Ecological Management Plan – Peka Peka to Ōtaki Project

FCCL-EV-MPN-0009

FINAL C – September 2017

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

New Zealand Government

Contents

AUTHORISATION AND REVISION RECORD

Revision	Status	Author	Date	Description
A	Draft	Dean Miller	3/3/17	First draft (for PA Review)
B	Draft	Dean Miller	4/4/17	For Council Review
B.1	Draft	Dean Miller	19/5/17	For Council Review
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CERTIFICATION RECORD

Revision	Action	Name	Position	Date	Signature
	Approved by:	Richard Percy	Project Leader	18/9/17	
	On behalf of GWRC				

CONSENT COMPLIANCE FRAMEWORK

Resource Consent Conditions relevant to ecological aspects of the Project including a reference to the Section of this EMP where details are provided.

Reference	Summary of requirement	EMP Section
G.15	Annual reporting requirements	8
G.31	EMP submission must be within 20 working days prior to construction commencing	In progress
G.32	States the purpose of the EMP and that the EMP must be prepared by a suitability qualified and experienced ecologist and finalised in consultation with Nga Hapu o Ōtaki and Kāpiti City District Council (KCDC). Construction must not commence until the consent holder has received the Manager's written certification of the EMP	1
G.33	EMP requirements in relation to: Effects minimisation Compliance with management triggers and thresholds Habitat compensation Fish rescue and relocation plan Lizard management plan Powelliphanta traversii Ōtaki Monitoring details Remedial/response actions Salvage and relocation of valued ecological elements Details of waterway diversion channel Effects avoidance on the ecological site at Mary Crest (minimising native terrestrial and wetland vegetation and minimising ground water drawdown) Minimise effects from temporary causeways on stream habitat and values	 3.3, 4.2, 5.2 and 6.2 6.6 and 5.6.1 4.3, 5.4, 5.5, 6.4 and 6.5 6.2.7 and 6.2.8 4.2.3.1 4.2.3.2 5.6 and 6.6 4.3.2, 5.6.2 and 6.6 4.2.4 6.2 5.2.2 6.2.4

Reference	Summary of requirement	EMP Section
G.34	Requirement for the EMP to include a revegetation and mitigation strategy that includes a 5 year maintenance period, stock exclusion, reviews and programme for remedial actions were required	3, 4.2.2, 4.3, 5.3, 5.4 and 6.5
G.35	Requirement for EMP to specifically identify any area subject to a QEII covenant and specific techniques to manage effects on Peripatus in bush areas on Steven's property	7
G.35A	Requirement for ongoing legal protection of all ecological mitigation areas	7
G. 35B	Requirement for mitigation works to be staged to minimise lag between effects and mitigation (lag < 1 year)	3.5, 3.6, 4.3, 5.3, 5.4, 5.5 and 6.5
G. 36	Requirement for the EMP shall be consistent with LUDP	1.2, 4.3.3
G.37	Requirement for submission of EMP to KCDC (for comment) at least 15 days prior to EMP submission to GWRC	1.5
G. 38	Monitoring shall be in accordance with EMP as required by condition G.33g in order to: Collect baseline information on freshwater turbidity Monitor freshwater ecology during construction to identify changes Survey for NZ Pipit south of Mary Crest and in the dunes north of Ōtaki prior to construction Survey for Banded dotterel in the vicinity of the proposed Ōtaki River bridge crossing before and during bridge construction Monitor vegetation and freshwater ecology following project completion to confirm mitigation requirements Undertake fish passage monitoring as required by Condition WS.9	 6.6.2.1 6.6.3 and 6.6.4 4.2.5 6.2.1 4.3.2, 5.6.2 and 6.5 6.6.5
G.39	Requirements for turbidity monitoring including:	6.6.2.1, 6.6.3 and 6.6.4

Reference	Summary of requirement	EMP Section
	Pre-construction monitoring Pre-construction purpose Turbidity monitoring parameters Need for a gross exceedance trigger and an elevated level trigger Reporting Quarterly review of trigger levels	
G.40	Requirements for mudfish surveys by a suitably qualified ecologist which include: Intended survey methodology Alternative survey methodology Relocation methodology Provision of results Full details of methodology for certification prior to implementation	6.2.8
G.41	Construction monitoring requirements (in accordance with the EMP) Sediment monitoring Monitoring effects of the construction on waterways including sediment, oil and grease, aquatic invertebrates and fish	6.6
G.42	Construction monitoring turbidity trigger response requirements	6.6.4
G.43	Post-construction monitoring requirements including: Monitoring of native bush and wetlands The need for 5-years of post-construction monitoring Aquatic ecology monitoring including 2 years of stream/river monitoring of sediment, macroinvertebrates and fish, fish passage, 5 years of aquatic invertebrate monitoring in mitigation wetlands and 5 years of riparian buffer monitoring	5.6.1 6.6.5

