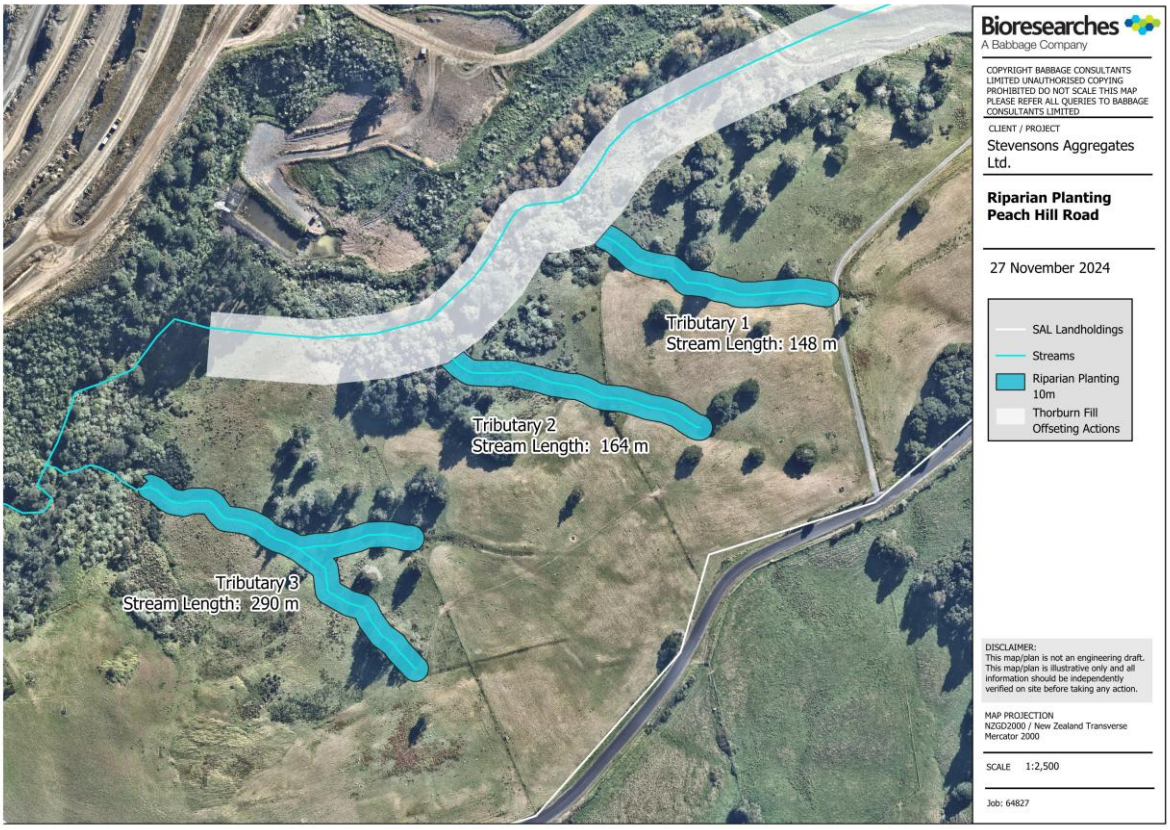


Figure 5. Peach Hill Road streams and potential stream offset areas.

Peach Hill Road tributaries 1, 2 and 3 drained a pastoral catchment, that runs stock. The streams were all intermittent with soft substrates and mostly very poor or no shading (Photo 1 and Photo 6). SEVs were carried out on Tributary 1 and the upper and lower reaches of Tributary 2, as representative of the watercourses in this area[6]. The streams were soft bottomed, dominated by silt, narrow (<0.5m) and open, with stock access. The riparian vegetation was dominantly comprised pasture grasses with patches of exotic weed species (woolly nightshade and gorse), with occasional scatter mature native trees (pūriri, tōtara).

[6] Refer to Section 2.5.2 of the EcIA for details of the SEV methodology.

Photo 1. Tributary 1 SEV reach

Photo 2. Tributary 1 lower reach

Photo 3. Tributary 2 mid reach

Photo 4 Tributary 2 Lower reach

Photo 5. Tributary 3

Photo 6. Small pool in Tributary 3

Table 8. Peach Hill Road Tributaries

	Tributary 1	Tributary 2 Upper & Lower	Tributary 3
Habitat Features			
Average width (m)	0.46	0.4	0.41
Average depth (m)			
Dominant substrates	Silt	Silt	Silt
Macrophyte abundance	nil	nil	nil
Riparian vegetation	Pasture grass with occasional mature native tree	Pasture grass & gorse, changing to mature natives within pasture grass in lower reach	Pasture grass and occasional gorse
Stream Ecological Value - current	0.39	0.39 & 0.59	0.39
Stream Ecological Value - potential	0.69	0.69 & 0.79	0.69

4.2 Davies Road Offset site – current

The stream adjacent to Davies Road is the lower reaches of the mainstem stream to which the Peach Hill Road streams (Section 4.1 above) flow. The stream is an unnamed tributary of the Maketu Stream and ultimately drains to the Hingaia Stream north west of the Quarry. The two stream reaches are identified as Davies Road Lower Mainstem (Site 1, DR-1) which flows in a general north to south direction, and the Upper Mainstem (Site 2, DR-2) which mostly flows east to west (Figure 6).

Several natural inland wetland areas at Davies Road were also present along with the stream, but as the wetlands were small, pastural wetlands, isolated from each other and only intermittently wet, there was doubt as to the surety of the potential and outcome for wetland offset, and it was assessed that they would be only used if the quantum of offset could not be achieved at an alternative site.

Figure 6. SEV reach site locations on the Davies Road area of the Drury Quarry Zone .

Davies Road Site 1: SEV DR-1 Lower Stream

The lower mainstem of the stream formed a natural channel with no incision, running through pasture (Photo 7). An SEV was undertaken in this reach. The stream was completely accessible to stock and there was severe pugging for the length of the reach (Photo 8). The stream ran adjacent to two wetland areas, one larger one on the true right bank and a smaller one on the true left. The stream varied between 1 m and 3.2 m in width, averaging 1.85 m, and it had good flow, however the hydrologic conditions were generally uniform with no deep pools or riffles present throughout the assessed reach. On average, the stream had a depth of 0.12m and the overall SEV score was 0.39.

The substrate was comprised nearly entirely of silt, with some gravel present. Directly upstream of the sampled reach the substrate had a higher composition of gravels and cobble. The stream also had high macrophyte abundance throughout, consisting mostly of water celery (*Apium nodiflorum*), watercress (*Nasturtium officinale*) and some starwort (*Callitriche stagnalis*), with macrophyte root mats present across much of the stream. There was no riparian shading, and the only vegetation present were grazed pasture grasses, gorse and some *Juncus effusus* at the northern end of the reach.

Photo 7. Davies Road lower SEV site

Photo 8. Davies Road lower reach with stock

Davies Road Site 2: SEV DR-2 Upper Stream

The upper Davies Road tributary SEV (SEV DR-2) was approximately 200m upstream of the lower site. The stream formed a moderately incised, natural channel that flowed from the edge of a patch of native and exotic vegetation, through pasture (Photo 9). Stock had access to the stream and pugging of the stream and banks was evident. The stream ranged between 0.61m and 2.5m wide, with an average width of 1.46m. Hydrologic conditions were variable, with both deep and shallow pools present, and an average depth of 0.16m.

Medium to large gravels, a small proportion of cobbles, all with a coating of silt, made up the substrate of the middle of the reach (Photo 10) with larger boulders occasionally present in the upper section of the reach. The riparian vegetation was primarily pasture grass, however, some well-established kahikatea (*Dacrycarpus dacrydioides*), pūriri (*Vitex lucens*) and willow trees (*Salix* sp.) provided moderate shading to the stream in the middle and upper reaches. The true right bank was vegetated with a mix of native shrubs and exotic pest plants for the upper 80m, while the true left bank was pasture throughout the approximately 300m length. Macrophyte abundance was minimal, with a small amount of water celery and starwort, and that only present in the lower part of the stream reach. The averaged SEV score was 0.44, a reflection of the dominance of pasture at the site, partial barrier to fish passage provided by one of the two crossings, and the layer of fine sediments over the hard substrates.

Photo 9. Davies Road upper reach

Photo 10. Davies Road upper reach, hard substrate with layer of fine sediment.

Table 9. Davies Road stream habitat characteristics.

	Site 1 Davies Road Tributary Lower Reach	Site 2 Davies Road Tributary Upper Reach
Habitat Features		
Average width (m)	1.86	1.46
Average depth (m)	0.12	0.16
Dominant substrates	Silt and roots	Gravel
Macrophyte abundance	Common	Rare
Macrophyte species	Water celery, watercress, starwort	Water celery, starwort
Riparian vegetation	Pasture grass	Pasture grass with occasional exotic and native trees
Stream Ecological Value - current	0.39	0.44
Stream Ecological Value - potential	0.66	0.72

4.3 Tutaenui Stream and West Stream Offset Sites – Current

4.3.1 Introduction

The streams on the Tuakau proposed offset site were ground-truthed on 19 May 2022, with the detailed SEV assessments carried out on 13 September 2022 and 13 November 2023. Both the Western Stream and the Tutaenui Stream were assessed using the SEV methodology (refer to the EcIA Section 2.5.2).

The two stream sections assessed are illustrated in Figure 4.

4.3.2 Western Stream – SEV 1

The stream running within the site near the western boundary of the Tuakau Site (Western Stream) averaged 3.92m wide and formed a long run. The true right bank (western bank) was raised forming a stop bank and the true left bank was comparatively flat allowing full access to the floodplain with a small floodgate near the outlet of the stream to the Waikato River, which was affecting the stream flow.

A second wider stream ran parallel with the boundary of the site 10 - 15 m to the west of the Western Stream.

The Western Stream formed a wide U-shaped channel with mainly soft substrates and limited hydrological heterogeneity. The riparian vegetation was depauperate, comprised dominantly of short pasture grasses with occasional poplar trees at the downstream end and two small kahikatea on the true left bank. The current SEV score was calculated to be 0.35 with the potential score calculated as 0.6 with 10m of riparian planting and fencing on each bank, some remediation of the current partial barrier to fish passage and some habitat enhancements in the upper reaches.

4.3.3 Tutaenui Steam – SEV 2

Tutaenui Stream originates in the Auckland Region, in Pukekohe, before flowing generally southwards into the Waikato Region and to the Waikato River. Within the Tuakau Site the stream formed a wide run, approximately 8.4m wide in the upper reaches and up to 22m wide in the lower reaches (average 11.3m). The form and function was similar, albeit on a larger scale, to the Western Stream with mainly soft substrates, and depauperate riparian vegetation. Some hard substrate was present in the Tutaenui Stream with large wood (occasional logs) and riffle sections in the upper and middle of the stream under low flows. Common bullies

and koi carp were both observed during the SEV assessments. Fish habitat quality and abundance was high, with aquatic macrophytes (mainly *Egeria densa*), undercut banks, deep pools and woody debris all common. The current SEV score was calculated to be 0.40 with the potential score calculated as 0.58 with 20m of riparian planting and fencing on the true right bank.

4.4 Stream Offset - Environmental Compensation Ratio Calculations for Streams

The current SEV score for the Sutton Block expansion streams at the impact site ranged between 0.34 and 0.6 . The potential for these streams is assessed assuming riparian restoration of the stream has taken place and is well established to a level providing at least 70% shade to the stream bed. Loss of the stream reaches, as proposed, would produce an impact SEV of 0.0.

The current SEV score of the proposed restoration streams at the Peach Hill Road site range between 0.39 and 0.59, with the potential scores for the site streams following enhancement with riparian planting and removal of culverts assessed to be 0.69 to 0.79.

The current SEV scores of the proposed restoration streams at the Davies Road site are 0.39 and 0.44, with the potential scores 0.66 and 0.72 following restoration and riparian planting.

After using the available offset sites on the Drury Quarry landholdings, the remaining stream offset will be carried out at the Tuakau site.

The current SEV score of the proposed restoration streams at the Tuakau Site range between 0.35 and 0.40, with the potential score for the site streams following restoration and enhancement of riparian vegetation, removal of fish barriers and with some instream enhancements, assessed to be 0.55 and 0.58.

The ECR equation is detailed in Section 3.3 and Table 10 presents a summary of the SEV inputs to the ECR, including the areas of loss and the parameters at the offset sites, with further summary data presented in Appendix C to Appendix E.

Table 11 provides the range of offset site data for the ECR and Table 12 presents the offset SEV, stream length and stream width data for the ECR calculations, with further detail presented in the Appendices.

Table 10. Estimation of area of offset and ECR Inputs

ECR Inputs and Calculation	
Impact Streams	
SEVi-Current (range)	0.34 - 0.67
SEVi-Potential (range)	0.49 - 0.72
SEVi-Impact (range)	0.0
Stream bed area loss m^2	1,698
Stream length loss	3,341
Average stream width (range)	0.15 – 1.38
Offset Streams - Peach Hill Road Site, SAL Drury Quarry Landholdings	
SEVm-Current (range)	0.39 – 0.59
SEVm-Potential	0.69 – 0.79
Average stream width (range)	0.4 – 0.46
Offset Streams - Davies Road Site, SAL Drury Quarry Landholdings	
SEVm-Current (range)	0.39 – 0.44
SEVm-Potential	0.66 – 0.72
Average stream width (range)	1.46 - 1.86
Offset Streams - Tuakau Site	
SEVm-Current (range)	0.35 - 0.40
SEVm-Potential	0.58 - 0.60
Average stream width (range)	3.9 - 8.4[7]

Table 11. Summary SEV, stream length and stream width data from Offset Sites for ECR

	SEV Current	SEV Potential	Length (m) available	Stream Width (m)
Peach Hill Road Site, SAL Drury Quarry Landholdings				
Tributary 1	0.39	0.69	148	0.46
Tributary 2 up	0.39	0.69	130	0.4
Tributary 2 down	0.59	0.79	34	0.39
Tributary 3	0.39	0.69	290	0.41
Total length & Average width			602	0.42
Davies Road Site, SAL Drury Quarry Landholdings				
Lower Reach	0.39	0.66	300	1.86
Upper Reach	0.44	0.72	150	1.46
Total length & Average width			450	1.66
Tuakau Site				
Western Stream	0.35	0.60	740	3.9
Tutaenui Steam	0.40	0.58	2,300	8.4[3]
Total length & Average width			3040	6.2

The ECR calculations area presented as a rolling calculation table in Appendix F, and in summary as Table 12.

