REPORT

Tonkin+Taylor

DRAFT Off-Site Stream Compensation Plan

Auckland Regional Landfill

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18/12/19	1	Draft OSSCP for consent application	A Wong J Quinn	J Markham	S Eldridge

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Glossary

Specific terms	
AEcE	Assessment of Aquatic and Terrestrial Ecological Values and Effects Report, Tonkin + Taylor, 2019 (Technical Report G, consent applications 30/5/19)
AUP OP	Auckland Unitary Plan (Operative in Part)
BEO	Base Ecological Option
CEMP	Construction Environmental Management Plan
DOC	Department of Conservation
EERP	Ecological Enhancement and Restoration Plan
EGM	Ecological Gains Matrix
NSMA	Natural Stream Management Areas identified in the AUP OP
SCWP	Stream compensation works compliance plan
SEA	Significant Ecological Areas identified in the Auckland AUP OP
SEV	Stream Ecological Valuation
VCMP	Vegetation Clearance Management Plan
General terms	
Auckland Regional Landfill or ARL	Project name, encompassing the landfill itself as well as all ancillary activities within the WMNZ landholdings.
Landfill footprint	The area (plan area) occupied by the landfill which has a lining system onto which waste is placed.
NPS	National Policy Statement
Project footprint	The area that includes the Landfill footprint and also includes those areas outside the Landfill footprint but within the WMNZ landholdings where ancillary activities are proposed to occur
Waste Management NZ Limited or WMNZ	Company name of applicant.
WMNZ landholdings	The entire landholdings secured by WMNZ at Wayby Valley.

1 Introduction

1.1 Background

This draft Offsite Stream Compensation Plan has been prepared to support Waste Management NZ Ltd's (WMNZ) application for resource consents for the construction and operation of a new regional landfill facility on WMNZ landholdings, between Warkworth and Wellsford. The WMNZ landholdings are located near the Wayby Valley, adjacent to State Highway 1 (SH1) 13 km northwest of Warkworth, within the Rodney Ecological District in the northern part of the Auckland region (see Appendix A, Figure 1). The Auckland Regional Landfill (ARL) landfill footprint will be located within a pine forested valley, and ARL project footprint will include an access road, a bin exchange area, several smaller access roads and ancillary activities (such as office buildings), stockpiles, a clay borrow pit, and erosion and sediment controls (e.g., stormwater and sediment ponds and wetlands). The proposed landfill is described in detail in the Assessment of Environmental Effects (AEE) Report (May 2019).

These project activities are expected to have a range of effects on aquatic ecological values on the WMNZ landholdings and these effects are described in the Assessment of Aquatic and Terrestrial Ecological Values and Effects Report (AEcE) (Tonkin + Taylor, 2019) that accompanied the resource consent application (Resource Consent Application, Volume 2, Technical Report G).

A suite of Ecological Management Plans collectively sets out the procedures for addressing adverse ecological effects associated with the landfill through proposed conditions provided in the resource consent application. These plans also set out monitoring and the review process to be undertaken both pre and post construction with the individual monitoring requirements described in the individual management plans. The collective objective of these draft plans is to set out the proposed range of measures to avoid, remedy, mitigate, offset or compensate for effects on ecological values.

1.2 Plan purpose and draft consent condition scope

1.2.1 Stream loss

This Off-Site Stream Compensation Plan (OSSCP) sets out the methods that will be used to address residual adverse effects of stream loss as a result of the development of the ARL.

1.2.2 Consent conditions

The OSSCP has been developed in accordance with and to satisfy the proposed Auckland Regional Landfill consent conditions (Consent application number BUN60339589).

These consent conditions will be addressed through the implementation, monitoring, and reporting procedures set out in this OSSCP.

1.3 Roles and responsibilities

The implementation of the OSSCP will be the responsibility of WMNZ. It will be implemented under the supervision of the lead freshwater project ecologist and in consultation with design engineer and site engineer, and landscape contractors as required.

WMNZ will be responsible for seeking landowner permission and agreement to implement the OSSCP which involves work on land outside WMNZ landholdings. WMNZ will undertake consultation with mana whenua, community representatives, and landowners (where applicable) to obtain access to the required and agreed 20-year average annual 1.5 km of stream length for enhancement and restoration purposes.

1.4 Process for informing landowners in the Hōteo catchment

Placeholder to address proposed condition - Process for informing landowners within the Hōteo Catchment, including criteria for selection and the establishment of a group comprising mana whenua and community representatives and land-owners to provide suggestions on restoration sites. To be developed through consent process.

1.5 Plan structure

The OSSCP is set out as follows:

- Section 1 – Introduction (this section);
- Section 2 – Ecological Gains Matrix;
- Section 3 – Offsetting principles;
- Section 4 – Additional compensation measures
- Section 5 - Monitoring and reporting requirements.

2 Ecological gains matrix (EGM)

2.1 Offset requirement

This OSSCP presents an overall offset and compensation package to address residual effects of stream loss as a result of the development of the ARL. WMNZ has committed to enhancing three times the stream length impacted by the project. This equates to up to 46.2 km of stream enhancement over the life of the project, at an average of 1.5 km per year, of which a portion will take place off the WMNZ landholdings as described below. The total impact length may decrease if further modifications to the footprint can be made.

Biodiversity offsetting is an action to address significant residual adverse effects of development and should only be used after steps to avoid, remedy, or mitigate have sequentially been exhausted. Biodiversity offsetting requires adhering to principles and use of accounting currencies to balance losses and gains; so that no-net-loss or net-gain objectives can be demonstrated with transparency. Biodiversity offsetting is based on and requires a series of widely accepted principles that illustrate the level of rigour required and that differentiate offsetting from environmental compensation[1].

Compensation is the last tier in the mitigation hierarchy. Compensation is not a form of offsetting and does not require that no net loss is achieved. The proposed compensation measures outlined in the following section are considered to be in general accordance with many of the principles of offsetting (detailed further in Section 3).