Reference	Summary of requirement	EMP Section
G.44	Requirements for all ecological monitoring to be undertaken by suitably qualified and experienced ecologists and inspection and reporting requirements for monitoring results	1.1 8
G.45	Response requirements for exceedance of trigger levels for any monitoring limit or management trigger level set in the EMP during or post construction (exclusive of turbidity)	6.6.5, 6.6.3 and 6.6.4
G.46	Ecological mitigation requirements including: a) 1.5ha of terrestrial mitigation planting, 1.1ha of wetland mitigation planting, and swamp forest plantings at Mary Crest or if unable to be achieved, alternative options are stated b) Riparian planting shall be a minimum of 2,601 lineal metres at least 20 m width either side of the bank c) Landscape and visual planting shall include approx. 1.77ha at Pareomatangi Reserve; and approx. 38 ha of native planting landscape treatments	4.3, 5.4 and 5.5 6.5 Refer LUDP
G.46A	Banded dotterel compensation requirements, which includes removal of woody weeds from nesting area prior to breeding season and during construction	6.3
G. 47	Requirements to ensure terrestrial, wetland, and riparian habitat reflects similar indigenous ecosystem types to what is being replaced	4.3, 5.4 and 5.5
WS.3	Diversion design and construction to maintain natural stream flows and avoid fish passage barriers. Design shall occur in consultation with an aquatic ecologist	6.4.1
WS.4	Culverts on select watercourses shall be designed to facilitate fish passage in accordance with GWRC publication, including specific requirements for Mangapouri and Mangaone Streams	6.2.6
WS.5	Requirement for verification in writing by an engineer and aquatic ecologist that the permanent stream	6.2.4.2

Reference	Summary of requirement	EMP Section
	diversions are completed in accordance with the SSEMP stream diversion plan	
WS.6	Requirement that the design of waterways shall include a specific programme and methodology to manage migration of native fish and included as part of the SSEMP	6.2.3
WS.8	The maximum length of reclamation or diversion shall not exceed 2,750 m	5 and Appendix G
WS.9	Fish passage requirements, including: Visual inspection of structures and works where fish passage is required 1 and 4 years after installation Remedial requirements in the event of fish passage restriction Visual inspection requirements Requirement for inspection report within 1 month of undertaking inspections by aquatic ecologist and engineer Remedial actions must be undertaken within 3 months of submitting the report	6.6.5
WS.10	During construction the works shall be regularly inspected and maintained to ensure that fish passage is not impeded	6.6.3.5
WS.12	Temporary culvert design requirements which includes Installation 300 mm below stream bed to facilitate fish passage	6.2.4.1
WS.13	Stream must be reinstated to natural state after removal of temporary culverts unless otherwise agreed by the Manager	6.2.4.5

1 INTRODUCTION

1.1 Project background

This Ecological Management Plan (EMP) has been developed for the State Highway 1 Peka Peka to Ōtaki (PP2O) Expressway. Works will occur over a 200 week period from 25 November 2017. The works will entail construction of a 12km, 4-lane Expressway, consisting of:

- 1.4M m^3 Earthworks
- 9 km local road
- 10 No. Bridges, including 330m, Ōtaki River Crossing
- Ōtaki Intersection - split
- East-West connections – Ōtaki, Te Horo
- Grade separation – Taylors Road
- 1.6 km railway realignment

The works will follow a general programme of enabling works and site establishment, followed by rail realignment and bridge construction and then road construction.

The key Project parameters are given in Table 1.

Table 1: Contract details

TABLE HEADING	
Project Name	*Peka Peka to Ōtaki Expressway*
Nature of project	*13 kms of new expressway and 10 new bridges*
State Highway Classification	*SH 1*
Commencement	*25 November 2016*
Project End Date	*07 January 2021*
Project Manager	*Craig Pitchford (NZTA)*
Principals advisor	*Ron McFadyen (Opus)*
Contractor	*Fletcher Construction*
Contract Manager	*Andy Goldie (Fletcher)*
Councils with Jurisdiction	*Greater Wellington Regional Council (GWRC)* *Kāpiti Coast District Council (KCDC)*

This EMP is in general accordance with the version submitted with the designation and consent applications for the Project and has been prepared by Tonkin & Taylor Ltd (T+T) ecologists. Dean Miller has compiled the plan and written the aquatic ecology components. Terrestrial and wetland components of the plan have been written by Liz Deakin and Matt Baber.

All of the monitoring set out in this EMP will be undertaken by suitably qualified ecologists.

1.2 EMP purpose

The purpose of this EMP is to outline the approach for ensuring that the adverse effects of the Peka Peka to Ōtaki Expressway Project (the Project) are avoided, remedied or mitigated and to set out how Fletcher intends to achieve compliance with the ecology related conditions of Resource Consents NSP13/01.003 to NSP 13/01/.51.

Resource Consent Condition G.32 sets out the EMP purpose as follows:

1) *To detail the ecological management programme that will be implemented to appropriately manage effects of the Project on the environment during the construction phase and once the Project is operational;*
2) *To document the permanent mitigation measures, including the restoration, management and maintenance of ecological mitigation, as well as the mechanisms for developing relevant mitigation and restoration plans for terrestrial and freshwater habitat;*
3) *To ensure that mitigation has been successful by establishing post-construction monitoring and response procedures; and*
4) *To ensure that any long-term effects are appropriately managed through monitoring, adaptive management and implementation of appropriate responses.*

Our overarching goal is to achieve a no net loss of biodiversity values affected by the Project and to therefore align with the Transport Agency's Ecological Resources Objective E2 (NZTA, 2008). To this end, we consider it essential to develop a holistic EMP that is cohesive and integrates with the Construction Environmental Management Plan (CEMP), Site Specific Environmental Management Plans (SSEMPs), the Landuse and Urban Design Plan (LUDP) and Greenroads (Bronze) certification.