[7] Using the upper average width of the Tutanui Stream, rather than total average width of 11.3m

Table 12. Summary of ECR with site at which impact stream is offset (refer Appendix F).

Stream	Offset Stream	ECR	Method	Indicative Activity Staging
Approximate 3 – 15 Year Pit				
Stream 5	Western Stream	3.6	Enhancement	Stage 1 - 2
Stream 6 headwater tributaries	Western Stream	2.94	Enhancement	Stage 1
Stream 6 lower	Western Stream	3.18	Enhancement	Stage 1
Stream 6 east branch	Western Stream & Tutaenui Stream	2.94 & 4.08	Enhancement	Stage 1
Stream 6 west branches	Tutaenui Stream	4.08	Enhancement	Stage 1
Stream 9	Tutaenui Stream	5.0	Enhancement	Stage 1 & 5
Approximate 15 – 50 Year Pit				
Stream 7 upper	Tutaenui Stream	4.08	Enhancement	Stage 3
Stream 7 lower	Tutaenui Stream	4.42	Enhancement	Stage 3
Stream 1a	Peach Hill Road Tributaries and Davies Road Up	3.35 -5.03	Enhancement	Stage 4
Stream 1b	Davies Road Up	2.63	Enhancement	Stage 4
Stream 2 headwater tributary	Davies Road Upper and Lower, and Western Stream	3.59 -4.02	Enhancement	Stage 5
Stream 2 Upper intermittent	Western Stream	4.32	Enhancement	Stage 5
Stream 2 Upper permanent	Western Stream	4.32	Enhancement	Stage 4
Stream 2b	Western Stream	3.60	Enhancement	Stage 4

The quantum of offset for the stream length that will be lost to the Sutton Block quarry pit, using the SEV /ECR methodology and enhancement on the Offset sites (Streams at Peach Hill Road, Davies Road and Tuakau), is 2,029 lineal metres of stream length. This is divided into the 1052m available on the SAL Drury Quarry landholdings, 740 m of enhanced stream habitat on the Western Stream (Figure 9) and 237 m of enhanced stream habitat on the Tutaenui Stream (refer to Appendix F).

The ECR methodology recognises that there are values associated with edge habitat and the proximity to banks and requires that the minimum replacement length must at least be equal to stream length lost, i.e. at least a 1 : 1 ratio for length. Consequently, as the total stream length loss of at the Sutton Block is 3,341 m, an additional 1,549 m at the Tutaenui Stream is required to meet the total length lost at the Sutton Block pit (refer Figure 9). This will consequently result in an additional 13,012 m² of stream bed habitat enhanced over and above the ECR requirement for offset.

Although the stream *length* loss to offset *length* ratio is 1 : 1, it is the bed *area* that is the main driver of the SEV/ECR, as it is the bed that provides the majority of the habitat. Although the ECR ratios ranged from 1 : 2.6 through to 1 : 5 (refer Table 12 and Appendix F), the overall stream loss bed area to stream offset bed area are very much higher (because of the additional length required) and the bed area loss : gain ratio is 1 :10, which is a huge gain in habitat enhancement of the stream bed.

The total stream bed loss of intermittent and permanent streams at the Sutton Block is 1,698 m², which is offset by 16,882 m² of intermittent, but mostly permanent streams. As discussed above, the loss of the intermittent stream habitat, much of which would only be present for short periods of the year, will be offset by permanent

habitat, present all year around. The stream ecological values of connection with upstream habitats, habitat for aquatic macroinvertebrates, including macroinvertebrates that are not just seasonal, food and habitat (pools, undercuts, woody debris) for native fish, will all be provided continuously and to a much greater extent in the permanent streams, compared to the intermittent streams, providing additionality in the stream offset.

Additionality in the stream offset is also achieved as the vast majority of the riparian planting will be completely established well prior to the time of the stream loss, due to the staging of the impact on the streams running out over about 50 years. The 1.5 multiplier included within the SEV/ERC methodology for the usual time lag in riparian vegetation establishment was retained in the calculations, when it was largely redundant (refer to Section 3.3), as the offset revegetation will be present well prior to the loss.

In summary, using the SEV/ECR methodology, at the proposed Tuakau Site streams, enhancement of 1052m at Drury Quarry (Peach Hill Road and Davies Road streams), 740 m of the Western Stream and 1549 m of the Tutaeui Stream are required to offset the loss of streams at the proposed Sutton Block expansion of Drury Quarry. This will provide a 1 : 1 ratio for loss of stream length and a 1 : 10 ratio for loss of stream bed area.

In regard to loss of stream extent, the Sutton Block expansion area was redesigned in 2023 to be set back further from Kaarearea Paa avoid significant reclamation, including further reclamation of Stream 4 and avoid the loss of the southern boundary streams and wetlands. The redesign avoided the loss of 610 m of natural stream length, and, where possible, stream extent has been maintained or lengthened by stream diversions, in the lower catchment, below the upper dam (115 m). In addition, 128 m of stream will be recreated within the current footprint of the upper dam pond. (E2:9 EcIA).

As stated in the EcIA, the detailed designs of the permanent stream diversion below the dam; the recreated stream channel within the footprint of the current dam pond; will be a collaborative design between the project ecologists and project engineers and contractors.

4.5 Biodiversity Gains and Habitat Enhancement

Biodiversity gains at the offset sites would be achieved through the enhancement of the existing habitat to improve its condition; by fencing the area from stock; the reinstatement of some of the rock within and adjacent to the watercourse; the removal or modification of structures providing total and partial barriers to fish passage; and ongoing weed control of the restoration plantings.

Combined with these enhancement activities, habitat creation is proposed, involving restoration planting of species that form the early stages in a succession towards a native forest habitat. The restoration planting provides aquatic ecological benefits provided by replacing pasture grass and/or weed species with native shrubs and trees in the riparian zone (providing temperature control and reduction of nuisance growth of aquatic vegetation through shading); woody debris in the stream (increasing habitat and refuges for invertebrates and fish); stabilisation of channel banks and channel shape; and reduction of nutrient and sediment inputs into the streams.

5 WETLAND OFFSET METHODOLGY AND CALCULATIONS

5.1 Tuakau Wetland Offset Site – current

The wetland area identified on the Tuakau Site as the proposed offset site for the loss of wetlands in the Sutton Block project area is located in wetted pasture located immediately south of a covenanted 3.59 ha stand of kahikatea and immediately north of the Waikato River (Figure 7). Directly east of the site a second 4.97 ha stand of kahikatea is present and west of the site is an extensive wetland known as the 'Piggott Wetland', which underwent extensive restoration undertaken by Fish and Game in 2017 (Waikato Catchment Ecological Enhancement Trust, 2022). Between the river and the proposed offset wetland is a small stopbank which would prevent smaller flood events from inundating the wetland area, however the wetland would still flood when this bank is overtopped or when excess rainfall occurs within the wetland's catchment.

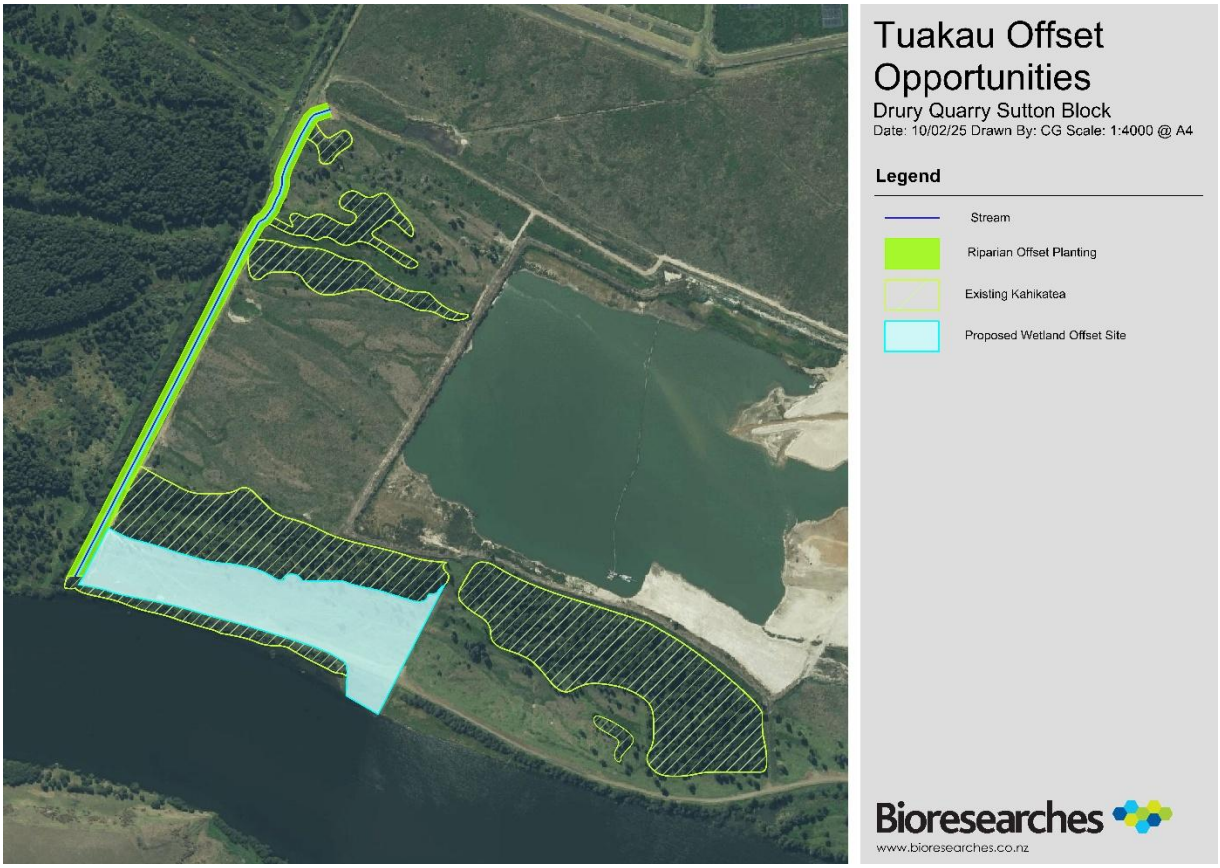


Figure 7. Proposed wetland offset site connected and surrounding habitats (extent of wetland offset area to be determined).

The area in which the offset wetland is located is generally flat, low lying land adjacent to the Waikato River which forms part of the river floodplain. It contains of a mosaic of shallow hollows (approximately 0.5 m lower than the surrounding area) which at the time of the site visit contained standing water up to 0.4 m in depth; but would possibly be dry in summer months (Photo 11 to Photo 14).

Vegetation varied between these areas of higher and lower topography; the higher areas generally consisted of creeping bent (*Agrostis stolonifera*), kikuyu (*Cenchrus clandestinus*), creeping buttercup (*Ranunculus repens*) and sparse dock (*Rumex obtusifolius*); whilst in the hollows, vegetation was dominated by spearwort (*Ranunculus flammula*), water pepper (*Persicaria hydropiper*), creeping bent, creeping buttercup; mercer grass

(*Paspalum distichum*) and starwort (*Callitriche stagnalis*), with areas of periphyton and bare ground also present.

Rushes, including soft rush, jointed rush and wīwī (*Juncus effusus*, *J. articulatus* and *J. edgariae*, respectively) were present throughout the area, with densities greatest in or adjacent to the hollows, and scattered black alder (*Alnus glutinosa*) were also present. In one location to the north-west of the wetland; in an area of deeper water, was a patch of reed sweetgrass (*Glyceria maxima*).

Photo 11. An example of a deeper hollow within the proposed wetland restoration area

Photo 12. The proposed wetland restoration area

Photo 13. The proposed wetland restoration area

Photo 14. A shallower hollow within the proposed wetland restoration area

Although the proposed restoration wetland is currently dominated by exotic pasture species with low botanical value and is heavily impacted by stock grazing; it has good hydrological connectivity to the river, is at least seasonally if not permanently wet, and has excellent potential for further restoration of the natural hydrological regime and vegetation composition. With slight modifications to the levels of the land adjacent to the stream running along the western end of the site, wetland creation would be easily achieved. These modifications would be adding a small dip or several shallow dips in the access track immediately to the east of the stream to levels similar to those immediately upstream, where the tidal flow moves in and out of the kahikatea stands and wetted pasture areas.

Other benefits of restoring this area to an indigenous wetland habitat, is to restore connectivity to the large area of kahikatea landward of the proposed site, connectivity to the large areas of restored kahikatea wetland to the west of the site and the connectivity to the Waikato River (Figure 7). Restoration of this area, along with the riparian planting along the Western Stream will connect these isolated habitats into one large, contiguous habitat.