As detailed within the AEcE, 3.5 km of stream loss will be offset within the WMNZ landholdings and is detailed in the Ecological Enhancement and Restoration Plan (EERP). These offset enhancement activities within the WMNZ landholdings will be commenced at an early stage.

A further 10.5 km of stream within WMNZ landholdings is proposed to be enhanced (refer to Table 4.22 AEcE) to contribute to the stream compensation package. The details of this enhancement are included in the EERP. Taking into account the 14 km of stream being enhanced within the WMNZ landholdings, a further 32.2 km of stream enhancement is required to be undertaken outside of WMNZ landholdings to meet the overall required maximum length of 46.2 km.

2.2 Biodiversity offsetting principles

This proposed OSSCP has been developed in general accordance with principles of offsetting outlined within best practice guidance[2]. While this OSSCP does not aim to provide for a 'no-net-loss' of ecological function via a robust and transparent accounting framework, it does adopt other widely accepted biodiversity offsetting principles. The key principles that are incorporated into this OSSCP are described in Table 2.1.

[1] Maseyk, F., Ussher, G., Kessels, G., Christensen, M., and Brown, M. (2018). Biodiversity offsetting under the Resource Management Act: a guidance document.

[2] New Zealand government Guidance on Good Practice Biodiversity Offsetting in New Zealand (DOC, 2014), Biodiversity Offsetting under the Resource Management Act (Maseyk et al, 2018), and Policy E3.3.(4) and Appendix 8 of the AUP OP. Department of Conservation (2014). Guidance on good practice biodiversity offsetting in New Zealand.

Table 2.1: Biodiversity offsetting principles considered and utilised in the EGM.

Principle	Definition for offsetting	Incorporation and adoption into compensation package
Additionality	Achieving biodiversity outcomes above results that would have occurred if the offset had not taken place. To demonstrate additionality, the change in biodiversity value must be evaluated under both a 'with offset' and a 'without offset' scenario to calculate the amount of additional gain that can be accounted towards offset action(s).	All proposed enhancement and restoration actions will be additional to what is otherwise required.
Ecological equivalence - 'like for like'	Evaluation and comparison of the same ecosystems, vegetation, habitats, and species existing in them. Exchanging the same type of biodiversity to determine and quantum the required offset to achieve 'no-net-loss' or 'net-gain'.	Exchanging like for like along a continuum of similar aquatic ecosystems:1) aquatic habitat type (i.e. exchanging stream loss for stream enhancement); 2) the average width of streams being enhanced is comparable to those impacted; and 3) characteristics (i.e. stream classification).
Proximity	Nearby impact and offset sites are more likely to contain similar biodiversity features (e.g. in the same ecological district, catchment, or other natural boundary).	WMNZ will confirm location of stream enhancement, however the objective is to identify sites in the following order of preference – within the precinct, within the Hōteo River catchment, within the Kaipara Harbour catchment, and within the Auckland Region. The aim is to carry out offsite stream compensation within the same ecological district, close to the Project area, where this will result in the best ecological outcome.
Long-term outcome/permanence	Design and implementation of a biodiversity offset should be based on securing ecological outcomes that last at least as long as the project's impacts and, preferably, in perpetuity.	WMNZ is committed to providing protection of plantings through covenants or other similar mechanisms.
Time lag	Temporal discrepancies between when biodiversity is lost and when biodiversity gains are fully delivered.	WMNZ is committed to enhancing no less than 1.5 km of stream per year.
Biodiversity and ecosystem function improvement	Demonstrable improvement in the ecological values at the site proposed as an offset.	The ecological benefits associated with each of the proposed enhancement activities and BEO are described within this OSSCP.

2.3 Purpose of EGM

As the proposed compensation sites are as yet unknown and to provide certainty regarding the ecological benefits an Ecological Gains Matrix (EGM) has been developed to provide a toolbox approach to address residual effects (Table 2.2).

The intention of the EGM is to provide WMNZ a range of compensatory activities to achieve ecological enhancement of stream ecosystems within the Hōteo River catchment. The following enhancement actions and benefits can be anticipated:

- Riparian restoration;
- Fencing for stock exclusion;
- Legal protection;
- Weed and animal control and maintenance for defined periods;
- Remediation of barriers to fish passage;
- Daylighting culverted streams;
- Online wetland enhancement;
- Improved biodiversity of riparian margins;
- In-stream habitat enhancement to increase habitat heterogeneity;
- Provision of stepping stones or improved corridors for fauna movement;
- Connectivity with existing areas of ecological value;
- Catchment scale enhancement.

The EGM provides a selection of base enhancement options (BEO) with associated multipliers (Table 2.2). The multiplier recognises the quantum of ecological benefit gained from that specific BEO in relation to the stream length lost.

Additional 'enhancement activities' are actions that promote greater ecological outcomes on top of each BEO (Table 2.3). Each additional enhancement activity has an associated value that is added to each BEO multiplier as appropriate.

By way of example:

- BEO 2 requires between 10 and 19 m riparian planting (with fencing and protection) and is considered the minimum standard of enhancement. This has a multiplier of 1.
- Every 1 km of this type of enhancement will be equivalent to 1 km of compensation length required to be provided.
- If the 1 km of planting is adjacent to existing protected areas, in a headwater catchment or creates connectivity with wider ecological landscape features, the multiplier would increase from 1 to 1.2. In this scenario, this enhancement package would be equivalent to 1.2 km of compensation length required to be provided.

As the potential compensation sites are as yet unknown and to be confirmed, an enhancement plan will be developed for each compensation site. Each enhancement plan will confirm the enhancement actions proposed to be undertaken and details of the associated multipliers and length of compensation achieved.

It is intended that a minimum of 80% of the compensation length required will be provided by BEO 1, 2, 3, 4 or 5. These BEOs are considered to be relatively easy to implement and give a high likelihood of demonstrable ecological improvement.