This EMP will form Appendix J to the Construction Environmental Management Plan (CEMP) for the Project.

1.3 EMP scope

The scope of this EMP is as per the requirements of Resource Consent Conditions which are summarised as follows:

- Conditions G.33 to G.37 that set out the purpose, required content, consultation requirements and timeframes for document submission and plan implementation.
- Conditions G.38 to G.45 that set out the ecological monitoring requirements for the project, including pre-construction, during construction and post-construction activities.
- Conditions G.46 to G.47 that set out the required quantums, locations and timeframes for ecological mitigation (habitat restoration and compensation works).

- Conditions WS.1 to WS.14 that address controls and standards for works in watercourses.

A detailed schedule of Resource Consent conditions relevant to ecology is provided as a preface to this EMP. This schedule includes EMP section references to where in the document the condition is addressed. Broadly the scope of this EMP includes:

- Details of how effects on vegetation, habitats and fauna will be minimised;
- Details of the habitat restoration and compensation to be undertaken including a revegetation and mitigation strategy;
- A fish rescue and relocation plan;
- A lizard management plan;
- Details for dotterel, pipit, mudfish, *Powelliphanta traversii* surveys and management;
- Detail the salvage of elements of any valued habitat of indigenous flora and fauna (including felled logs) that have been lost as a result of the Project where practicable, including provision for transfer of elements of the affected habitat to ecological mitigation sites;
- Details of the ecological monitoring to be undertaken pre-construction, during construction, and post-construction;
- Details of the remedial/response and maintenance actions proposed;
- Details for each new diversion channel if available (otherwise the details are to be provided in the SSEMPs).

Ecological compensation work outside of the Designation was excluded from the design and construction contract. This was on the basis that this work is often left to the end of the project and NZTA wished to ensure the planting would happen early in the project timeline (rather than at the end), sufficient funding was available and a good result was achieved. Baseline turbidity monitoring was also undertaken separately for project programming reasons.

The following EMP items have been, or are being addressed by NZTA separately to Fletchers scope, but are covered by way of summary in the main body of this EMP with detailed reports provided as appendices:

- Condition G.46 (a).(i).(a) – 1.5 ha of edge and interplanting of indigenous forest species. This was removed from the tender scope and is being addressed by Opus on behalf of NZTA (NTT-000148). An EMP prepared by Opus and covering Condition G.46 (a).(i).(a) is provided as Appendix A and includes maps showing planting areas and extents.
- Conditions G.46b – Stream mitigation (riparian planting). The bulk of the mitigation riparian planting (including planting maintenance and monitoring) was removed from the tender scope and is being addressed by Opus on behalf of NZTA (NTT-000073). An EMP prepared by Opus and covering consent condition G.46 b) is provided as Appendix A and includes maps showing planting areas and extents.
- Condition G.39 – pre-construction turbidity monitoring: this work has been undertaken by Opus on behalf of NZTA. A summary report has been provided in Appendix B 'for information' but the outcomes of this work have not been used to set the turbidity triggers for the 'elevated trigger level' and 'gross exceedance trigger'. Section 6.6.4.2 outlines the proposed trigger levels to be used during construction.

The EMP will be finalised in consultation with Ngā Hapū o Ōtaki (NHo Ō) and the Kāpiti Coast District Council (KCDC). The final draft EMP will be lodged with Greater Wellington Regional Council (GWRC) for certification at least 20 working days before the commencement of construction.

1.4 Site Specific Environmental Management Plans

Detailed terrestrial, riparian and wetland mitigation and monitoring plans will be set out in the respective SSEMPs as it is considered appropriate to develop plans based on detailed design, which is in progress.

This EMP provides the tools and framework from which the SSEMP's will be developed and we have signalled throughout the document where further detail will be provided through the SSEMP process.

Project ecologists will review and have input into all SSEMPs prepared for the Project.

1.5 Consultation

1.5.1 Ngā Hapū o Ōtaki

Ngā Hapū o Ōtaki and NZTA have agreed on a Cultural Mitigation Plan. The Cultural Mitigation Plan seeks to provide NHoŌ with the ability to exercise Kaitiatanga over its traditional lands in respect of Expressway design and construction. The Plan requires the establishment of a Kaiarahi. The Kaiarahi will provide the key point of contact and coordination for NHoŌ involvement in the Project and provide leadership in respect of cultural inductions, monitoring and ceremonies.

A Kaiarahi will be located in the Fletcher Construction Company (FCC) office to ensure the consideration of matters of interest to NHoŌ can be expedited promptly. The Kaiarahi will be involved in the design process, construction supervision and environmental monitoring. The Kaiarahi will be supported by Kaitaki who provide support in supervision and monitoring activities and provision of specialist advice.