The wetland areas proposed to be reclaimed by the Sutton Block pit are described in the EcIA report (E2:9 EcIA). Additional detail, including the wetland attributes and the species lists are provided in Table 7, Table 13 and Appendix G**.**

5.2 Wetland Offset

Although the wetlands are different in their landscape position, in that the impact wetlands are located in an upper portion of a catchment and the offset wetland is located in the lower reaches of the Waikato River catchment, the offset wetland and the wetlands to be lost at the Sutton Block site are very similar in terms of:

- Their exotic-dominated species assemblages, which are invaded by pasture species, with some colonisation by native species;
- Their hydrology, which includes both permanently and intermittently saturated areas;
- Their condition, which has been degraded by removal of the original forest cover, invasion of exotic species, and lack of fencing which has allowed their continued grazing by stock.
- Their historic vegetation cover, which would have been a form of kahikatea forest (MF4), or Kahikatea, pukatea forest (WF8).

The dominant wetland attributes for both the impact wetland and proposed offset wetland are listed in Table 13.

Table 13. Wetland Attributes Table

Attribute	Assessment Criteria or Measurement unit	Impact Wetlands					Offset Wetland
		Wetlands 1	Wetland 2a	Wetlands 6	Wetlands 7	Wetland 9	
Vegetation - Native species richness	% of native species (refer Appendix 8)	20%	24%	13%	8%	29%	10%
Vegetation - Dominant	Percentage of plant cover that is exotic	95%	75%	95%	98%	85%	98%
Structural tiers	Number of vegetative tiers	2	2	2	2	2	2
Hydrology	Desktop & Site inspections	Permanent	Permanent	Intermittent	Intermittent	Intermittent	Permanent
Number of hydrological units present	Count undertaken during site assessment	2 (permanently saturated centre, intermittently saturated edges)	3 (standing water where raupō is present, permanently saturated centre, intermittently saturated edges)	1 (intermittently saturated areas)	1 (intermittently saturated areas)	1 (intermittently saturated areas)	2 (open water and saturated areas)
Location in Catchment	GeoMap & aerial photos	Upper	Upper	Upper	Upper	Mid	Lower
Potential for native aquatic fauna	Assessment from hydrology	Moderate - likely used by longfin eels as they move upstream, and potential habitat for common native birds (e.g. pūkeko).	Moderate - likely used by longfin eels as they move upstream, and potential habitat for common native birds (e.g. pūkeko).	Negligible - no water for most of the year.	Low – water present for some of the year, may provide some foraging habitat for common native birds (e.g. pūkeko).	Negligible – only damp habitat for part of the year.	Moderate – likely used by some fish species when flooded, and potential to be used by water bird species such as pūkeko, shags and spoonbill.
Wetland Hydrosystem	Johnson & Gerbeaux (2004)	Palustrine	Palustrine	Palustrine	Palustrine	Palustrine	Palustrine

Structural Class	Johnson & Gerbeaux (2004)	Swamp	Swamp	Seepage	Seepage	Seepage	Swamp
Wetland vegetation type	Classified in accordance with Singers *et al.* (2017).	Exotic wetland	Raupō reedland with areas of exotic wetland on periphery	Exotic wetland	Exotic wetland	Exotic wetland	Exotic wetland/ damp pasture
Size	m^2	10, 727	2290	554	487	40	32,812[8]
Area to perimeter ratio	Ratio of the area to the length of perimeter not contiguous with a native/natural habitat	11:1	7:1	3:1	4:1	2:1	52:1[9]
Potential for enhancement	Site assessment	Moderate – could be fenced to prevent stock access with a vegetated buffer. Would still lack connectivity to other contiguous habitats and be limited by downstream fish passage barriers.	Moderate – could be fenced to prevent stock access with a vegetated buffer. Would still lack connectivity to other contiguous habitats and be limited by downstream fish passage barriers.	Low – could be fenced to prevent stock access with a vegetated buffer, but no water most of the year.	Moderate – could be fenced to prevent stock access with a vegetated buffer.	Low – currently mostly fenced, but very limited water most of the year.	Excellent - bounded by rivers or streams on two sides, was once a wetland now improved pasture with stock, no potential for future development, buffered by river, stream and stand of protected kahikatea. Excellent potential for hydrological restoration with minimal works.

[8] Area available at the chosen offset site (Figure 7).
[9] Calculated on the total area of the chosen offset site.

All of the wetlands (impact and offset) are palustrine seepages or swamps; have poor native species diversity; all except the Wetland 2 raupō swamp, have 75% or more dominance by exotic plants; all have the same number of structural tiers (herbs and/or rushes); all except a portion of one are exotic wetlands or damp pastural wetlands; and all of the impact wetlands have a moderate to low area to perimeter ratio i.e. their exposure to land-use pressures is high. At the proposed offset site, with the enhancement measures proposed, there will be a high net biodiversity gain, with additionality, no time lag, no harm to the offset location and an excellent outcome in the landscape context (Table 13).

As the features of the impact and offset wetlands are so similar, and the biodiversity gains at the offset site so high (Table 15), the quantum of offset has been calculated based upon on bed area. Wetland offset will based on a 1:2 (impact: restoration/enhancement) ratio of area of loss for wetlands lost. As much of the wetland loss will occur after the first 20 years of the quarry's expansion, the offset wetlands will be well established prior to the loss of the impact wetland, which should ensure there is no net loss of ecological functioning or biodiversity.

Confirmation of Net Gain using the Biodiversity Compensation Model

To provide surety for the wetland offset calculations above, the wetland data was inputted into a Biodiversity Compensation Model (BCM). The Biodiversity Offset Accounting Model (BOAM) was not used as the model requires a pristine reference site, which is the benchmark for the completed restoration activities, and that model could not be reliably quantified. We could not locate a suitable site, of a suitable age with the restoration and enhancements that are proposed and therefore defaulted to the BCM (refer Section 3.4).

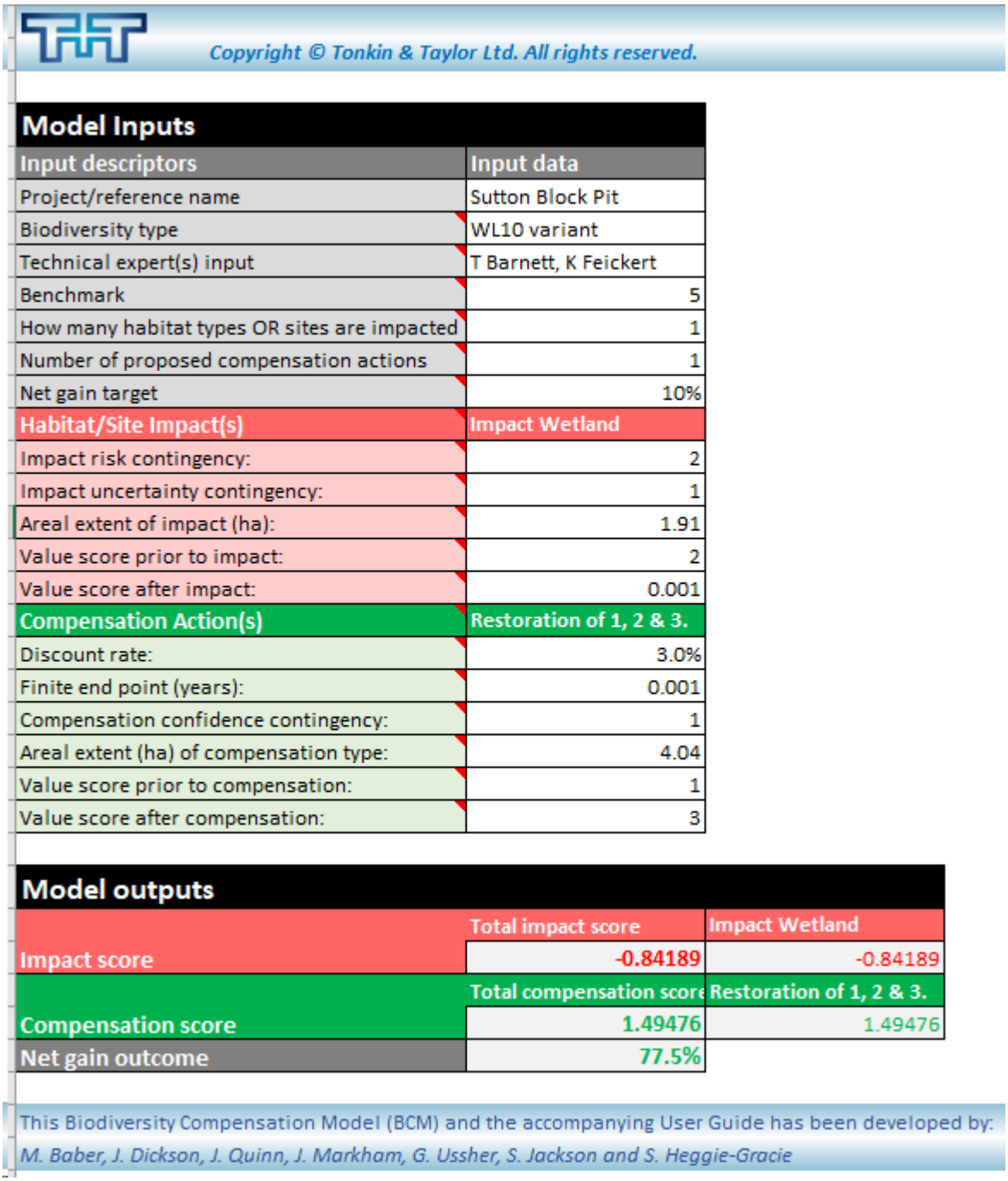
The BCM input parameters are detailed in Table 14. A 'screenshot' of the completed BCM model with the input and outputs is provided in Figure 8. BCM model inputs and outputs are for compensation of 1.9 ha of wetland loss. This shows that the BCM predicts that the proposed restorative actions would achieve a compensation score 78% higher than the impact score.

A 'net gain outcome' target of 10% is considered to be generally appropriate, with a higher target meaning the greater likelihood of that No Net Loss or preferably Net Gain outcomes will be achieved. The 78% score indicates a very strong 'net gain' in biodiversity values, confirming that the proposed actions are suitable to manage the ecological impact of the proposed wetland loss associated with the Sutton Block pit.

Table 14. BCM model inputs and justification

Model Inputs		
Input descriptors	**Input data**	**Justification for input parameters**
Project/reference name	Sutton Block Pit	N/A
Biodiversity type	Exotic wetland	As observed during site visits
Technical expert(s) input	T Barnett	Based on assessments provided by J Shanks, T Barnett, L Drummond and K Feickert
Benchmark	5	5 is the recommended benchmark as per Baber *et al.* (2021a).
How many habitat types OR sites are impacted	1	One – the Impact Wetland
Number of proposed compensation actions	1	One action is proposed, being restoration and enhancement of the area bounded between the Waikato River, the western stream of the Tuakau Site and the protected band on kahikatea in the western corner of the Tuakau Site. The exotic wetland and wetted pasture areas will be enhanced and restored to become representative of a historic kahikatea swamp, including fencing and undertaking of animal pest control, which will form part of the restoration and enhancement activities. As specified by Baber *et al.* (2021a): "*Where compensation actions differ AND are undertaken in different locations or sites, or the spatial extent of the compensation action is different, then each action must be assessed independently. In some instances, different compensation actions in the same location can be lumped into a single compensation action (e.g., native revegetation and weed control), provided appropriate justification is given. Similarly, it may be appropriate to combine the same compensation action at different locations into a single compensation action, with appropriate explanation*."
Net gain target	10%	'*For compensation a Net Gain outcome target of 10% is considered by the authors to be generally appropriate*' – Baber *et al.* (2021a).
Habitat/Site Impact(s)	**Impact Wetland**	**N/A**
Impact risk contingency:	2	A score of two is representative of a 'Moderate risk/Moderate value'. This has been conservatively applied, and it is expected that a score of one is perhaps more appropriate. It is not expected that there is likelihood of permanent and irreplaceable loss of significant biodiversity values occurring, as there are very limited significant biodiversity values at the impact site.
Impact uncertainty contingency:	1	A score of one is representative of a low uncertainty. It is considered that there is a low level of uncertainty regarding the risk of permanent or irreplaceable biodiversity loss.

Areal extent of impact (ha):	1.91	18,758 m^2 / 1.88 ha of wetland loss is to occur, plus a 2% contingency for small riparian seepage wetlands = 1.91 ha.
Value score prior to impact:	2	Wetlands are of low or moderate current ecological value, and of moderate potential ecological value, which equates to a score of two.
Value score after impact:	0.001	0.001 is the lowest score able to be entered into the model, which equates to an ecological value of zero after impact.
Compensation Action(s)	**Restoration of the Tuakau Site described above**	**N/A**
Discount rate:	3.0%	'*A discount rate of 3% is recommended*.' – Baber *et al.* (2021a).
Finite end point (years):	0.001	A five-year end point is usually based upon the AUP guidance for monitoring the success of restoration plantings, as described in Appendix 16, Section 16.5 of the AUP. As the restoration and enhancement activities will be occurring at least 5 years prior to the wetland loss, with the majority of restoration and enhancement activities occurring 20 years prior to the loss of the habitats, the number of years between the impact and assessment of biodiversity gain is zero (i.e. 0.001 for this model)
Compensation confidence contingency:	1	A score of two equates to 'very high confidence'. Baber *et al*. (2021a) describe 'high confidence' as: *'Very high confidence: The proposed compensation measure uses methods that are well tested and repeatedly proven to achieve intended biodiversity gains; evidence based expert opinion is that success is very likely. Likelihood of success is > 90%. Calculated biodiversity gain is multiplied by 0.925.'* This is considered a suitable level of confidence, given that restoration plantings and creation of wetlands are a frequently undertaken activity within Auckland, with good success rates, due to the rapid growth of wetland vegetation, especially where ongoing maintenance is applied, as is recommended in this report.
Areal extent (ha) of compensation type:	4.04	This is the minimum extent of wetland enhancement and restoration area in one block on the Tuakau Site.
Value score prior to compensation:	1	The wetlands are mainly wetted pasture areas with full stock access, including pigs, and have a 'low' ecological value which equates to a score of one.
Value score after compensation:	3	It is expected that with the proposed restoration activities, the ecological value of the wetlands would increase to 'high', which equates to a score of three.