Two example case studies are provided in Appendix A.

Table 2.2: Ecological Gains Matrix – Base Enhancement Options

		Enhancement Activities	Riparian margin width			Vegetation	Permanent, stock proof fencing		Protection by covenant	Weed & Pest Control [3]	Barriers to fish passage		
			≥ 20 m	10 19 m	5 - 9 m	Native planting	Yes	No	Yes	Yes	Remediation of all barriers	Remediation but a partial barrier may remain	Multiplier for each enhancement activity
Base Enhancement Options	BEO 1	Riparian planting with extra wide margins (≥ 20 m). Considered to provide a higher level of ecological benefit.	✓			✓	✓		✓	✓	✓		1.05
	BEO2	Riparian planting with wide margins (19 – 10 m). Considered to provide a high level of ecological benefit.		✓		✓	✓		✓	✓		✓	1
	BEO 3	Riparian planting with narrow margins (9 – 5 m). Considered to provide a high level of ecological benefit for streams of <1 m wide, and a moderate level of benefit for streams > 1m wide.			✓	✓	✓		✓	✓		✓	0.95
	BEO 4	Wetland enhancement where the wetland may be infill planted but the key driver is the creation of a riparian margin. The multiplier applies to the entire area subject to enhancement including the wetland and riparian buffer. In this case, 10 m^2 of wetland enhancement equates to 1 m of compensation length required.		✓		✓	✓		✓	✓			0.1
	BEO 5	Daylighting or culvert removal and reinstatement of natural channel with riparian enhancement.	✓	✓	✓	✓	✓		✓	✓	✓		1.5
	BEO 6	No riparian planting proposed, but the margins will be fenced and with protection by covenant.					✓		✓				0.6
	BEO 7	Within existing areas of riparian vegetation that are subject to a partial level of protection (for example, forestry margins or significant ecological area) this will provide protection by way of covenant on title.						✓	✓				0.2

Table 2.3: Ecological Gains Matrix – Additional Enhancement Activities - additions to the multiplier in Table 3.1.

		Activities	Additional multiplier
Additional enhancement activities	AEA 1	Addition of instream habitat features (for example but not limited to woody debris and cobbles).	+0.1
	AEA 2	Enhancement of riparian margins that provides catchment scale benefits by way of: • Being more than 1 km of continuous enhancement activity; • Enhancement of a headwater catchment; and • Enhancement of riparian margins adjacent to existing protected or vegetated areas.	+0.2
	AEA 3	Enhancement activity is limited to infill planting an existing vegetated margin with >50% cover.	-0.1

[3] Weed and pest control for a defined period.

2.4 Compensation site selection

This EGM focuses on the long-term outcomes expected to be achieved under best practice management. Because our focus is on the gains proposed, the inherent current value of a stream is not required to be quantified.

To achieve greater ecological benefits, degraded streams at a catchment-level scale will be preferred and prioritised for enhancement and restoration actions. Degraded stream systems, for instance, are characteristic of rural catchments with unrestricted stock-access and minimal existing riparian vegetation or overgrown with exotic weed or pest plant species.

Maximum stream widths have been applied to our EGM to acknowledge movement along the continuum of the 'like-for-like' offsetting principle.

2.5 Base enhancement options

The following section outlines the expected standard for the BEO components as outlined within Table 2.2.

2.5.1 Riparian planting

2.5.1.1 Width

The role of riparian vegetation is pivotal to maintaining stream ecosystem functions. Riparian vegetation, depending on the width and composition, can contribute to[4][5][6]:

- Reducing stream temperature fluctuations by providing shade vital for aquatic fauna survival and to suppress the growth of macrophytes (oxygen-demanding),
- Influencing the hydraulic energy input into the stream (controlling the amount and fluctuations),
- Influencing the chemical energy input and transfer (tree root and woody material interaction),
- Stream bank and channel stability,
- Maintaining water quality by reducing nutrient and sediment inputs (riparian vegetation filtering of surface water runoff),
- Providing instream habitat for aquatic fauna (i.e. fallen large woody material and tree root) as well as terrestrial fauna (e.g. birds, lizards, insects, bats etc),

Riparian zone width plays an important role in supporting a self-sustaining and weed suppressing margin. TP 148[7] outlines three recommended width buffers based on relative stream width.

- A 5-6 m buffer is recommended only for narrow streams and dense planting is encouraged.
- A 10 m buffer allows for of native regeneration and succession, however the outer edges of the riparian vegetation would likely experience edge effects and established weeds may spread where canopy gaps occur.

[4]Holmes, R., Hayes, J., Matthaei, C., Closs, G., Williams, M., and Goodwin, E. (2016). Riparian management affects instream habitat condition in a dairy stream catchment. New Zealand Journal of Marine and Freshwater Research 50 (4), 581 – 599

[5] Parkyn, S., Shaw, W., and Eades, P. (2000). Review of information on riparian buffer widths necessary to support sustainable vegetation and meet aquatic functions. Prepared by NIWA for Auckland Regional Council. Auckland Regional Council Technical Publication Number 350, 38 pages

[6] Quinn, J. M., Williamson, R. B., Smith, R. K., and Vickers, M. L. (1992). Effects of riparian grazing and channelization of streams in Southland, New Zealand. 2. Benthic invertebrates. New Zealand Journal of Marine and Freshwater Research 26, 259 – 273

[7] Auckland Regional Council (2001). Strategy guideline, planting guide riparian zone management. Technical Publication 148.

- A 15-20 m buffer is recommended to support a self-sustaining native margin and the buffer is wide enough to suppress the spread of weed growth.

Notwithstanding width of the stream, narrow riparian margins can still provide shade, woody debris, habitat and localised bank stabilisation. However wider margins are more effective at reducing nutrient inputs to stream channels in rural catchments[4].