The Mitigation Plan also requires the preparation and implementation of a Cultural Monitoring Plan. The Cultural Monitoring Plan will be complimentary to the EMP and where possible will be aligned, for example in the location of monitoring points. Once the Cultural Monitoring Plan has been prepared an assessment of the Cultural Monitoring Plan and the EMP will be undertaken to determine if the EMP requires any amendment.

1.5.2 Kāpiti Coast District Council

The draft EMP is required to be provided to Kāpiti Coast District Council (KCDC). The purpose of this is to ensure that relevant requirements of the EMP are reflected in the Landscape Urban Design Plan. This includes such matters as the identification of suitable plant species for rehabilitation activities, mitigation planting requirements and areas of high ecological value. KCDC reviewed version B1 of this EMP and feedback and comment has been incorporated as appropriate.

1.6 Document structure

This EMP is set out as follows:

- **Section 1** – Introduction as above.
- **Section 2** – Ecological values and effects summary.
- **Section 3** – Ecological mitigation strategy and framework: Our framework for complying with the Project designation and resource consent conditions and managing terrestrial, wetland and freshwater ecological effects.
- **Section 4** – Terrestrial ecology effects management and monitoring.
- **Section 5** – Wetland ecology effects management and monitoring.
- **Section 6** – Freshwater ecology effects management and monitoring.
- **Section 7** – Ongoing protection of ecological mitigation areas.
- **Section 8** – Reporting requirements and timeframes.

2 ECOLOGICAL VALUES AND EFFECTS

2.1 Ecological context and values

Ecological values within and around the designation are described in detail in the documentation supporting the Environmental Protection Agency (EPA) application for the project and in the evidence and conferencing documents prepared through the Board of Inquiry (BOI) process. Ecological values are therefore only summarised here. The locations of important ecological values are shown on the Ecology Layout Plans (Drawings DG-CE-0801 to 0817) provided as Appendix C.

The expressway alignment passes through a highly modified landscape that is now dominated by agriculture, and to a lesser extent horticulture, viticulture and urban/suburban land use. Correspondingly, indigenous habitats and vegetation have been significantly reduced from their former extent with only 1.7 % of indigenous vegetation cover and 1.3 % of wetlands now remaining. What does remain is ecologically significant (Table 2) and therefore warrants efforts to both minimise adverse effects and to appropriately mitigate for effects that cannot be avoided.

Table 2: Area or lineal extent of each broad habitat category and nationally 'Threatened' 'At Risk' or legally protected species that are known or likely to be present within each habitat type

Habitat types with significant ecological values within the designation	Associated nationally 'Threatened', 'At Risk' or legally protected species that are known to be present or likely present	Total ha / km
Farmland/Duneland	NZ pipit	Approx. 27 ha
Mature native forest and groups of trees	Native lizards, land snails, peripatus	0.39 ha
Braided river bank	Banded dotterel	Unknown area (surveys required)
Freshwater wetland	None known to be present but spotless crake, marsh crake and Australasian bittern could potentially be present	0.8 ha
Waterways	Longfin eel, koaro, inanga, red-fin bully, giant kokopu, shortjaw kokopu, torrentfish, lamprey and brown mudfish	2.84 km

2.2 Adverse ecological effects

Potential adverse effects associated with the construction and operations of PP2O will primarily occur through habitat loss associated with vegetation clearance, earthworks and stream culverting and diversions. Ongoing indirect effects on remaining habitat in close proximity to the preferred alignment are also expected. Potential effects on ecological values associated with the Project include:

- damage to remaining areas of native bush habitat immediately adjacent to the Project footprint as a result of construction activities;
- edge effects due to the loss of bush from the edges of Hautere Bush F, Cottle's Bush and bush to south of Te Hapua Road;
- potential adverse effects on peripatus through habitat loss and/or edge effects;
- potential adverse effects on lizards and the 'Nationally Critical' *Powelliphanta traversii Ōtakia* (herein Ōtaki Snail) due to habitat loss and edge effects;
- disturbance to NZ pipit populations south of Mary Crest and in the dune areas north of Ōtaki;
- disturbance to nesting Banded Dotterels in the vicinity of the Ōtaki Bridge crossing;
- potential effects on the hydrology of the remaining part of the Ōtaki Railway Wetland;
- loss of c.0.5ha of habitat from the Ōtaki Railway Wetland;
- adverse effects on aquatic life due to sediment and contaminant discharges to watercourses during construction;
- adverse effects on fish passage during, and as a result of construction activities;
- impediment of fish passage by various new culverts installed along the expressway; and
- the loss of waterway habitat due to installation of culverts and stream diversions at various locations along the Project.

3 ECOLOGICAL MITIGATION STRATEGY AND FRAMEWORK

In this section we summarise the general approach to the management of actual and potential ecological effects associated with the Project.

3.1 General approach and guiding principles

The approach to managing ecological effects was established through the Designation/consent BOI process and the associated consent level design (prepared by Opus, URS and Holmes Consulting) and this is reflected in the Designation and Resource Consent conditions.