Model Inputs

Input descriptors	Input data
Project/reference name	Sutton Block Pit
Biodiversity type	WL10 variant
Technical expert(s) input	T Barnett, K Feickert
Benchmark	5
How many habitat types OR sites are impacted	1
Number of proposed compensation actions	1
Net gain target	10%
Habitat/Site Impact(s)	**Impact Wetland**
Impact risk contingency:	2
Impact uncertainty contingency:	1
Areal extent of impact (ha):	1.91
Value score prior to impact:	2
Value score after impact:	0.001
Compensation Action(s)	**Restoration of 1, 2 & 3.**
Discount rate:	3.0%
Finite end point (years):	0.001
Compensation confidence contingency:	1
Areal extent (ha) of compensation type:	4.04
Value score prior to compensation:	1
Value score after compensation:	3

Model outputs

	Total impact score	Impact Wetland
Impact score	-0.84189	-0.84189
	Total compensation score	Restoration of 1, 2 & 3.
Compensation score	1.49476	1.49476
Net gain outcome	77.5%	

This Biodiversity Compensation Model (BCM) and the accompanying User Guide has been developed by:
M. Baber, J. Dickson, J. Quinn, J. Markham, G. Ussher, S. Jackson and S. Heggie-Gracie

Figure 8. BCM Model inputs and outputs for compensation of 1.91 ha[10] of wetland loss

5.3 Enhancements, Restoration and Wetland Creation

The proposed offset for the impact wetlands would form a single large mosaic wetland. The wetland would be enhanced with weed removal (specifically pest plants and aggressive exotic species) and enrichment planting with a variety of native wetland plants to increase the species diversity, increase the dominance of indigenous wetland plants, provide tiers in the wetland, and increase the number of habitat types in the wetland area.

[10] 1.88 ha plus 2% for minor seepage wetlands = 1.91 ha (refer

Table 14).

The wetland would be fenced from stock, and habitat would be created within the margins with restoration planting of low-lying tier, shrub tier and tree tier native species (including kahikatea) providing a gradient from the obligate wetland plants, through to facultative wetland vegetation to terrestrial vegetation on the higher ground. The size, shape and site of the offset wetland would have a high area to perimeter ratio (refer Table 13), and consequently, the exposure to land-use pressures once enhanced would be very low.

The offset wetland is bounded by the Waikato River to the south, a stream to the west and a kahikatea treeland and swamp to the north. The area has only been able to be maintained as improved pasture through farm management, including grazing, and formation and maintenance of bunds from the stream and river. Although the Waikato River is not saline adjacent to the site, it is still strongly tidal and changes throughout the day change in height. Minimal works on a small area of the access track and small bund between the stream and the proposed offset area would allow water to seep into the wetland area at the top of most of the tides and restore part of the original hydrology to the site (without turning the area into a pond), similar to areas upstream of the proposed offset wetland on this site (Photo 15 and Photo 16) and in other wetland areas recently assessed downstream on the Waikato River[6].

The bund to the Waikato River will be slightly lowered in two areas to create slightly lowered swales to allow water to flow into the wetland area and either out of the western stream or out of the swale, recreating moving water and a stream / wetland mosaic.

Photo 15. Low point adjacent to Western Stream

Photo 16. Wetland formed beyond the low point adjacent to the Western Stream

Fencing and replanting of the wetland offset areas with native wetland vegetation, linking these areas to the kahikatea wetland and Piggott wetland; and increasing the connectivity of the area to the Waikato River and its tributaries will result in a significant positive effect on ecological functioning of the wetland and biodiversity well above the actual and potential values of the sites.

In addition, the proposed riparian planting along the western stream will provide a planted corridor between the offset wetland, the lower (south-western) kahikatea wetland, and the isolated stands of kahikatea further up the catchment (Figure 7); creating an ecological corridor on the Tuakau Site extending for 1.5 km along the wetlands and stream.

The proposed wetland offset will result in 4 ha of biodiversity offset within the Tuakau Site wetland area providing a ratio of 1 : 2 (impact: restoration/enhancement) for all the wetlands lost within the Sutton Block,

irrespective of when they will be lost. This will provide time for the wetland to become well established and provide surety for the biodiversity gains.

Table 15. Ecological Values Assessment of the Wetland Enhancement at the Proposed Offset Site after 10 Years

Attribute	Assessment Criteria or Measurement unit	Impact Wetlands	Enhanced Offset Wetland	Uplift in Ecological Value / Importance to the Site (EIANZ Guidelines)
WETLAND SIZE				
Size	m²	18,758[7]	40,400	Very High
Area to perimeter ratio	Ratio of the area to the length of perimeter not contiguous with a native/natural habitat	1:1 to 11:1 – Low and indicative of a high level of edge effects.	47:1 – High, indicative of a low level of edge effects.[11]	Very High
VEGETATION CHARACTERISTICS				
Wetland vegetation type	Singers *et al.* (2017) and Singers and Rogers (2014)	Exotic wetland (EW) & Raupō Reedland (WL19)	Kahikatea Swamp (no category) combination of Flaxland (WL18); and Kahikatea Forest (MF4).	High
Vegetation - Native species richness	% of native species (refer Appendix 8)	8-29%	90%	Very high
Vegetation - Dominant	Percentage of plant cover that is exotic	75-98%	20%	High
Structural tiers & richness	Number of vegetative tiers	1	3	Very high
HYDROLOGY				
Hydrology	Desktop & Site surveys	Permanent & Intermittent	Permanent	Low
Number of hydrological units present	Count undertaken during site assessment	1 - 3	2 - 3	Low
FAUNA				

[11] Calculated on the 4.04 ha of proposed offset restoration area.

Potential for native aquatic fauna	Desktop & Site surveys	Low - significant fish barriers downstream	Moderate to High – connectivity to the Waikato River, which is inhabited by a suite of native fish species.	High
Potential for birds and other fauna		Common native bird species only, such as pūkeko. Limited likelihood of other threatened birds accessing the wetland due to limited connectivity to other suitable habitats. Bats have not been detected within the area.	Large well buffered wetland habitat has high potential to be used by native bird species such as pūkeko, shags and spoonbill, and also some potential for other less common wetland birds such as bittern and fernbird have potential to utilise existing connectivity to disperse into the wetland. Long-tailed bats ('Threatened - Nationally Critical' threat status) are known to utilise the neighbouring kahikatea stand. It is highly likely this population would utilise the restored wetland area for foraging and in the very long-term, roosting.	Very high
SUMMARY				
Summary of potential for enhancement	Site assessment	Low. Fencing, buffer planting and restoration planting could be undertaken, but the wetlands would still lack connectivity to other contiguous habitats, and be limited by downstream fish passage barriers and a lack of incentive to restore and maintain fragmented swampy areas. Ecological value even if restored would be unlikely to exceed 'Moderate'.	Excellent The wetland is bounded by rivers or streams on two sides. It was once a wetland, however, due to modifications and deforestation it is now improved pasture which is frequently grazed by stock. The wetland is buffered by the river, stream, the stand of protected kahikatea and Piggot wetland. Excellent potential for hydrological restoration with minimal work required to achieve this. Incentive to restore and maintain. Due to the high level of connectivity to adjacent habitats which support threatened and/or at risk fauna species (e.g. long-tailed bats (Threatened, Nationally critical), little black shag (At risk – Naturally uncommon), īnanga (At-risk, Declining)), it is highly likely that the wetland will become habitat for these species also.	High
EIANZ attributes to be considered when assigning ecological value or importance to a site or area of vegetation / habitat / community for the wetland enhancement site at 10 years.				

Representativeness / naturalness	Large scale natural wetland dominated by indigenous vegetation, buffered by kahikatea	High
Rarity / distinctiveness	Large indigenous wetlands are now rare both regionally and nationally	Very High
Diversity and Pattern	Diverse range of indigenous vegetation in a variety of structural tiers	High
Ecological Context	Large size and links kahikatea forest habitats and riparian habitats over a 1.5km long area.	High
Potential Ecological Value		**VERY HIGH**

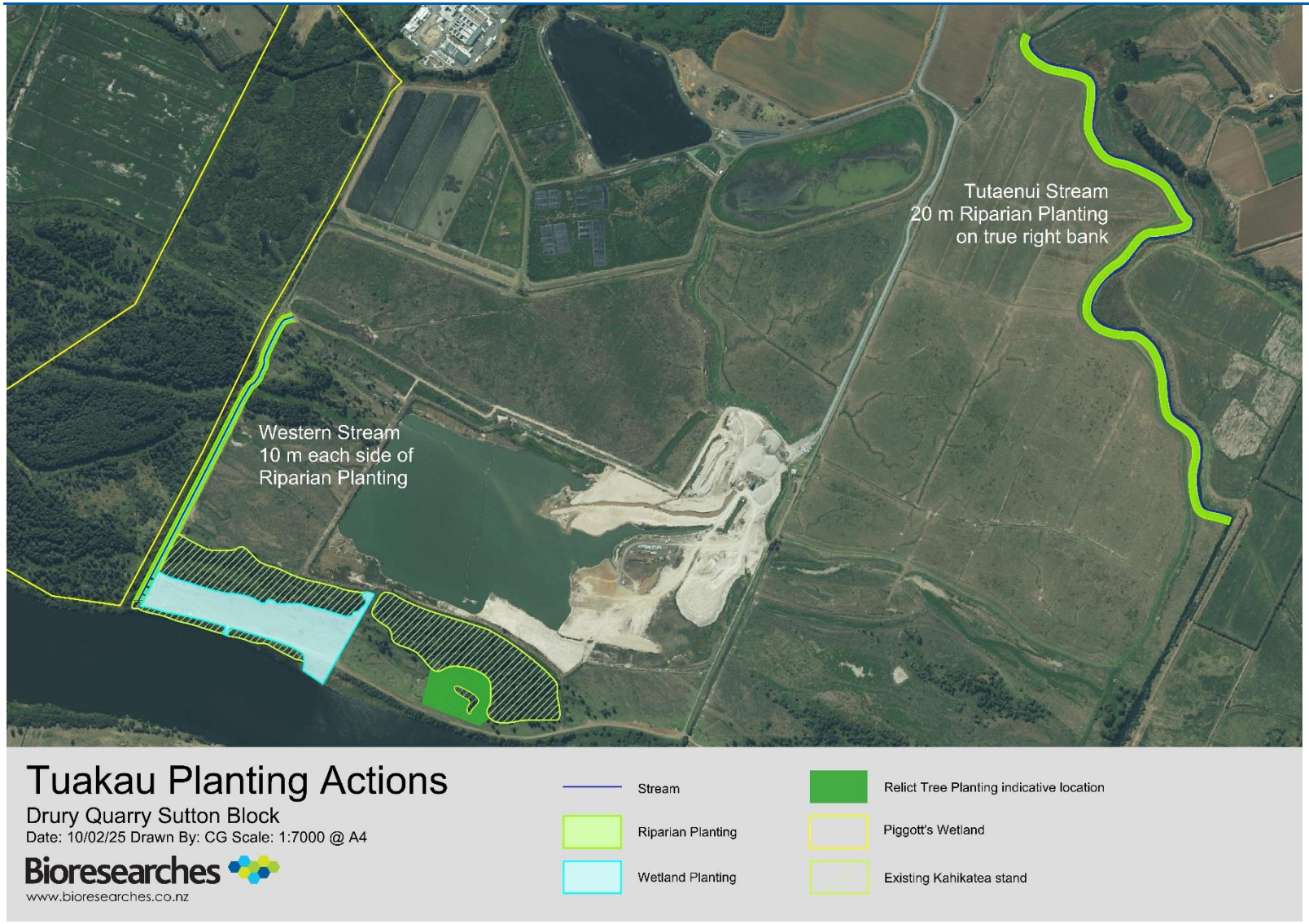


Figure 9. Proposed Sutton Block stream and wetland offset at the Tuakau Site.

6 STAGED RESTORATION AND MONITORING

A multistage approach is required to fully restore and enhance the vegetation within the proposed offset wetland and the riparian areas. Enrichment species require more protection from the elements and are best planted 3-5 years after pioneer planting. The multistage approach is outlined below, and provided in detail in the Net Gain Delivery Plan: Riparian Planting (E9:9 NGDP:RP) and Net Gain Delivery Plan: Wetland Planting (E8:9 NGDP:WP):

Stage 1: **Perimeter fence construction -** Fence all areas to be planted to ensure segregation from stock.

Weed management – Eradicate all weeds present and dispose at a transfer station.

Animal pest control – Begin baiting, trapping and shooting programmes to reduce animal pest indices.
Construction – Completion of any works required on bunds or within the wetland for restoration.

Stage 2: **Planting Programme** - Prepare enhancement area and plant pioneer species according to the planting schedule.

Stage 3: **Ongoing Maintenance** - Replace any unsuccessful plantings and release seedlings from any persistent invasives or new incursions. Weed maintenance should continue for a minimum of five years. Plant enrichment species after 3-5 years.

This would be carried out in accordance with the NGDP:RP and NGDP:WP, as recommended in the EcIA report, which would include:

a) Specific wetland restoration design details; and
b) Planting plans, including, as a minimum

- Weed Management;
- Animal Pest Management;
- Planting (Species mix, spacing, density, plant size, requirement for plants to be eco-sourced, and maintenance); and
- Monitoring.