In keeping with these recommendations and ecological benefits, our EGM categorises riparian margin widths into three base levels, each considered to contribute to an improved aquatic system:

- BEO 1 will comprise a riparian buffer of ≥ 20 m and have a multiplier of 1.05.
- BEO 2 will comprise a riparian buffer of 10 – 19 m and have a multiplier of 1; and
- BEO 3 will comprise a riparian buffer of 5 – 9 m and have a multiplier of 0.95.

In the SEV methodology, buffer widths of greater than 5x channel width have been recognised to provide very high filtering capacity of overland run-off. Therefore, in a scenario where a buffer width of 5 – 9 m, under the BEO 3 compensation package, is more than five times wider than the channel width of the enhancement stream, it will count as a BEO 2 compensation package and subsequently adopt a multiplier of 1.

A stream channel is defined by the distinguished transition between the bed and bank and is in accordance with the definitions provided in Chapter J of the AUP OP.

2.5.1.2 Riparian composition

The composition of the riparian margin is important as it links stream and terrestrial systems through the contribution of woody debris, nutrient transfer, root zone connectivity, and overhanging plants to support native fish spawning habitat. In the SEV methodology, mature native vegetation is considered to have higher ecological value than most other vegetation complexes.

Riparian planting considered under each of the BEO will consist of native nursery crop species such as kānuka and mānuka scrub in the first instance. Supplementary native canopy tree mix species will be included to direct and drive long-term successional trajectories to reflect nearby Significant Ecological Areas (SEA) and terrestrial biodiversity features of the current or historic landscape. To encourage planting success and survival, plant species will be eco-sourced from the Rodney Ecological District.

SEAs in the wider Hōteo catchment include critically endangered vegetation types WF7 (puriri forest) and WF8 (kahikatea, pukatea forest) and an endangered vegetation type WF11 (kauri, podocarp, broadleaved forest)[8].

Due to individual site requirements, final compensation planting specifications will be developed on a site by site basis. Opportunities for mana whenua participation in species selection will be provided. However, as a starting point we have provided a list of species, densities, and spacings that would form the basis of a self-sustaining riparian margin in Table 2.3.

[8] Singers, N., Osborne, B., Lovegrove, T., Jamieson, A., Boow, J., Sawyer, J., Hill, K., Andrews, J., Hill, S., and Webb, C. (2017). Indigenous terrestrial and wetland ecosystems of Auckland. Auckland Council

Table 2.4: Stream compensation planting species and specifications (non-exhaustive list and are subject to change on a site by site basis).

Riparian margin zone	Structural category	Common name	Scientific name	Initial or Enrichment	Plant grade	Approximate Spacing (m)	Densities (%)
Lower bank	Clump forms	Purei	*Carex secta*	Initial	0.5 L	0.5	80
		Purei	*Carex virgata*				
		Tussock sedge	*Carex geminata*				
		Giant umbrella sedge	*Cyperus ustulatus*				
	Ferns	Mamaku	*Cyathea medullaris*	Initial	PB3	0.5	20
		Wheki	*Dicksonia squarrosa*				
		Kiokio	*Blechnum novae-zelandiae*				
Upper bank	Shrubs	Manuka	*Leptospermum scoparium*	Initial	PB3	1	70
		Kanuka	*Kunzea ericoides*				
		Ti kouka	*Cordyline australis*				
		Mahoe	*Melicytus ramiflorus*				
		Mapou	*Myrsine australis*				
		Harakeke	*Phormium tenax*				
		Kaikomako	*Pennantia corymbosa*				
		Koromiko	*Hebe salicifolia*				
		Pate	*Schefflera digitata*				
	Sub-canopy Trees	Titoki	*Alectryon excelsus*	Enrichment	PB3	2	15
		Karaka	*Corynocarpus laevigatus*				
		Miro	*Prumnopitys ferruginea*				
		Hinau	*Elaeocarpus dentatus*				
	Canopy Trees	Pukatea	*Laurelia novae-zelandiae*	Enrichment	PB5	5	15
		Kahikatea	*Dacrycarpus dacrydioides*				
		Taraire	*Beilschmiedia tarairi*				
		Rewarewa	*Knightia excelsa*				
		Puriri	*Vitex lucens*				

		Kohekohe	*Dysoxylum spectabile*				
		Rimu	*Dacrydium cupressinum*				

2.5.2 Wetland enhancement

Enhancement of wetlands will have positive aquatic outcomes due to their vital role in improving water quality, flood control, sediment and runoff trapping, as well as providing habitat for some aquatic fauna.

Recognising that there are dissimilarities between wetland and stream ecosystems, there are benefits to aquatic systems from wetland restoration particularly where wetland and stream systems interact. Therefore, wetland enhancement is appropriate to contribute to a compensation package and will have a multiplier of 0.1. For clarity, for every 10 m^2 wetland enhancement will be considered equivalent to 1 m (lineal metre) of compensation required to be provided.

The BEO 4 wetland enhancement package will include infill planting of the wetland area as well as wetland riparian buffer planting (consistent with the recommendations within Section 3.2.1). Buffer widths will be developed on a site by site basis due to site-specific conditions, however a width of 15 m is considered to be sufficient to protect wetlands[9][10]. A list of species and general specifications that would form the basis of a self-sustaining wetland area is provided in Table 2.5.

Table 2.5: General wetland compensation planting species and specifications (species are not limited to this list and are subject to change on a site by site basis).