Opus and NIWA scientists addressed ecological matters and effects management using the mitigation hierarchy approach as set out in the Standard on Biodiversity Offsets published by the Business and Biodiversity Offsets Programme (BBOP) in 2012. The BBOP (2012) ecological mitigation hierarchy is set out in Table 3. The BBOP hierarchy approach does not necessarily follow the RMA requirements or language around avoiding, remedying or mitigating effects so we have included a column describing how RMA terminology fits within the hierarchy and in the context of the Project. This is based on the guidance in the Ecological Impact Assessment Guidelines (EIANZ, 2015).

We purposely avoided the use of the term “offset” as this implies the use of a model and/or “ecological currency” to measure biodiversity exchanges. The approach for PP2O through the consent was to apply agreed loss-to-gain ratios based on professional judgement and other project case studies.

This EMP follows the effects mitigation hierarchy framework as detailed in Table 3 and builds on the consent level EMP to specifically reflect the actual and potential effects associated with the project’s detailed design. Some or all of the steps in the hierarchy are applicable depending on the nature of the works and the scale of effects.

The following sections summarise in broad terms how adverse effects of the Project can be further avoided, minimised, remedied, mitigated or compensated by appropriate management during and after construction. Examples are provided for clarity.

Detailed information on effects management for terrestrial, wetland and freshwater ecological effects are provided in Sections 4, 5 and 6 respectively. This includes information on the staging of mitigation works with respect to Condition G.35B.

All areas subject to rehabilitation, restoration and habitat creation will be subject to 5 years of maintenance (fencing, stock exclusion and pest/weed control) and long-term legal protection.

Table 3: Ecological mitigation hierarchy

BBOP hierarchy	RMA terminology	Details
1) Avoidance	Avoid	Measures taken to avoid creating impacts from the outset, such as careful spatial or temporal placement of elements of infrastructure, in order to completely avoid impacts on certain components of biodiversity.
2) Minimisation	(Mitigate)	Measures taken to reduce the duration, intensity and/or extent of impacts (including direct, indirect and cumulative impacts, as appropriate) that cannot be completely avoided, as far as is practically feasible. Generally undertaken at or about the site of impact.
3) Rehabilitation /restoration	Remedy	Measures taken to rehabilitate degraded ecosystems or restore cleared ecosystems following exposure to impacts that cannot be completely avoided and/ or minimised. Generally undertaken at or about the site of impact.
-	Mitigate	Measures taken to minimise (see above), moderate, alleviate and reduce ecological impacts. This includes addressing habitat loss impacts through on and off-site **like for like** replacement of values and/or function.
4) Compensation	Compensate	Measures taken to compensate for any residual significant, adverse impacts that cannot be avoided, minimised, rehabilitated /restored (remedied) or mitigated in order to achieve no net loss or a net gain of biodiversity. Generally a non-like for like replacement of values. Compensation work can take the form of positive management interventions such as restoration of degraded habitat, arrested degradation or averted risk, protecting areas where there is imminent or projected loss of biodiversity.

3.2 Effects avoidance

Several measures were taken to avoid adverse ecological effects during the specimen design and BOI design processes. Measures included realigning the highway to avoid significant sites and minimising the Project footprint when passing through significant ecological sites that could not be avoided.

Because the design works within a relatively narrow Designation no further measures to avoid adverse effects have been undertaken. Effects avoidance is therefore not addressed further in this EMP.

3.3 Effects minimisation

The updated design, like the design approved by the BOI, will have potential adverse ecological effects on forest, wetland and stream/river habitat types and associated species. However, overall, Fletcher's design will result in reduced adverse ecological effects. Specifically, Fletchers has achieved a comparative reduction in total effects on native bush by 0.06 ha and a reduction in direct effects on stream habitats by around 750 m. This has been achieved by:

- Vertically lowering the alignment in several locations, which results in significantly less earthworks and a reduction in the overall alignment footprint relative to the specimen design; and
- Significantly reducing the quantum of stream diversion that is required.

A range of specific measures to minimise ecological effects are also built into the consent conditions for the Project (e.g. Condition G.33). These include:

- Design and construction methods to minimise loss of ecological values;
- Requirements for culverts and diversions to enable fish passage;
- Pre-construction surveys and salvaging and relocation operations for nationally 'At Risk' or otherwise ecologically significant values including: NZ pipit (survey only), native lizards, native fish, a native snail *(Powelliphanta traversii Ōtaki*) and the velvet worm (*Peripatus* spp.);
- Salvage and redeployment of dead and felled native logs and stumps, which harbour biodiversity e.g. the velvet worm, and/or will serve to enhance ecological mitigation sites;
- Buffer planting and edge protection at forest patches that are subject to some vegetation removal; and
- Pre-construction, construction and post construction monitoring and adaptive management with respect to construction effects on waterways.

Permits for surveying, salvaging and handling wildlife will be obtained from Ministry for Primary Industries and the Department of Conservation as required.

3.4 Rehabilitation and restoration (remedy)

The Project includes measures to rehabilitate degraded ecosystems and restore cleared ecosystems following exposure to impacts that cannot be completely avoided and/or minimised. Examples include:

- Banded dotterel breeding habitat improvement (weed control) upstream of the new Ōtaki Bridge site.
- Reinstatement and rehabilitation of areas of the Ōtaki Railway Wetland following construction.