Figure 10 to Figure 13 provide a Wetland Concept Design for the wetland offset area and an indicative design for the stream restoration features.

Figure 10. Indicative Offset Wetland Design at the Tuakau Site.

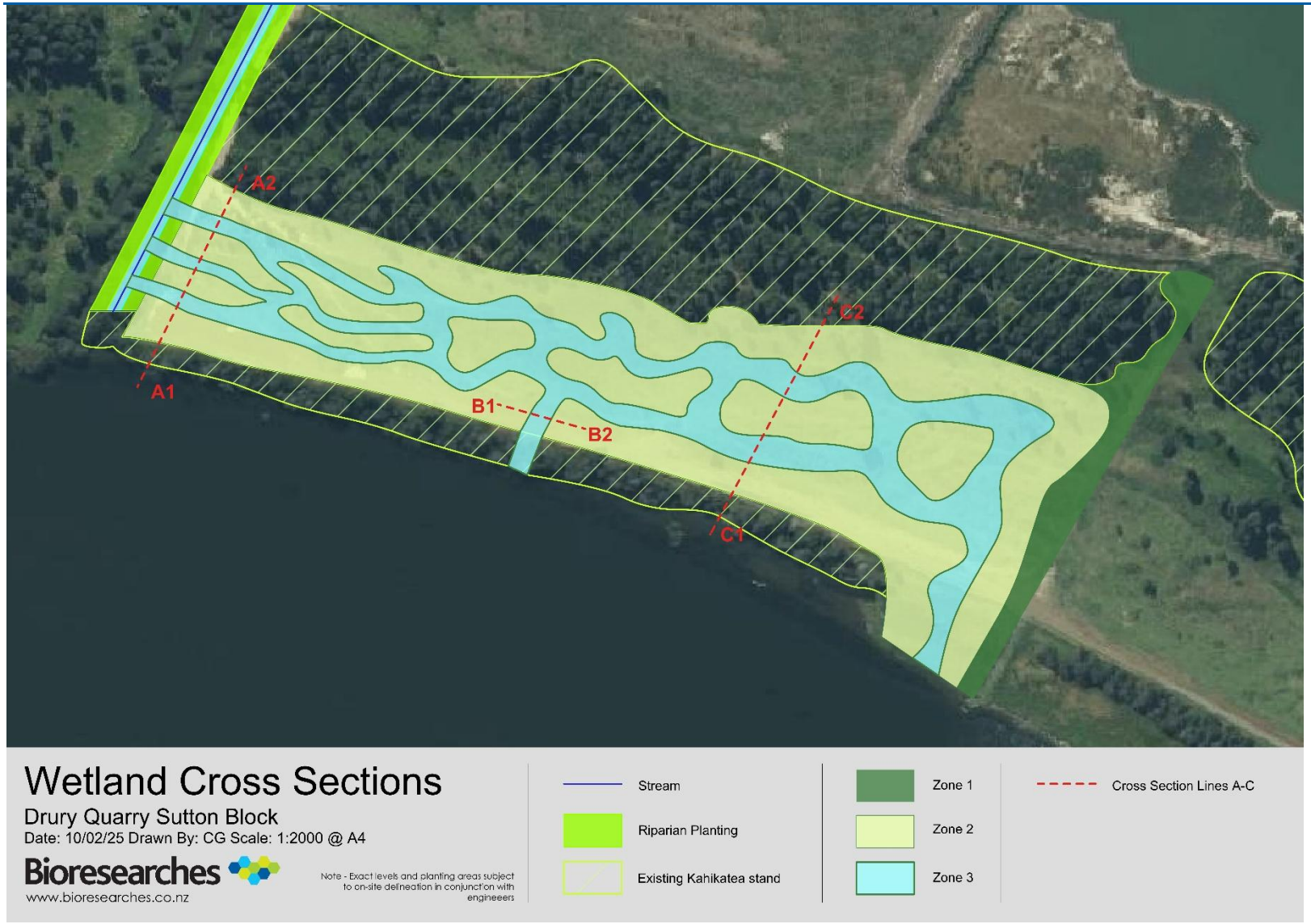


Figure 11. Tuakau Wetland Concept Design (including cross-section lines for Figure 12)

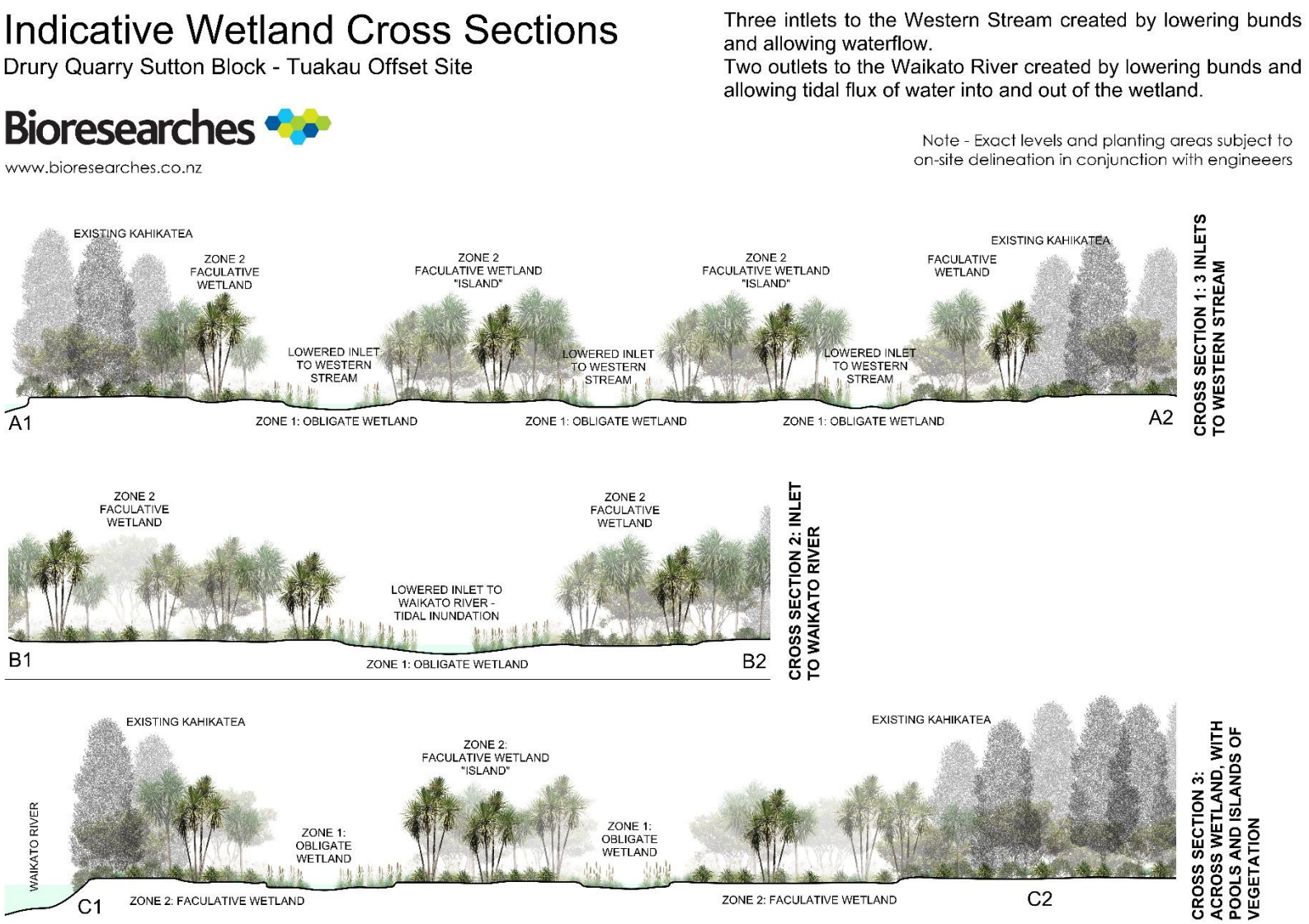


Figure 12. Tuakau Indicative Wetland Cross Sections

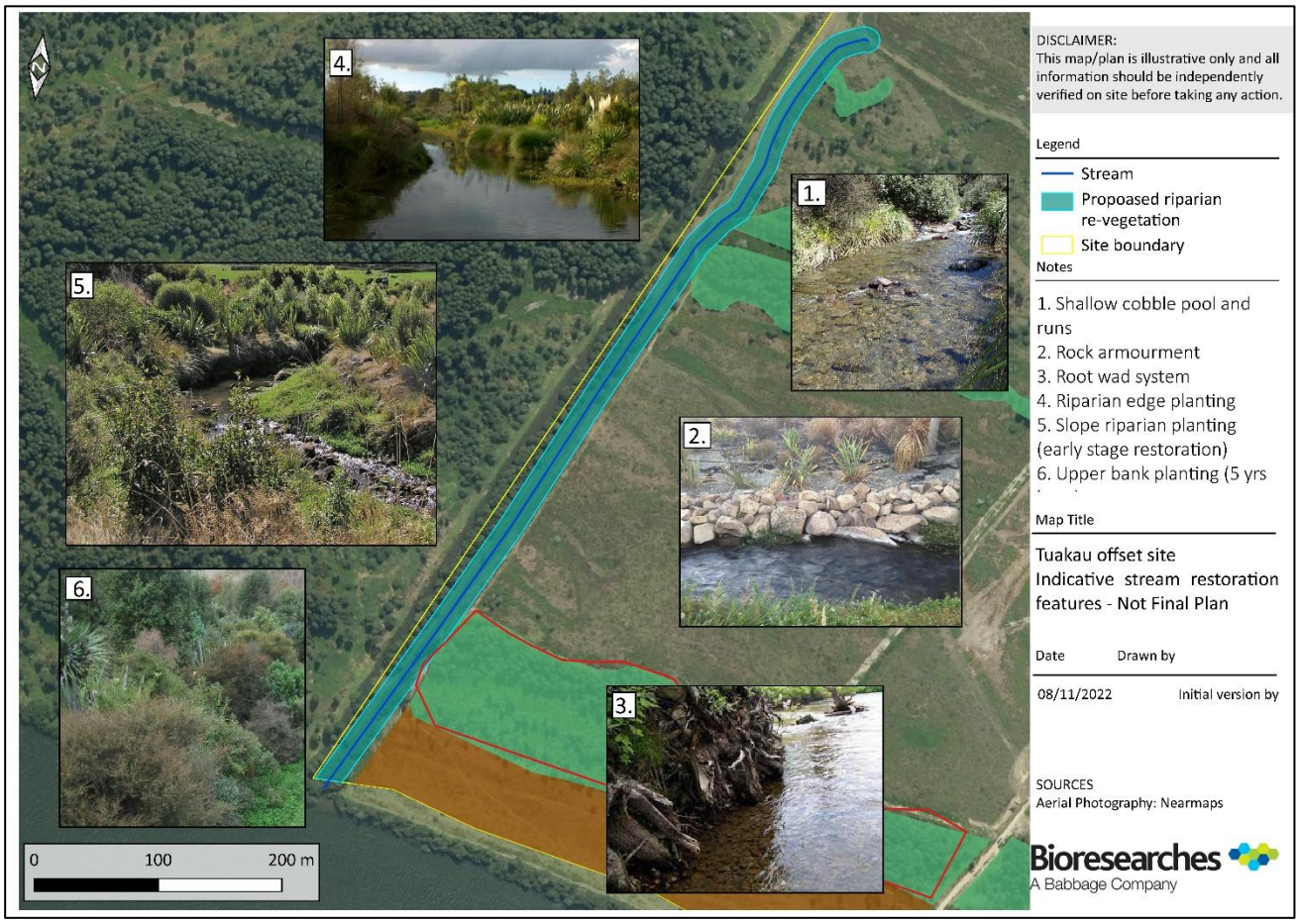


Figure 13. Concept Design - Indicative Stream Restoration Features

Table 16 and Table 17 provide species list of native plants that are appropriate to the habitats and the ecological area. These lists are recommendations and provide a basis to ensure the biodiversity outcomes are achievable, but are subject to refinement upon consultation.