Common name	Scientific name	Initial or Enrichment	Plant grade	Approximate Spacing (m)
Swamp astelia	*Astelia grandis*	Initial	0.5 L	0.5
Kiokio	*Blechnum novae-zelandiae*	Initial	0.5 L	0.5
Mānuka	*Leptospermum scoparium*	Initial	PB3	1
Swamp coprosma	*Coprosma tenuicaulis*	Initial	PB3	1
Tangle fern	*Gleichenia dicarpa*	Initial	0.5 L	0.5
Baumea	*Machaerina rubiginosa*	Initial	0.5 L	0.5
Harakeke	*Phormium tenax*	Initial	PB3	1
Toetoe	*Austroderia toetoe*	Initial	PB3	1
Purei	*Carex secta*	Initial	0.5 L	0.5
Swamp sedge	*Carex virgata*	Initial	0.5 L	0.5
Round-leaved willow herb	*Epilobium rotundifolium*	Initial	0.5 L	0.5
Cabbage tree	*Cordyline australis*	Initial	PB3	1
Raupō	*Typha orinetalis*	Initial	0.5 L	0.5
Pūrua grass	*Bolboschoenus fluviatilis*	Initial	0.5 L	0.5

[9]Castelle, A. J., Johnson, A. W., and Conolly, C. (1994). Wetland and stream buffer size requirements: a review. Journal of Environmental Quality 23 (5), 878 – 882

[10] Collins, R., McLeod, M., Hedley, M., Donnison, A., Close, M., Hanly, J., Horne, D., Ross, C., Davies-Colley, R., Bagshaw, C., Matthews, L. (2007). Best management practices to mitigate faecal contamination by livestock of New Zealand waters. New Zealand Journal of Agricultural Research 50, 267-278.

Common name	Scientific name	Initial or Enrichment	Plant grade	Approximate Spacing (m)
Lake clubrush	*Schoenoplectus tabernaemontani*	Initial	0.5 L	0.5
Jointed twig rush	*Machaerina articulata*	Initial	0.5 L	0.5
Kutakuta	*Eleocharis sphacelata*	Initial	0.5 L	0.5
Club rush	*Ficinia nodosa*	Initial	0.5 L	0.5
Kaikomako	*Pennantia corymbosa*	Initial	PB3	1
Kahikatea	*Dacrycarpus dacrydioides*	Enrichment	PB3	5
Swamp maire	*Syzigium maire*	Enrichment	PB3	5

2.5.3 Stock-proof fencing

Livestock exclusion from streams provides benefits beyond decreasing direct sediment runoff from livestock trampling[11][12]. Fencing provides improvements on multiple aspects at reach-level such as supporting riparian vegetation development, which in turn provides shading, increases biodiversity, and creates habitat for terrestrial fauna. Even without riparian planting, rank grass that can establish in the absence of grazing can filter overland runoff, removes the direct input of animal waste to streams and enables banks to stabilise[5].

The proposed minimum standard, of a fit for purpose livestock exclusion fencing, will include a permanent, 8 wire post and batten conventional fence by the landowner.

Livestock exclusion fencing is required for all but one BEO. Livestock fencing is not considered necessary in existing SEA and forestry areas where no stock access is expected due to existing forest-surround fencing (BEO 7). Multipliers applied consider the amount and type of enhancement activities within each BEO.

Fencing will not be considered to contribute to any BEOs where it is otherwise required by the NPS FM and/or AUP OP. Only where fencing is not required by the NPS and AUP OP will it be additional and therefore considered within the EGM.

2.5.4 Legal protection

Protection in perpetuity is a biodiversity offsetting principle designed to secure long-term ecological outcomes. At a minimum, this requires that the compensation activities put in place (planting, fencing etc) are intended to be protected in that location in perpetuity.

Protection measures, such as covenant conditions, will be developed in consultation with landowners on a site by site basis and will be detailed in each five yearly forward-looking Stream Compensation Works Compliance Plan (SCWP).

Protection by way of covenant on title is required for all BEOs included within this EGM.

[11] McDowell, R. W., Hedley, M. J., Pletnyakov, P., Rissmann, C., Catto, W., and Patrick, Wes. (2019). Why are median phosphorus concentrations improving in New Zealand streams and rivers? Journal of the Royal Society of New Zealand 49 (2), 143 -170

[12] Wilcox, R. J. Monaghan, R. M., Quinn, J. M., Srinivasan, M. S., Houlbrooke, D. J., Duncan, M. J., Wright-Stow, A. E., and Scarsbrook, M. R. (2013). Trends in water quality of five dairy farming streams in response to adoption of best practice and benefits of long-term monitoring at the catchment site. Marine and Freshwater Research 64, 401 – 412

2.5.5 Weed and animal control and maintenance

Post-planting maintenance is vital to achieving restoration outcomes and planting success. Maintaining a weed free enhancement area at establishment improves the likelihood of plant success and reduces maintenance pressures in the long term. Standard protocols and methods will be utilised depending on the existing state and likely pressures.

A general weed control method of compensation planting may include (but not limited to) chemical and manual weed control to be carried out twice a year, once in spring and once in autumn for the first three years after the initial planting has been carried out. The aim will be to reduce pressure on the enhancement plantings by suppressing the reestablishment of pest plants, aid the depletion of pest plants in the soil seedbank, and remove pest plant seed source.

From the fourth year or for up to five years, pest plants will be controlled annually during summer. Manual release of plantings or weed trimming is recommended where appropriate. Pest plants along riparian margins will be controlled for five years or until 90% canopy closure is achieved, immediately following initial planting efforts to support establishment.

Replacement of plants which do not survive is important in order to ensure gaps are not created which could allow weeds to enter the planting area. Replacement planting will be carried out until 90% survival is achieved.

Hares (*Lepus europaeus*), rabbits (*Oryctolagus cuniculus*), possum (*Trichosurus vulpecula*), pukeko (*Porphyrio melanotus*) have been previously observed on site and are likely to damage plantings. Animal control could include pegging down plants to prevent pukeko damage, bait stations, kill traps, and/or pulse shootings control for other pest animals. Measures to control larger pest species (e.g. pigs) in connecting SEA or non-SEA forest areas could include targeted poisoning or culling. All pest animal control will be carried out by suitably qualified and certified contractors trained in pest control (e.g. use of poison).

Weed and/or pest animal control is a component of BEO 1 – BEO 5 within the EGM. Weed and pest animal control will be developed in consultation with landowners and pest control contractors on a site by site basis due to site specific requirements and will be detailed in each five yearly SCWP.