3.5 Effects mitigation

Consent conditions include requirements to address residual habitat loss impacts through measures that replace values and/or function in a like-for-like manner, either on-site (within Designation) or off-

site (out of Designation). For the purpose of this EMP we will refer to these measures as like for like mitigation. Examples include:

- The creation of the Kennedy Wetland (on-site) as a like-for-like replacement of values lost at the Ōtaki Railway Wetland site.
- Wetland planting and restoration at Mary Crest (on-site) as a like-for-like replacement of values lost at the Ōtaki Railway Wetland site.
- Edge and inter-planting and fencing of a degraded forest remnant (off-site) to replace values lost at forest remnants (e.g. Cottle's Bush and Hautere Bush).

The like-for-like mitigation work needs to be implemented on a staged basis in accordance with Condition G.35B to minimise the lag time between effects occurring and replacement values being realised. Timing details are provided as appropriate in Sections 4, 5 and 6.

All mitigation areas will be subject to 5 years of maintenance and long-term legal protection.

3.6 Compensation for residual effects

Ecological compensation is proposed to address the balance of the habitat loss effects (residual effects) that cannot be avoided, remedied or mitigated. Compensation measures include:

- Riparian retirement and restoration to compensate for stream habitat lost due to culverting and diversion activities. This will mainly be undertaken out of Designation (off-site) but with some on-site (within Designation).
- Planting of swamp forest at Mary Crest to compensate for residual wetland habitat loss.

The compensation work needs to be implemented on a staged basis in accordance with Condition G.35B to minimise the lag time between effects occurring and replacement values being realised. Timing details are provided as appropriate in Sections 4, 5 and 6.

All compensation areas will be subject to 5 years of maintenance and long-term legal protection.

4 TERRESTRIAL ECOLOGY EFFECTS MANAGEMENT AND MONITORING

4.1 Introduction

Measures for managing terrestrial ecology effects include minimising effects on habitats and fauna and like-for-like mitigation to address residual habitat loss.

Condition G.46 a) i) a) requires at least 1.5 ha of edge and inter-planting of indigenous terrestrial forest species (in and around one of the established remnants identified on Exhibit 10 (attached as Annexure 2 to the conditions)). This work is being planned and undertaken by Opus on behalf of NZTA. A separate Management Plan is being prepared by Opus for this work and is included as Appendix A. Summary information is provided in Section 4.3.

4.2 Minimising adverse effects

4.2.1 Minimising direct effects on valued vegetation and habitats for ecologically significant species in or close to the Project footprint

The proposed road design has achieved a slightly lower level of direct impact on forest habitats and trees relative to the BOI design on the whole. Estimated areas of direct habitat effects are presented in Table 4.

Table 4: Comparison of terrestrial habitat loss/effects for the BOI and proposed designs

Ecological value	BOI Design total loss/effects	Construction Design total loss	Difference in ha/lineal metre
Forest patches total	0.45 ha	0.39 ha	- 0.06 ha
Te Hapua Rd Bush	0.10 ha	0.14 ha	+ 0.04 ha
Cottle's bush	0.05 ha	0.05 ha	0
Hautere bush	0.30 ha	0.20 ha	- 0.10 ha
Trees (number)	Approx. 40	35	5

Where the Project passes through or close to areas of native bush it will be important to further ensure that habitat loss is kept to a minimum and that any further unnecessary habitat damage is avoided. This is particularly important at the following locations:

- Hautere Bush F (KCDC Ecosite # K038) – see EMP Drawing 0808.
- Scattered native trees across the general project footprint and in particular near the north end of Winiata Link – see EMP Drawing 0809.
- Cottle's Bush (KCDC Ecosite # K037) – see EMP Drawing 0809.
- Mary Crest Forest & Wetland Remnants (KCDC Ecosite # K235) – see EMP Drawing 0814.

- Te Hapua Rd Forest (Steven's Bush) (KCDC Ecosite # K324) – see EMP Drawing 0816.
- Ōtaki Railway Wetland (KCDC Ecosite # K134) – see EMP drawing 0803.

The following will be undertaken to further minimise terrestrial habitat loss where possible:

- A suitably experienced ecologist will undertake a walkover survey of the alignment prior to the preparation of SSEMPs and in conjunction with Project landscape architects to identify specific vegetation and trees near the works footprint that may be possible to retain. A follow up assessment will be undertaken by an arborist if required.
- A suitably experienced ecologist will be onsite during vegetation clearance and the establishment of a protective fence at or close to the above key locations to ensure that native vegetation loss and damage is minimised.

4.2.2 Minimising indirect effects on valued vegetation and habitats for ecologically significant species

The removal of vegetation from the edges of areas of bush can result in indirect damage to the vegetation and habitats that remain; most notably, through edge effects, which include exposure of vegetation and habitats at the newly created edges to increased wind and sun exposure, temperature extremes, and desiccation.

To minimise edge effects where mature native trees are removed from the edges of Hautere Bush F (K038, see EMP Drawing 0809), Cottle's Bush (K037, see EMP Drawing 0810) and bush to south of Te Hapua Road (K324, see EMP Drawing 0817), buffer planting will be undertaken along the edge to provide protection (in accordance with condition G.34a)). Where space is limited this buffer planting may extend to and on the road embankment.