Table 16. Indicative Planting List – Stream Riparian Areas

Common name	Scientific name	Tier	Value as bird food N - nectar; F - fruit and seeds
Stream Edge and Slope			
wineberry	*Aristotelia serrata*	Understory	-
swamp astelia	*Astellia grandis*	Grasses/sedges/ferns	-
purei	*Carex secta*	Grasses/sedges/ferns	-
swamp sedge	*Carex virgata*	Grasses/sedges	-
mingimingi	*Coprosma propinqua*	Understory	F
swamp coprosma	*Coprosma tenuicaulis*	Understory	F
cabbage tree	*Cordyline australis*	Understory	F/N
pukatea	*Laurelia novae-zelandiae*	Canopy tree	-
manuka	*Leptospermum scoparium*	Understory	N
kiokio	*Parablechnum novae-zelandiae*	Grasses/sedges/ferns	-
General Riparian Area			
titoki	*Alectryon excelsus*	Canopy tree	F
putaputaweta	*Carpodetus serratus*	Understory	F

twiggy coprosma	*Coprosma rhamnoides*	Understory	F
taupata	*Coprosma repens*	Understory	F
ponga	*Cyathea dealbata*	Understory	-
kahikatea	*Dacrycarpus dacrydioides*	Canopy tree	F
wheki	*Dicksonia squarrosa*	Understory	-
lacebark	*Hoheria populnea*	Understory	N
kanuka	*Kunzea robusta*	Understory	N
māhoe	*Melicytus ramiflorus*	Understory	F
māpou	*Myrsine australis*	Understory	F
kawakawa	*Piper excelsum*	Understory	F
tarata	*Pittosporum eugenioides*	Understory	F/N
kōhūhū	*Pittosporum tenuifolium*	Understory	F/N
pate	*Schefflera digitata)*	Understory	F
kowhai	*Sophora microphylla*	Canopy tree	N
pūriri	*Vitex lucens*	Canopy tree	F/N

Table 17. Indicative Planting Schedules – Wetlands

Planting area and habitat type	Common name	Scientific name	Wetland plant indicator rating (Clarkson *et al.* 2021)
Permanent standing water/open water areas	Kuta, Lake clubrush	*Schoenoplectus tabernaemontani*	OBL
	Kuta, Tall spike sedge	*Eleocharis sphacelata*	OBL
	Jointed twig rush	*Machaerina articulata*	OBL
	Pūrei	*Carex secta*	OBL
	Raupō	*Typha orientalis*	OBL
Temporary standing water, permanent saturation: **Swamp forest areas**	Pukatea	*Laurelia novae-zelandiae*	FAC
	Kahikatea, White pine	*Dacrycarpus dacrydioides*	FAC
	Toetoe	*Austroderia fulvida*	FAC
	Swamp maire, Maire tawake	*Syzygium maire*	OBL
	Poataniwha	*Melicope simplex*	Not Rated
	Swamp sedge	*Carex virgata*	FACW
	Swamp coprosma	*Coprosma tenuicaulis*	FACW
	Mingimingi	*Coprosma propinqua*	FAC
	Saltmarsh ribbonwood	*Plagianthus divaricatus*	FACW
Temporary standing water, permanent saturation: **Flaxland habitat**	Harakeke, New Zealand flax	*Phormium tenax*	FACW
	Cabbage tree, Ti kōuka	*Cordyline australis*	FAC
	Giant umbrella sedge, Upoko-tangata	*Cyperus ustulatus*	FACW
	Swamp astelia	*Astelia grandis*	OBL
	Cutty grass, Rautahi	*Carex geminata*	FACW
Higher areas with intermittent	Kahikatea, White pine	*Dacrycarpus dacrydioides*	FAC
	Manatu, Lowland ribbonwood	*Plagianthus regius subsp. regius*	FACU

saturation and occasional flooding: **Swamp forest areas**	Weeping mapou	*Myrsine divaricata*	FAC
	Pukatea	*Laurelia novae-zelandiae*	FAC
	Tūrepo, small-leaved milk tree	*Streblus heterophyllus*	Not Rated
	Round-leaved coprosma	*Coprosma rotundifolia*	FAC
	Coastal kōwhai	*Sophora chathamica*	Not Rated
	Kaikōmako	*Pennantia corymbosa*	Not Rated
Higher areas with intermittent saturation and occasional flooding: **Cabbage tree wetland carr habitat**	Cabbage tree, Ti kōuka	*Cordyline australis*	FAC
	Harakeke, New Zealand flax	*Phormium tenax*	FACW
	Kiekie	*Freycinetia banksii*	FACU
	Swamp mahoe	*Melicytus micranthus*	FAC
	Mānuka	*Leptospermum scoparium*	FAC
	Wīwī	*Juncus edgariae*	FACW
	Cutty grass, gahnia	*Gahnia lacera*	Not Rated

In addition to planting of the riparian area, streams enhancement actions are also proposed within and adjacent to the streams, at appropriate areas, including modification or removal of the partial fish barrier in the Western Stream; additional of cobble to create habitat for macroinvertebrate and for fish spawning; boulders to create variability in the hydrology and habitat; and addition of root wads for habitat creation (Figure 13).

Monitoring of biodiversity offset actions is critical to determining overall offset success, and both stream and wetland offset areas should be monitored to ensure the expected biodiversity gains are achieved, with additional measures to be under taken if the gains fall short of expect outcomes.

The stream offset areas should be reassessed using the SEV methodology at five years to ensure the SEV values have been achieved or exceeded. This should be provided as a condition of consent, with the provision for additional remedial actions (e.g. additional time, additional planting, additional offset), if the predicted SEV scores have not been achieved.

The wetland and riparian planting areas should be monitored annually for weed presence, with problem weeds controlled periodically. Wetland monitoring should be undertaken biennially, in general accordance with the Wetland Condition Index (Clarkson *et al.* 2003) or other suitable monitoring methodology to assess trends in wetland condition.

These details i.e. planting plans, pest management, monitoring requirements and stream enhancements, are provided within separate plans:

- E9:9 NGDP: Riparian Planting (NGDP:RP)
- E8:9 NGDP: Wetland Planting (NGDP:WP)

7 ASSESSMENT AGAINST THE PRINCIPLES OF AQUATIC OFFSETING

The exposure draft document for the National Policy Statement for Freshwater Management (NPS-FM)[12] sets out eleven principles that underpin the concept of aquatic biodiversity offsetting (Section 3.2). These principles are identified in Table 18 with a brief explanation of how the proposed aquatic habitat offset for the Drury Quarry Sutton expansion will satisfy them.

Table 18. Principles of aquatic biodiversity offsetting and how these will be achieved for the Sutton Block expansion at Drury Quarry and the Tuakau Offset Site.

	Tuakau Site
1. Adherence to effects management hierarchy	Assessments prior to offset using the Ecological Impact Assessment Guidelines (EcIAG) for use in New Zealand, published by EIANZ (Roper-Lindsay *et al*. 2018). Avoidance / minimisation of ecological effects through design has been proposed wherever this has been practicable /possible. Redesign and avoidance of stream loss and wetland loss on the southern boundary and north-eastern boundary of the pit. Minimisation of ecological effects through native fish recovery and relocation; stream diversions rather than reclamations where possible; riparian planning of watercourses and wetlands immediately adjacent to the pit; monitoring and augmentation of flows to adjacent streams; where more than minor residual adverse effects cannot be avoided, minimised, or remedied, aquatic offsetting is provided
2. When aquatic offsetting is not appropriate	Offset can achieve the conservation outcomes specified in the NPS-FM. Specifically, there is no net loss of irreplaceable habitat; there is adequate certainty about the success of the proposed offset measures; and it is the most technically feasible option to address the residual effects after application of the initial steps of the effects management hierarchy.
3. No net loss and preferably a net gain	Like-for-like with streams offset by streams and wetlands offset by wetlands. SAL Drury Quarry offset streams like-for-like in terms of position in the landscape and stream attributes. Offsite, permanent and intermittent streams offset with permanent streams, which provide stream habitat values (connection; macroinvertebrates; fish habitat) throughout the year (refer Section 3.5). Accounting using the SEV and ECR methodology for stream loss, and including doubling the required stream bed area through meeting the SEV/ECR requirements for stream length. Achieving a 1: 1 ratio for stream length and a 1 : 10 gain for stream bed area, resulting in a Net gain. Net gain with the riparian planting on the Tuakau site Western Stream also providing riparian ecosystem services to the property boundary stream running parallel to the Western Stream. Wetland habitats offset at a 1 : 2 ratio, with surety checked by the BCM which predicts that the proposed restorative actions would achieve a compensation score 78% higher than the impact score, well exceeding the 10% 'net gain outcome' target considered to be generally appropriate.
4. Additionality	There are no current or future plans to undertake any of the proposed revegetation and restoration actions. Replacement plantings will be protected where they currently have no protections.
5. Leakage	The aquatic offset design and implementation will avoid displacing harm to this location, and will ensure that potential harm to existing biodiversity will be mitigated and temporary.
6. Long term outcomes	Offsets will comprise revegetation along extensive lengths of river banks, linking a major tributary to the Waikato River. Wetland areas will link the habitats to the

[12] Ministry for the Environment (2022). Exposure draft of amendments to the National Policy Statement for Freshwater Management 2020.

	riparian areas and to adjacent high-value habitats. The rationale for the selection of the restoration wetlands is based on multiple factors, and is detailed in Section 3.5.
7. Landscape context	The offset will occur on-site within the SAL Drury Quarry landholdings and off-site at the Tuakau Site, 16 km of the impact site. The Peach Hill Road streams and Davies Road stream, drain to the same Hingaia Stream catchment as the Sutton Block pit streams. Although the Tuakau offset site is not hydrologically connected, with the impact site draining to the Manukau Harbour and the offset site draining to the Waikato River, both water bodies then drain to the same coastline, only separated by the Awhitu Peninsula. (Refer Section 3.5). All restoration actions will be legally protected in perpetuity, and monitored for a minimum 5 years to ensure offset targets are achieved. The site is now owned by the applicant. The riparian restoration planting will link to wetland areas and forested areas, and will link the new riparian areas and to adjacent high value habitats.
8. Time lags	The planting and restoration activities will occur 10, 20 and 30 years prior to much of the loss. Even so, the SEV/ECR model has a time lag component incorporated within the methodology and more than 95% of the wetland loss will occur *after* 10 years, giving the offset wetlands a decade or more to establish prior to the loss. With regard to the wetland loss, the wetland restoration will occur well prior to the wetland loss, with only 2% of the wetland loss occurring by Year 10, 42% by Year 20 and the remainder, 57%, occurring after 20 years. The offset wetland will be established, well prior to the loss, resulting in no time lag.
9. Science and mātauranga Māori	The design of the biodiversity offset will be based on established and proven methods for fauna and flora management and restoration. The biodiversity offset will provide careful consideration to opportunities for maximising ecological outcomes as well as providing for interests of the land owners and Drury Quarry stakeholders, including tangata whenua.
10. Tangata whenua or Stakeholder participation	Drury Quarry (SAL) is active in the community, has long-term relationships that are built on dialogue and collaboration. The project to date has included consultation with local iwi, and new relationships will be established with the stakeholders at the site, and the immediate area.
11. Transparency	Accounting using the SEV and ECR methodology for stream loss, as recommended by Auckland Council, as well as the EIANZ guidelines for assigning ecological values. Calculations and summary tables are provided in this report. The wetland habitat and attributes are tabulated in the report with additional data provided in the Appendices. The wetland calculations are based on the primary attributes of the wetlands, which have been assigned in accordance with nationally and regionally accepted reference documents, including Johnson and Gerbeaux (2004) as published by the Department of Conservation and the Ministry for the Environment and Singers et al. (2017) as published by Auckland Council; as well as the EIANZ guidelines for assigning ecological values. To add surety to a net gain for wetlands the BCM was also calculated, and the calculation are also tabulated in this report. The Biodiversity Compensation Model predicts that the proposed restorative actions would achieve a compensation score 78% higher than the impact score, and indicates a very strong 'net gain' in biodiversity values. Site-specific planting plans for the stream and wetland habitats have been developed, and success monitoring of the restoration activities is recommended; and regular maintenance and monitoring reports will be provided to Council and (where appropriate) other stakeholders.

8 CONCLUSIONS

Expansion of Drury Quarry into the Sutton Block will result in stream loss and wetland loss over a fifty-year period, equating to 3,341 lineal metres of stream loss and 1.88 ha of wetland loss.

Offset for the loss of aquatic habitats is proposed, using the SEV / ECR methodology for streams and wetland restoration based upon a quantum of bed area and the BCM, on streams and wetlands at the Drury Quarry site and the SAL Tuakau Site, located approximately 16 km south-east of the quarry. Stream enhancements, including riparian planting, addition of habitat (boulders, root wads), removal of culverts, partial restoration of native fish passage, and habitat creation are proposed as part of the offset package; plus restoration of wetland. At the Drury Quarry offset site and Tuakau Site, 3.3km of stream will be enhanced with riparian planting and fencing; culverts removed or replaced; a flood gate will either be removed or modified to allow for fish passage; and 4.04 ha of wetland will be restored, including creation of wetland habitat. (Figure 11).

The stream and wetland planting plans for the offset areas at both the Drury and Tuakau sites will provide additional details of the restoration and enhancement activities, including species compositions and habitat enhancements or modifications.

The restoration and enhancement of the degraded aquatic habitats will provide for a positive aquatic ecological benefit resulting in an overall net gain, with habitat creation, biodiversity gains, and restore connectivity to existing habitats and restoration habitats over extensive areas of both catchments.

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APPLICABILITY AND LIMITATIONS

Restrictions of Intended Purpose

This report has been prepared solely for the benefit of Stevenson Aggregates Limited as our client with respect to the brief. The reliance by other parties on the information or opinions contained in the report shall, without our prior review and agreement in writing, be at such party's sole risk.

Legal Interpretation

Opinions and judgements expressed herein are based on our understanding and interpretation of current regulatory standards and should not be construed as legal opinions. Where opinions or judgements are to be relied on, they should be independently verified with appropriate legal advice.

Maps and Images

All maps, plans, and figures included in this report are indicative only and are not to be used or interpreted as engineering drafts. Do not scale any of the maps, plans or figures in this report. Any information shown here on maps, plans and figures should be independently verified on site before taking any action. Sources for map and plan compositions include LINZ Data and Map Services and local council GIS services. For further details regarding any maps, plans or figures in this report, please contact Bioresearches.