2.5.6 Fish passage remediation

A large proportion of native fish are diadromous, which means they spend portions of their life cycles travelling between freshwater streams and the sea[13]. Galaxiids, bullies, and smelt breed in freshwater and migrate downstream to grow to adulthood at sea. While eels migrate to sea to breed and return to freshwater streams where they grow to adulthood.

Maintaining continuity of passage upstream and downstream is therefore vital for all aquatic fauna to complete their life cycle. Barriers to passage can include natural features such as waterfalls and cascades but within modified environments can also include perched culverts, weirs, fords and dams. The level to which the barrier has an impact is driven by fish species expected to be present, location within the catchment and presence of other barriers.

Our EGM system expects that BEO 1 will have no existing barriers or the remediation of existing barriers to fish passage while other BEOs may have some partial barriers. Remediation of existing barriers could include:

- Removal of perched culverts,
- Replacement of perched culverts,
- Installation of baffles to existing non-perched culverts,

[13]National Institute of Water and Atmospheric (2018). New Zealand Fish Passage Guidelines

- Construction of fish passage ladders, and/or
- Retrofitting perched culverts with spat ropes or fibreglass ladders.

Remediation measures will be developed in accordance with best practice methods described in the New Zealand Fish Passage Guidelines[13] and detailed on a site by site basis in the five yearly SCWP.

2.5.7 Culvert removal or daylighting

'Daylighting' is the removal of a culvert and reinstatement of an open stream channel. This increases available stream habitat and provides community shifts especially in aquatic invertebrates[14]. The ecological gains from the removal of existing culverts, and in turn creating new stream habitat, therefore corresponds to the highest multiplier of 1.5 in BEO 5 of our EGM.

Daylighting package will also include planting of riparian margins with native vegetation, livestock exclusion fencing, protected in perpetuity, any potential barriers to fish passage removed, and receive weed and/or pest control.

2.6 Additional enhancement activities

2.6.1 Instream enhancement and bank regrading

Physical instream features are important in providing habitat for aquatic fauna through habitat heterogeneity in the channel[15].

Many rural streams have been modified through straightening or deepened and have a paucity of instream habitat often limited to extensive macrophytes. Minor or major works to these channels can result in substantial improvements to stream functions. For instance, addition of woody debris and cobbles can contribute to improved ecological function and is considered to have more benefits than stream channels where habitat is limited to macrophytes.

Similarly, gentle bank slopes support fish spawning[13] and bank regrading may be an option proposed to contour banks to a slope of < 10° to promote fish spawning.

Instream enhancement (for example through the deployment of wooden logs and/or rock substrates) is an add-on to any BEO in the EGM. Including instream enhancement will contribute to an additional 0.1 to the BEO multiplier.

Instream enhancement will be determined on a site by site basis to acknowledge the type of instream elements that are appropriate for the stream. Upcoming opportunities and programme for instream enhancement will be detailed in the SCWP.

2.6.2 Catchment level continuity

Reach scale enhancement actions as outlined within this OSSCP provide real benefits to ecological values but these are often limited to a local zone of influence and certain parameters. Catchment scale enhancement has a greater influence on ecosystem function compared to many small-scale enhancement efforts[16].

[14] Neale, M., W. and Moffett, E. R. (2016). Re-engineering buried urban streams: daylighting results in rapid changes in stream invertebrate communities. Ecological Engineering 87, 175 – 184

[15] Lepori, F., Palm, D., and Malmqvist, B. (2005). Effects of stream restoration on ecosystem functioning: detritus retentiveness and decomposition. Journal of Applied Ecology 42, 228 – 238

[16] Doehring, K., Clapcott, J. E., and Young, R. G. (2019). Assessing the functional response to streamside fencing of pastoral Waikato streams, New Zealand. Water 11, 1-22

Where reach scale efforts can result in shade across the stream cross section, 1 km of planting where 75% shade is achieved can result in an instream temperature reduction of 5^{o}C[17] . Therefore there are benefits to wider catchments when headwaters are planted[5]. Similarly, while a riparian buffer can filter runoff from a single paddock, water quality within the stream is affected by activities beyond the immediate enhancement area.

As such it is considered that enhancement across a wider catchment or enhancement that improves landscape connectivity will provide higher ecological benefit than reach scale only.

Catchment level continuity or direct connectivity of our compensation efforts to existing SEA will contribute to an additional 0.2 to BEO multipliers.

2.6.3 Infill planting

Riparian vegetation integrity is a recognition of the strong interdependence between the land and water interface. Intactness of riparian vegetation is needed to support stream bank stability, filter for ground water entering the stream, providing habitat for aquatic fauna through tree roots.

Selected enhancement streams may have existing riparian vegetation, whether it be native or exotic (but non-invasive) species. Even if not a full margin, the vegetation will be providing measurable aquatic benefits however not to the same extent as if planting into bare ground.

Infill planting in the riparian margin under >50 % existing canopy will result in a deduction of -0.1 to any BEO.

2.7 Statutory considerations

Several proposed enhancement activities may require resource consents to execute instream works or to remove riparian vegetation along margins. This may be required for instream enhancement (e.g. deployment of logs and rocks), removal of weed plants (e.g. disturbance to the streambed), or replacement or removal of culverts.

Any resource consents that may be required will be detailed in the five yearly SCWP on a site by site basis, and would be obtained prior to works occurring.

[17]Collier, K.J., Cooper, A.B., Davies-Colley, R.J., Rutherford, J.C., Smith, C.M., and Williamson, R. B. (1995). Managing riparian zones: a contribution to protecting New Zealand's rivers and streams. Vol 2. Department of Conservation.

3 Additional compensation opportunities beyond the EGM

It is intended that the proposed enhancement activities outlined within the EGM make up the majority of the compensation offered to address residual effects. However, there may be additional non 'like for like' projects or opportunities that could contribute to aquatic ecological improvement.