Buffer planting will include dense plantings of early succession, wind and sun tolerant species that are present and common within the respective forest patches e.g. ngaio, kanuka, wineberry, *Pittosporum tenuifolium* and *Coprosma repens*. These will be locally eco-sourced to ensure that they are genetically adapted to the site conditions.

Details of buffer planting specifications, maintenance and monitoring will be provided in the appropriate SSEMP. Maintenance of planted buffer areas will be undertaken over a period of 5 years from the time of completion of the planting.

Vegetation cover and composition will be assessed during regular inspection monitoring (every 2 years) by assessing a number of vegetation plot indicators following Clarkson et al. 2003. The following indicators will be used:

- Canopy cover: % cover introduced vs. native canopy cover
- Understorey cover: % cover introduced vs. native cover
- Total species: % no. introduced spp. vs. native spp.
- Overall stress/dieback evaluation
- Evaluate any damage by introduced mammalian pests
- Evaluate any drought damage

Following inspection monitoring visits, adaptive management may be required in the form of weed management control and infill planting. Based on the extent of weed presence, an appropriate weed management regime will be employed (e.g. 2-3 times/year). Where any remedial actions are required, a programme and description of remedial actions shall be provided to the GWRC for certification. These actions shall be carried out as soon as practicable having regard to weather and appropriate planting seasons.

At the end of the five year maintenance period, revegetation success of the wetlands will be assessed. Overall criteria for planting success are an 80 % canopy cover, a self-sustaining structure and retention of >80% of the planted diversity.

The results of the review shall be provided to GWRC for certification and will identify:

- That the revegetation has met the requirements of the EMP; and/or
- To identify any remedial actions that need to be carried out.

Where any remedial actions are required, a programme and description of remedial actions shall be provided to the Manager for certification. These actions shall be carried out as soon as practicable having regard to weather and appropriate planting seasons.

4.2.3 Minimising effects on ecologically significant species

4.2.3.1 Lizards

A range of methods will be employed to optimise the effectiveness and efficiencies of lizard salvaging and relocation programmes. In general, all native-dominated forest within the footprint will be checked for native lizards in warmer months (November to March) and before clearance work is undertaken. The Project will affect approximately 0.39 ha of suitable habitat that may support lizard species. This includes Hautere Bush F (K038, see EMP Drawing 0808), Cottle's Bush (K037, see EMP Drawing 0809) and bush to south of Te Hapua Road (K324, see EMP Drawing 0814).

Potential adverse effects on habitats will be managed through:

- Salvaging (in warmer months) to minimise loss of herpetofauna within the Project footprint;
- Habitat enhancement at the designation relocation sites, including deployment of logs and pest weed control; and
- The creation and enhancement of native habitat through terrestrial, wetland and riparian mitigation plantings.

Skinks that could be potentially present within native vegetation in the Project footprint include the common skink, spotted skink and brown skink. The common and brown skink are classified as 'Not Threatened' whereas the spotted skink is classified as 'At Risk". Skink salvaging will include:

- Deployment of reptile shelters (single layered 500mm x 450mm onduline sheets) in suitable habitat within the Project footprint. Generally, this will be undertaken at least 10 weeks prior to vegetation clearance/earthworks activities. Based on an initial assessment, we expect to deploy a total of 100 reptile shelters within approximately 0.39 ha of suitable habitat over the course of the Project (i.e. approx. 1 shelter/40 m^2).

- Undertake reptile shelter checks three times per week and manual searches to capture skinks during warmer summer months (November – March) beginning two weeks prior to vegetation clearance/earthworks activities. Manual searches will include:
    - turning over or pulling apart cover objects (e.g. coarse wood debris); and
    - raking of leaf litter or ground cover.
- Undertake construction (machinery) assisted salvaging during vegetation clearance activities that may include:
    - mulching of low stature non-woody vegetation;
    - turning over of large cover objects that cannot be searched manually (e.g., large decomposing logs); and
    - searching epiphytes (on felled trees).
- All captured skinks will be placed in a container along with leaf litter and relocated into the nearest relocation site on the same day of capture.
- A silt fence will be established between the remaining vegetation and the Project footprint to prevent skinks from moving back into the Project footprint. This fence will be linked to the vegetation protection fence.

Geckos that may be present within the native forest patches include the Ngahere gecko (otherwise known as the Southern North Island Forest gecko) and the Barking gecko (otherwise known as the Wellington green gecko), both of which are classified as 'At Risk'. To capture these species we will undertake the following activities:

- Each site identified as suitable habitat for geckos will be searched on three separate nights beginning at least three weeks prior to vegetation clearance using standard nocturnal searching techniques using powerful spotlights. Approximately 30 person hours of searching per site will be undertaken during warmer summer months (November-March). If geckos are detected, then an additional 10 person hours searching will be undertaken until no further geckos are found. If geckos continue to be found, then gecko searching will continue until a maximum of 150 person hours is undertaken.
- All captured geckos will be placed in a container along with leaf litter and transported to the nearest relocation site (as per Designation Condition requirements) on the same night of capture.
- To minimise mortality and injury to geckos not detected during salvaging operations, felled trees will be de-limbed and vegetation ('slash') will be stockpiled against remaining native vegetation indefinitely. In time, this will enable geckos to disperse out of stockpiles and into the adjacent forest. We expect this to significantly reduce potentially adverse effects on geckos as standard vegetation clearance protocol is to mulch vegetation.