Appendix A Drury Quarry – Sutton Block Stream Characteristics at SEV sites

Habitat Parameter	Stream 1	Stream 2 Headwaters	Stream 2 Upper	Stream 3	Stream 4 Upper & mid	Stream 4 lower	Stream 5	Stream 6	Stream 7	Stream 9
Habitat Features										
Average width (m)	0.68	0.43	0.71	0.39	1.65	2.51	0.56	0.61	0.53	0.36
Average depth (m)	0.14	0.04	0.19	0.03	0.22	0.21	0.06	0.08	0.15	0.04
Dominant substrates	Gravel, silt, woody debris	Silt	Gravel, cobble, silt	Clay and silt	Bedrock, cobbles and gravel	Boulders, cobble, silt	Silt over bedrock	Silt with bedrock	Silt	Silt
Macrophyte abundance	Nil	Nil	Nil	Nil	Occasional	Rare starwort or watercress	Nil	Rare starwort or watercress	Occasional starwort	Nil
Riparian vegetation	Grass and damaged native trees	Native scrub	Native scrub in upper reach; pasture lower	Pasture	Gorse and pasture, with occasional native shrubs	Pasture with occasional gorse and pampas	Pasture and regenerating native bush	Pasture with occasional native trees	Pasture and gorse	Native scrub
Water Quality										
Date	12/10/2020	14/08/2024	12/10/2020	12/10/2020	10/11/2021	27/07/2018	10/11/2021	17/11/2021	17/11/2022	14/08/2024
Time	10:00	11:00	13:20	-	9:55	-	14:20	-	-	11:00
Temperature (oC)	13.2	-	13.1	-	15.1	-	18.1	-	-	-
Oxygen saturation (%)	87	-	97	-	86.7	-	81.2	-	-	-
Dissolved oxygen (g/m3)	9.1	-	10.1	-	8.7	-	7.86	-	-	-
Conductivity (mS/cm)	98.1	-	102	-	109.6	-	95.4	-	-	-
Macroinvertebrates										
Sampling protocol	HB	-	HB	-	HB	-	SB	HB	-	-
No. of taxa	11	-	27	-	18	-	14	15	-	-
Dominant taxon	Mayfly *Zephlebia*	-	Mayfly *Zephlebia*	-	Amphipod	-	Amphipod	Freshwater snail	-	-
EPT	5	-	17	-	2	-	2	5	-	-
%EPT*	96	-	64	-	2	-	10	3	-	-
MCI	116 'Good'	-	114 'Good'	-	73 'Poor'	-	107 'Good'	112 'Good'	-	-
SQMCI	6.92 'Excellent'	-	5.98 'Good'	-	4.57 'Fair'	-	5.64 'Good'	4.16 'Good'	-	-
Koura	Common	-	Common upstream	-	Occasional	-	-	-	-	-
Fish										
Species recorded	Nil	Nil	Shortfin & longfin eel*	Nil	Longfin eel	-	Nil	Nil	-	Nil
Number of fish	0	0	2	0	1	-	0	0	-	0
Fish IBI Score & Rating	0 'no natives'	0 'no natives'	34 'Fair'	0 'no natives'	30 'Fair'	-	0 'no natives'	0 'no natives'	-	0 'no natives'
Stream Ecological Value										
SEV Score	0.55	0.54	0.67	0.46	0.46	0.42	0.53	0.4	0.34	0.51

Appendix B Summary SEV data from Impact Sites – Current

Function category	Report section	Function	Stream Number								
			1	2HW	2up	3	4	5	6	7	9
Hydraulic	4.1	NFR	0.68	0.87	0.89	0.61	0.63	0.68	0.61	0.57	0.63
Hydraulic	4.2	FLE	0.14	0.35	0.44	0.16	0.15	0.04	0.09	0.08	0.05
Hydraulic	4.3	CSM	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hydraulic	4.4	CGW	0.79	0.84	0.93	0.77	0.74	0.71	0.74	0.77	0.85
biogeochemical	4.5	WTC	0.64	0.74	0.62	0.38	0.40	0.64	0.16	0.32	0.92
biogeochemical	4.6	DOM	1.00	0.45	1.00	0.45	0.50	1.00	0.68	0.45	0.60
biogeochemical	4.7	OMI	0.65	0.56	0.70	0.40	0.20	0.60	0.00	0.00	0.56
biogeochemical	4.8	IPR	0.84	0.96	0.94	0.46	0.64	0.72	0.64	0.56	0.60
biogeochemical	4.9	DOP	0.41	0.28	0.39	0.28	0.52	0.64	0.36	0.19	0.37
habitat provision	4.10	FSH	0.15	0.18	0.57	0.53	0.10	0.05	0.10	0.05	0.14
habitat provision	4.11	HAF	0.80	0.65	0.92	0.46	0.52	0.71	0.48	0.38	0.55
Biodiversity	4.12	FFI	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00
Biodiversity	4.13	IFI	0.45	-	0.77	-	0.34	0.55	0.74	-	-
Biodiversity	4.14	RVI	0.17	0.20	0.25	0.07	0.06	0.05	0.02	0.01	0.34
Overall mean SEV score (maximum value 1)			0.55	0.54	0.67	0.34	0.45	0.53	0.40	0.34	0.51

Appendix C Summary SEV data from Impact Sites – Potential

Function category	Report section	Function	Stream Number								
			1	2HW	2up	3	4	5	6	7	9
Hydraulic	**4.1**	**NFR**	0.68	0.87	0.89	0.69	0.68	0.68	0.63	0.61	0.63
Hydraulic	**4.2**	**FLE**	0.27	0.49	0.44	0.28	0.22	0.05	0.14	0.14	0.17
Hydraulic	**4.3**	**CSM**	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hydraulic	**4.4**	**CGW**	0.79	0.84	0.93	0.73	0.80	0.71	0.75	0.76	0.85
biogeochemical	**4.5**	**WTC**	0.64	0.82	0.62	0.56	0.58	0.70	0.54	0.48	0.92
biogeochemical	**4.6**	**DOM**	1.00	0.68	1.00	0.68	1.00	1.00	0.68	0.68	0.60
biogeochemical	**4.7**	**OMI**	0.90	0.80	0.70	0.70	0.60	0.70	0.50	0.50	0.80
biogeochemical	**4.8**	**IPR**	0.84	0.96	0.94	0.72	0.76	0.72	0.78	0.72	0.60
biogeochemical	**4.9**	**DOP**	0.45	0.33	0.39	0.32	0.52	0.64	0.42	0.27	0.41
habitat provision	**4.10**	**FSH**	0.15	0.18	0.57	0.53	0.17	0.05	0.10	0.05	0.14
habitat provision	**4.11**	**HAF**	0.80	0.73	0.92	0.58	0.64	0.79	0.64	0.57	0.64
Biodiversity	**4.12**	**FFI**									
Biodiversity	**4.13**	**IFI**									
Biodiversity	**4.14**	**RVI**	0.34	0.40	0.25	0.21	0.17	0.22	0.14	0.14	0.38
Overall mean SEV score (maximum value 1)			**0.66**	**0.67**	**0.72**	**0.58**	**0.60**	**0.60**	**0.53**	**0.49**	**0.6**

Appendix D Summary SEV data from Offset Sites – Current and Potential

Tuakau Site

Function category	Report section	Function	Western Stream Current	Western Stream Potential	Tutaenui Stream Current	Tutaenui Stream Potential
Hydraulic	**4.1**	**NFR**	0.33	0.59	0.21	0.22
Hydraulic	**4.2**	**FLE**	0.14	0.32	0.06	0.20
Hydraulic	**4.3**	**CSM**	0.30	1.00	1.00	1.00
Hydraulic	**4.4**	**CGW**	0.72	0.75	0.77	0.83
biogeochemical	**4.5**	**WTC**	0.38	0.64	0.00	0.60
biogeochemical	**4.6**	**DOM**	1.00	1.00	0.68	1.00
biogeochemical	**4.7**	**OMI**	0.16	0.70	0.04	0.55
biogeochemical	**4.8**	**IPR**	0.20	0.58	0.78	0.78
biogeochemical	**4.9**	**DOP**	0.38	0.45	0.36	0.59
habitat provision	**4.10**	**FSH**	0.10	0.31	0.50	0.50
habitat provision	**4.11**	**HAF**	0.41	0.62	0.39	0.61
Biodiversity	**4.12**	**FFI**				
Biodiversity	**4.13**	**IFI**				
Biodiversity	**4.14**	**RVI**	0.07	0.29	0.01	0.12
Overall mean SEV score (maximum value 1)			**0.35**	**0.60**	**0.40**	**0.58**

Assumptions (refer Appendix E)

1. Riparian planting to 10m either side of stream or 20m on one bank.
2. Moving fish barriers i.e. flood gate in the Western Stream.
3. Small areas of natural instream enhancements (natural rock, large wood) where erosion or bank slumping is identified as a risk to property or riparian planting.
4. Increase in ecosystem functions associated with established riparian planting i.e. up to 70% shading, increase in organic inputs, increase in filtration, decrease in macrophytes.

Appendix E Assumptions for Calculation of Potential SEV Scores

Function and Variable	Potential SEV Score – Assumptions	
	Impact Streams: Streams 1 to 9	**Off-set Streams: Tutaenui Stream and Western Stream**
Hydraulic		
Vchann	Reduction in macrophytes at Stream 4, no change at other streams.	Some naturalisation with increase in roughness (addition of rock) and riparian vegetation, removal of flood gate.
Vlining	Some decrease in silt at Stream 4, no change at other streams	No change.
Vpipe	No change.	No change.
Vbank	No change.	No change.
Vrough	Changed to reflect riparian margins, usually with regenerating indigenous vegetation and fenced, to 10m on both banks.	Changed to reflect riparian margins, with regenerating indigenous vegetation and fenced, to 10m on both banks.
Vbarr	No change.	Removal or modification of flood gate on Western Stream, no change for Tutaenui Stream.
Vchanshape	No data entry required.	No data entry required.
Biogeochemical		
Vshade	Increased to reflect potential change in riparian margins.	Increased to reflect change in riparian margins.
Vdod	Increase to at Streams 3, 4, 6 & 7, where lower. No change at other sites.	Optimal, so no change.
Vveloc	No change.	No change.
Vdepth	No change.	No change.
Vripar	Changed to reflect riparian margins 10 m on each bank.	Changed to reflect riparian margins 10 m on each bank for the western stream, and 20m on one bank on the Tutaenui Stream.
Vdecid	No change, no deciduous	Removal of occasional exotic tree, replacing with indigenous vegetation.
Vmacro	Reduction in Stream 4, 6 & 7. No change in Streams 1, 2, 3 & 5.	Slight reduction in macrophytes with increased shading
Vretain	No data entry required.	No data entry required.
Vsurf	No change.	No change (Western Stream) and increase in wood component but reduction of macrophytes.
Vripfilt	Changed to reflect riparian margins.	Changed to reflect riparian margins.
Habitat provision		
Vgalspwn	No change due to topography	No change due to topography.
Vgalqual	Increase with shading.	Increase with shading.
Vgobspawn	No data entry required	No data entry required
Vphyshab	Increase in parameters associated with riparian planting.	Increase in parameters associated with riparian planting.
Vwatqual	No change.	No change.
Vimperv	No change.	No change.
Biodiversity		
Vfish	Removed for ECR.	Removed for ECR.
Vmci	Removed for ECR.	Removed for ECR.
Vept	Removed for ECR.	Removed for ECR.
Vripcond	No data entry required.	No data entry required

Vinvert	Removed for ECR.	Removed for ECR.
Vripconn	Slight change at Stream 4. No change at other Stream (incised).	No change.

Appendix F Rolling ECR Calculations

		Impact					Compensation/Offset							ECR		Compensated	Residual			
Stream ID	Impact type	SEVi-P	SEVi-I	Length (m)	Average width (m)	Streambed area (m2)	Stream ID	Compensation method *	SEVm-P	SEVm-C	Average width (m)	Length available (m)	Steambed area available (m2)	ECR	Strembed area compensation required (,m2)	Proportion of impact reach compendated	Compensation stream bed area still available (m2)			
Stream 1a	Reclamation	0.67	0	241	0.68	163.88	Peach T1	Enhancement	0.69	0.39	0.46	148	68.08	3.35	549.00	0.12	0.0			
		0.67	0			143.56	Peach T2 up	Enhancement	0.69	0.39	0.4	130	52	3.35	480.92	0.11	0.0			
		0.67	0			128.04	Peach T2 dc	Enhancement	0.79	0.59	0.39	34	13.26	5.03	643.38	0.02	0.0			
		0.67	0			125.40	Peach T3	Enhancement	0.69	0.39	0.41	290	118.9	3.35	420.08	0.28	0.0			
		0.67	0			89.90	Davies Up	Enhancement	0.72	0.44	1.46	300	438	3.59	322.69	1.36	115.3			
Stream 1b	Reclamation	0.49	0	74	0.5	37.00	Davies Up	Enhancement	0.72	0.44	1.46		115.3	2.63	97.13	1.19	18.2			
Stream 2 HW	Reclamation	0.67	0	367	0.43	157.81	Davies Up	Enhancement	0.72	0.44	1.46		18.2	3.59	566.43	0.03	0.0			
		0.67	0			152.74	Davies Dn	Enhancement	0.66	0.39	1.86	150	279	3.72	568.55	0.49	0.0			
		0.67	0			77.79	WestTrib	Enhancement	0.6	0.35	3.92	740	2901	4.02	312.71	9.28	2588.1			
Stream 2 Up Int	Reclamation	0.72	0	162	0.39	63.18	WestTrib	Enhancement	0.6	0.35	3.92		2588.1	4.32	272.94	9.48	2315.2			
Stream 2 Up Perm	Reclamation	0.72	0	114	0.4	45.6	WestTrib	Enhancement	0.6	0.35	3.92		2315.2	4.32	196.99	11.75	2118.2			
Stream 2b	Reclamation	0.6	0	241	0.28	67.48	WestTrib	Enhancement	0.6	0.35	3.92		2118.2	3.60	242.93	8.72	1875.2			
Stream 5	Reclamation	0.6	0	452	0.56	253.12	WestTrib	Enhancement	0.6	0.35	3.92		1875.2	3.60	911.23	2.06	964.0			
Stream 6 - HW	Reclamation	0.49	0	207	0.3	62.10	WestTrib	Enhancement	0.6	0.35	3.92		964.0	2.94	182.57	5.28	781.4			
Stream 6 - Lower	Reclamation	0.53	0	257	0.6	154.20	WestTrib	Enhancement	0.6	0.35	3.92		781.4	3.18	490.36	1.59	291.1			
Stream 6 - East	Reclamation	0.49	0	487	0.25	121.75	WestTrib	Enhancement	0.6	0.35	3.92		291.1	2.94	357.95	0.81	0.0			
		0.49	0			22.75	Tutanui	Enhancement	0.58	0.4	8.4	2300	19320	4.08	92.88	208.01	19227.1			
Stream 6 -West	Reclamation	0.49	0	92	0.15	13.80	Tutanui	Enhancement	0.58	0.4	8.4		19227.1	4.08	56.35	341.21	19170.8			
Stream 7 - upper	Reclamation	0.49	0	292	0.53	154.76	Tutanui	Enhancement	0.58	0.4	8.4		19170.8	4.08	631.94	30.34	18538.8			
Stream 7 - lower	Reclamation	0.53	0	270	1.38	372.60	Tutanui	Enhancement	0.58	0.4	8.4		18538.8	4.42	1645.65	11.27	16893.2			
Stream 9	Reclamation	0.6	0	85	0.36	30.60	Tutanui	Enhancement	0.58	0.4	8.4		16893.2	5.00	153.00	110.41	16740.2			
				3341		1698							1992.9	m remaining to use on the Tutanui			Bed Area			
												237	**m**	**of the Tutanui used for offset**			1993	m2		
												977	m	total offset at Tuakau Site			4894	m2		
												1052	m	Total offset at Drury Quarry			969.24	m2		
												2029	m	is total offset length						
											Total loss	1312	m	Additional length required						
											Therefo	**1549**	**m**	**is total required on Tutanui**			13012			
											Therefore	751	m	is length still available on Tutanui						
																	16882	m2 total offset area		
																1:	9.9	ratio of loss to offset bed area.		