Example of potential compensation opportunities include:

- Research funding of study and projects assessing the benefits of stream enhancement;
- Eel hatchery;
- Financial contributions to existing conservation works;
- Public access to waterways and education and signage; and
- Removal of deleterious objects from waterways (e.g. car bodies and rubbish).

These opportunities are likely to be raised by landowners within the Hōteo River catchment and where they can contribute to aquatic ecological benefit, the investment should be considered as part of compensation measures.

Any opportunities that arise will be assessed on a case by case basis and the relative benefits to aquatic ecology considered.

Details of the additional compensation opportunity will be included in the SWCP with justification as to the relative equivalent compensation length addressed.

4 Monitoring and reporting

4.1 Pre-compensation reporting

A pre-commencement stream compensation works compliance plan (SCWP) is required under condition XXX and is designed to give Auckland Council a level of certainty and detail of the compensation works to be carried out in advance.

The SCWP will contain site-specific details on enhancement actions when each compensation site is confirmed. The plan will include:

- Details of compensation stream selection including agreed site location(s);
- Landowner agreement details and confirmation of works;
- Stream details such as length of stream and stream name(s);
- Proposed BEO and AEA to occur within the next five planting seasons in accordance with the EGM as detailed in the OSSCP;
- Quantification of the compensation length being addressed by the proposed enhancement actions; and
- Enhancement plans for each confirmed compensation site including:
  - Planting species, densities, spacings;
  - Instream enhancement requirements (if necessary);
  - Legal protection to be placed on the land's title;
  - Maintenance specifications; and
  - Weed and pest control specifications.

The SCWP will be submitted to Auckland Council every five years prior to commencement of enhancement actions.

4.2 Post-compensation reporting

A compliance and progress report will be submitted to Auckland Council, at the end of each five years, confirming that the required enhancement actions and maintenance activities have been completed in accordance to that SCWP.

Each five yearly SCWP will provide a running total of a) the amount of stream proposed for the next five years, b) the total stream length already compensated for the project, and c) the remaining stream length required to be compensated for under the project's conditions.

The SCWP will demonstrate and step through the length of stream proposed for compensation in accordance with the EGM detailed in this OSSCP.

5 Applicability

This report has been prepared for the exclusive use of our client Waste Management NZ Limited, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

We understand and agree that our client will submit this report as part of an application for resource consent and that Auckland Council as the consenting authority will use this report for the purpose of assessing that application.

Tonkin & Taylor Ltd

Report prepared by:

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Alicia Wong Justine Quinn

Ecologist Senior freshwater Ecologist

Authorised for Tonkin & Taylor Ltd by:

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Simonne Eldridge

Project Director

Technical review: Josh Markham, Senior Ecologist.

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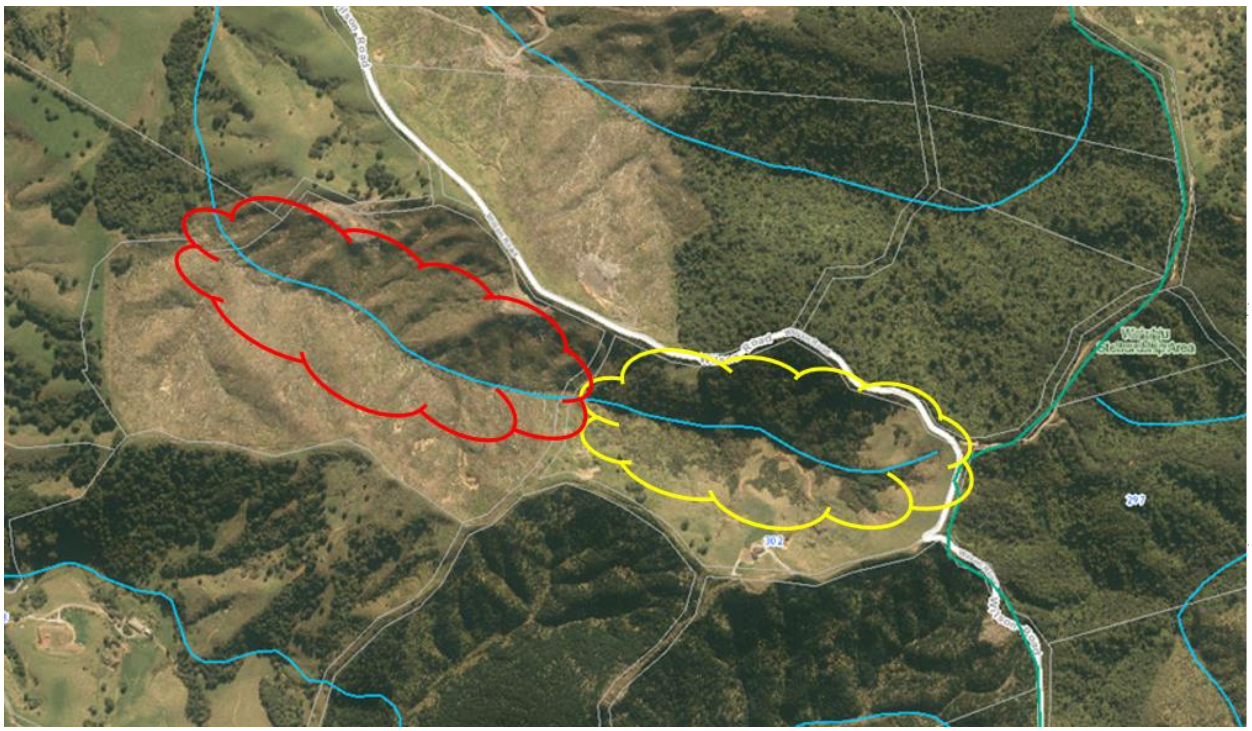
Appendix A: Case Studies

This section contains two case study examples to demonstrate how the EGM functions.