Appendix G Offset Wetland Species Lists – Current and Proposed

Table 19. Vegetation identified within the proposed offset wetland at the Tuakau Site

Scientific name	Common name	Threat classification (de Lange *et al.*, 2017)	Rating (Clarkson *et al.*, 2021)
Agrostis stolonifera	Creeping bent	Exotic	FACW
Paspalum dilatatum	Paspalum	Exotic	FACU
Paspalum distichum	Mercer grass	Exotic	FACW
Persicaria hydropiper	Water pepper	Exotic	FACW
Dacrycarpus dacrydioides	Kahikatea, White pine	Endemic	FAC
Alnus glutinosa	Alder	Exotic	FACW
Juncus articulatus	Jointed rush	Exotic	FACW
Juncus edgariae	Wīwī	Endemic	FACW
Juncus effusus	Soft rush	Exotic	FACW
Ranunculus repens	Creeping buttercup	Exotic	FAC
Ranunculus flammula	Spearwort	Exotic	FACW
Glyceria maxima	Reed sweetgrass	Exotic	OBL
Cenchrus clandestinus	Kikuyu	Exotic	FACU
Callitriche stagnalis	Starwort	Exotic	OBL
Rumex obtusifolius	Broad-leaved dock	Exotic	FAC
Plantago lanceolata	Narrow-leaved plantain	Exotic	FACU
Trifolium repens	White clover	Exotic	FACU
Stenotaphrum secundatum	Buffalo grass	Exotic	Not Rated
Prunella vulgaris	Self-heal	Exotic	FACU
Totals	**Native species richness**	**2**	
	Total species richness	**19**	
	Percent native species	**10.5**	

Table 20. Vegetation identified within Wetland 1.

Scientific name	Common name	Threat classification (de Lange *et al.*, 2017)	Rating (Clarkson *et al.*, 2021)
Agrostis stolonifera	Creeping bent	Exotic	FACW
Anthoxanthum odoratum	Sweet vernal	Exotic	FACU
Eleocharis acuta	Sharp spike sedge	Non-Endemic	OBL
Helosciadium nodiflorum	Water celery	Exotic	OBL
Isolepis levynsiana	Tiny flatsedge	Exotic	FAC
Isolepis sepulcralis	-	Exotic	FAC
Juncus articulatus	Jointed rush	Exotic	FACW
Juncus edgariae	Wīwī	Endemic	FACW
Juncus effusus* var. *compactus	Soft rush	Exotic	OBL
Juncus effusus* var. *effusus	Soft rush	Exotic	FACW
Lotus pedunculatus	Lotus	Exotic	FAC
Ludwigia palustris	Water purslane	Exotic	OBL
Paesia scaberula	Ring fern	Endemic	FACU
Parablechnum novae-zelandiae	Kiokio	Endemic	FAC
Paspalum dilatatum	Paspalum	Exotic	FACU

Paspalum distichum	Mercer grass	Exotic	FACW
Ranunculus flammula	Spearwort	Exotic	FACW
Ranunculus repens	Creeping buttercup	Exotic	FAC
Trifolium repens	White clover	Exotic	FACU
Ulex europaeus	Gorse	Exotic	FACU
Totals	**Native species richness**	**4**	
	Total species richness	**20**	
	Percent native species	**20**	

Table 21. Vegetation identified within Wetland 2a.

Scientific name	Common name	Threat classification (de Lange *et al.*, 2017)	Rating (Clarkson *et al.*, 2021)
Agrostis stolonifera	Creeping bent	Exotic	FACW
Anthoxanthum odoratum	Sweet vernal	Exotic	FACU
Callitriche stagnalis	Starwort	Exotic	OBL
Carex virgata	Swamp sedge	Endemic	FACW
Eleocharis acuta	Sharp spike sedge	Non-Endemic	OBL
Glyceria declinata	Glaucous sweetgrass	Exotic	OBL
Helosciadium nodiflorum	Water celery	Exotic	OBL
Isolepis levynsiana	Tiny flatsedge	Exotic	FAC
Isolepis sepulcralis	-	Exotic	FAC
Juncus articulatus	Jointed rush	Exotic	FACW
Juncus edgariae	Wīwī	Endemic	FACW
Juncus effusus* var. *compactus	Soft rush	Exotic	OBL
Juncus effusus* var. *effusus	Soft rush	Exotic	FACW
Lotus pedunculatus	Lotus	Exotic	FAC
Ludwigia palustris	Water purslane	Exotic	OBL
Myosotis laxa	Water forget-me-not	Exotic	OBL
Paesia scaberula	Ring fern	Endemic	FACU
Parablechnum novae-zelandiae	Kiokio	Endemic	FAC
Paspalum dilatatum	Paspalum	Exotic	FACU
Paspalum distichum	Mercer grass	Exotic	FACW
Ranunculus flammula	Spearwort	Exotic	FACW
Ranunculus repens	Creeping buttercup	Exotic	FAC
Trifolium repens	White clover	Exotic	FACU
Typha orientalis	Raupō	Non-Endemic	OBL
Ulex europaeus	Gorse	Exotic	FACU
Totals	**Native species richness**	**6**	
	Total species richness	**25**	
	Percent native species	**24**	

Table 22. Vegetation identified within Wetland 2b.

Scientific name	Common name	Threat classification (de Lange *et al.*, 2017)	Rating (Clarkson *et al.*, 2021)
Agrostis stolonifera	Creeping bent	Exotic	FACW
Anthoxanthum odoratum	Sweet vernal	Exotic	FACU
Callitriche stagnalis	Starwort	Exotic	OBL
Eleocharis acuta	Sharp spike sedge	Non-Endemic	OBL
Glyceria declinata	Glaucous sweetgrass	Exotic	OBL

Isolepis levynsiana	Tiny flatsedge	Exotic	FAC
Isolepis sepulcralis	-	Exotic	FAC
Juncus articulatus	Jointed rush	Exotic	FACW
Juncus edgariae	Wīwī	Endemic	FACW
Juncus effusus* var. *compactus	Soft rush	Exotic	OBL
Juncus effusus* var. *effusus	Soft rush	Exotic	FACW
Lotus pedunculatus	Lotus	Exotic	FAC
Ludwigia palustris	Water purslane	Exotic	OBL
Parablechnum novae-zelandiae	Kiokio	Endemic	FAC
Paspalum dilatatum	Paspalum	Exotic	FACU
Paspalum distichum	Mercer grass	Exotic	FACW
Ranunculus flammula	Spearwort	Exotic	FACW
Ranunculus repens	Creeping buttercup	Exotic	FAC
Rubus fruticosus	Blackberry	Exotic	FAC
Trifolium repens	White clover	Exotic	FACU
Ulex europaeus	Gorse	Exotic	FACU
Totals	**Native species richness**	**3**	
	Total species richness	**21**	
	Percent native species	**14.3**	

Table 23. Vegetation identified within Wetland 3.

Scientific name	Common name	Threat classification (de Lange *et al.*, 2017)	Rating (Clarkson *et al.*, 2021)
Anthoxanthum odoratum	Sweet vernal	Exotic	FACU
Carex virgata	Swamp sedge	Endemic	FACW
Eleocharis acuta	Sharp spike sedge	Non-Endemic	OBL
Helosciadium nodiflorum	Water celery	Exotic	OBL
Holcus lanatus	Yorkshire fog	Exotic	FAC
Isolepis sepulcralis	-	Exotic	FAC
Juncus articulatus	Jointed rush	Exotic	FACW
Juncus edgariae	Wīwī	Endemic	FACW
Juncus effusus* var. *effusus	Soft rush	Exotic	FACW
Ludwigia palustris	Water purslane	Exotic	OBL
Myosotis laxa	Water forget-me-not	Exotic	OBL
Paesia scaberula	Ring fern	Endemic	FACU
Persicaria hydropiper	Water pepper	Exotic	FACW
Ranunculus flammula	Spearwort	Exotic	FACW
Ranunculus repens	Creeping buttercup	Exotic	FAC
Ulex europaeus	Gorse	Exotic	FACU
Totals	**Native species richness**	**4**	
	Total species richness	**16**	
	Percent native species	**25**	

Table 24. Vegetation identified within Wetland 6.

Scientific name	Common name	Threat classification (de Lange *et al.*, 2017)	Rating (Clarkson *et al.*, 2021)
Agrostis stolonifera	Creeping bent	Exotic	FACW
Anthoxanthum odoratum	Sweet vernal	Exotic	FACU
Juncus articulatus	Jointed rush	Exotic	FACW

Juncus edgariae	Wīwī	Endemic	FACW
Juncus effusus* var. *effusus	Soft rush	Exotic	FACW
Lotus pedunculatus	Lotus	Exotic	FAC
Paspalum dilatatum	Paspalum	Exotic	FACU
Ranunculus repens	Creeping buttercup	Exotic	FAC
Totals	**Native species richness**	**1**	
	Total species richness	**8**	
	Percent native species	**12.5**	

Table 25. Vegetation identified within Wetland 7.

Scientific name	Common name	Threat classification (de Lange *et al.*, 2017)	Rating (Clarkson *et al.*, 2021)
Agrostis stolonifera	Creeping bent	Exotic	FACW
Anthoxanthum odoratum	Sweet vernal	Exotic	FACU
Holcus lanatus	Yorkshire fog	Exotic	FAC
Isolepis levynsiana	Tiny flatsedge	Exotic	FAC
Isolepis sepulcralis	-	Exotic	FAC
Juncus articulatus	Jointed rush	Exotic	FACW
Juncus edgariae	Wīwī	Endemic	FACW
Juncus effusus* var. *effusus	Soft rush	Exotic	FACW
Lotus pedunculatus	Lotus	Exotic	FAC
Paspalum dilatatum	Paspalum	Exotic	FACU
Paspalum distichum	Mercer grass	Exotic	FACW
Persicaria hydropiper	Water pepper	Exotic	FACW
Ranunculus repens	Creeping buttercup	Exotic	FAC
Totals	**Native species richness**	**1**	
	Total species richness	**13**	
	Percent native species	**7.7**	

Table 26. Vegetation identified within Wetland 8.

Scientific name	Common name	Threat classification (de Lange *et al.*, 2017)	Rating (Clarkson *et al.*, 2021)
Agrostis stolonifera	Creeping bent	Exotic	FACW
Carex gaudichaudiana	Gaudichaud's sedge	Non-Endemic	OBL
Carex virgata	Swamp sedge	Endemic	FACW
Deparia petersenii	Japanese lady fern	Non-Endemic	FAC
Diplazium australe	-	Non-Endemic	FACU
Galium palustre	Marsh bedstraw	Exotic	OBL
Holcus lanatus	Yorkshire fog	Exotic	FAC
Juncus articulatus	Jointed rush	Exotic	FACW
Lotus pedunculatus	Lotus	Exotic	FAC
Myosotis laxa	Water forget-me-not	Exotic	OBL
Parablechnum novae-zelandiae	Kiokio	Endemic	FAC
Ranunculus repens	Creeping buttercup	Exotic	FAC
Rumex obtusifolius	Broad-leaved dock	Exotic	FAC
Sonchus asper	Prickly sow thistle	Exotic	FACU
Totals	**Native species richness**	**4**	
	Total species richness	**14**	
	Percent native species	**28.6**	

Table 27. Vegetation identified within Wetland 9

Scientific name	Common name	Threat classification (de Lange *et al*., 2017)	Rating (Clarkson *et al*., 2021)
Callitriche stagnalis	Starwort	Endemic	OBL
Carex virgata	Swamp sedge	Endemic	FACW
Holcus lanatus	Yorkshire fog	Exotic	FAC
Juncus effusus* var. *effusus	Soft rush	Exotic	FACW
Lolium perenne	Perennial ryegrass	Exotic	FACU
Lotus pedunculatus	Lotus	Exotic	FAC
Ranunculus repens	Creeping buttercup	Exotic	FAC
Totals	**Native species richness**	**2**	
	Total species richness	**7**	
	Percent native species	**28.6**	

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