Case study 1: 20 m margins in headwaters



The above length of stream is 1.35 km long and located within the headwaters of a catchment. The upper section of the stream (shown in the yellow bubble) is already quite well planted, but could benefit from additional planting. Downstream of this within the red bubble there is no existing vegetation.

It is proposed to do 20 m riparian planting on either side of the stream for the entire 1.35 km. Within the EGM the following BEO and AEA would apply.

Yellow Bubble

The available stream length within the yellow bubble is 685 m. The multiplier for this section will include:

BEO 1 20 m riparian planting – multiplier of 1.05

AEA 2 headwater catchment and adjacent to SEA – additional 0.2

Infill planting as existing vegetation of > 50% coverage – minus 0.1

Total multiplier = 1.05 + 0.2 - 0.1 = 1.15

Therefore the 685 m proposed planting within Yellow Bubble is equivalent to 788 m of the compensation length required.

Red Bubble

The available stream length within the red bubble is 670 m. The multiplier for this section will include:

BEO 1 20 m riparian planting – multiplier of 1.05

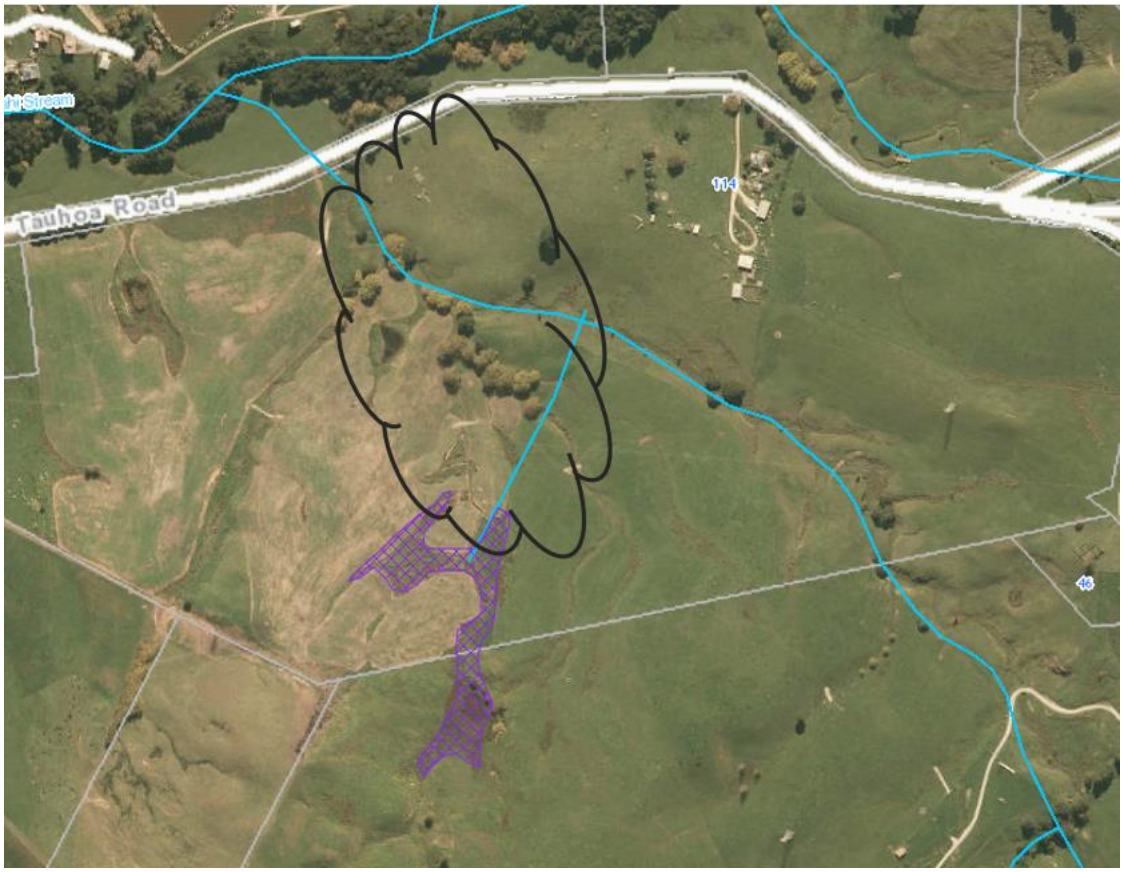
AEA 2 headwater catchment and taking length to > 1 km continuous – additional 0.2

Total multiplier = 1.05 + 0.2 = 1.25

Therefore the 670 m proposed planting within Red Bubble is equivalent to 837 m of the compensation length required.

The combined planting of 20 m either side of the 1.35 km of stream is equivalent to 1.63 km of the compensation length required.

Case study 2: Wetland and 10 m margins



The length of stream within the black bubble is 0.5 km long and located within lowland agricultural landuse. The headwaters of the stream connect into a wetland area of 9,500 m^2 (shown in purple hatching).

It is proposed to do 10 m riparian planting on either side of the stream and around the outside of the wetland.

It is also proposed to do infill planting of the wetland. Within the EGM the following BEO and AEA would apply.

Black Bubble

The available stream length within the black bubble is 0.5 km. The multiplier for this section will include:

BEO 2 10 m riparian planting – multiplier of 1 along the entire length

AEA 1 – instream enhancement along 0.15 km – additional 0.1 for this length

Total multiplier = 1+0.1 = 1.1 for 0.15 km AND 1 for 0.35 km

Therefore the 500 m proposed planting within Black Bubble is equivalent to 515 m (165 m + 350 m) of the compensation length required.

Purple Hatching Wetland

The available wetland area to be enhanced is 9,500 m^2. The multiplier for this section will include:

BEO 4 wetland enhancement – multiplier of 0.1

Total multiplier = 0.1

Therefore the proposed wetland planting within Purple Hatching is equivalent to 0.95 km of the compensation length required.

The combined planting of 10 m margins and wetland enhancement is equivalent to 1.47 km of the compensation length required.

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