Capture and release of lizards will be undertaken in general accordance with the following methodologies:

- Animals will be placed in ventilated two litre plastic containers for no longer than 4 hours and will be released in the selected relocation site.
- The container will contain vegetation for lizards approximately 30 mm deep and collected from the point of salvage.
- Care will be taken to keep the container at a constant ambient temperature.

- Lizards will be relocated under or into coarse woody debris within the same patch of bush (inside the designation) from where they were salvaged and within 2 hours of capture.
- The location of each individual released will be GPS recorded.
- The number of individuals of each relocated species will be recorded.
- Copies of all records will be provided to the DoC, KCDC and GWRC and these will be updated on a regular basis.
- A silt fence will be established between the remaining vegetation and the Project footprint to prevent skinks from moving back into the Project footprint. This fence will be linked to the vegetation protection fence.

4.2.3.2 Powelliphanta traversii Ōtaki management

The Project will affect approximately 0.25 ha of suitable habitat that may support *Powelliphanta traversii Ōtaki* snails (herein Ōtaki snails), which are classified as 'Nationally Critical', the highest threat category. Potential habitat includes Hautere Bush F (K038, see EMP Drawing 0808) and Cottle's Bush (K037, see EMP Drawing 0809). Search effort will include a minimum of 12 person hours across the two sites. If live snails or snail shells are found within a given site, then, as required by Consent Condition G.33(f), an Ōtaki snail management plan will be developed for their recovery and relocation.

The search methodology for land snails includes the following:

- Traversing the search area systematically to ensure a relatively even coverage. The search team will form a moving front traversing snail habitat within the area.
- Salvaging will involve searching through:
    - Leaf litter
    - Fallen logs and old tree stumps
    - Beneath aboveground tree roots
    - Gaps in existing tree trunk bark formation (for young/juveniles)
    - Niches at accessible mature tree branch/trunk interface (for young/juveniles)
    - Other moist, sheltered habitats/microclimates

4.2.3.3 Peripatus management

Peripatus, also known as velvet worm, inhabit damp, rotting timber, located in shady forests. Rotting timber will be checked in Steven's bush (to the south of Te Hapua Road (K324, see EMP Drawing 0814)). This location is in close proximity to the Project footprint and peripatus could therefore be indirectly affected by edge effects associated with the removal of edge vegetation. Effects on peripatus will be avoided or minimised through salvaging and relocation of peripatus habitat, most notably decomposing coarse woody debris (logs and stumps), into adjacent vegetation that will remain outside of the Project footprint. Note that peripatus cannot effectively be surveyed without destroying habitat (e.g. breaking apart decomposing logs). As such, we consider the most appropriate means of avoiding or minimising effects to be relocating habitat elements

4.2.4 Salvage of habitat elements

Areas where native logs and other habitat elements will be salvaged are shown on the EMP Drawings. Methods to guide the salvage, storage and relocation of valued habitat elements for indigenous flora and fauna (including felled logs) will be set out in the respective SSEMPs.

4.2.5 Pipit survey

NZ pipit surveys will be undertaken by a qualified ornithologist south of Mary Crest and in dunes north of Ōtaki in spring/summer prior to construction by delimiting the relevant habitat and grid-searching the Project designation. The number of birds seen and site locations will be recorded on GPS.

If any pipits are found, then mowing long grass prior to the breeding season is required (to ensure birds move away from the area and to minimise the chances of birds nesting occurring in the Project footprint).

4.3 Mitigation for terrestrial habitat loss

Condition G.46 a) i) a) requires at least 1.5 ha of edge and inter-planting of indigenous terrestrial forest species (in and around one of the established remnants identified on Exhibit 10 (attached as Annexure 2 to the conditions). This work is being planned and undertaken by Opus on behalf of NZTA.

A separate “Terrestrial Mitigation Planting Plan” is being prepared by Opus. Once finalised, the Terrestrial Mitigation Planting Plan will be provided with a re-issue of the EMP and included as Appendix A to this EMP.

Summary information is provided below.

4.3.1 Terrestrial mitigation work

Like-for-like mitigation for terrestrial habitat loss is being addressed separately by Opus on behalf of NZTA. A plan for this work is in preparation and will be provided in Appendix A to this EMP when available. In summary:

- Suitable sites have been identified and comprise five of the established remnants identified on Exhibit 10 (Annexure 2 to the conditions). This group of bush blocks are adjacent to Ōtaki Gorge Road and are classified as belonging to the Te Horo Forest Remnants, under the Greater Wellington Regional Council (GWRC) Key Native Ecosystems (KNE) programme, which is designed to protect areas that are important for native plants and animals in the Wellington region. The Te Horo Forest Remnants KNE site comprises five forest remnants located on alluvial river terraces to the west of the Ōtaki River, and are scheduled as ecological sites in the Kāpiti Coast District Plan.
- The full requirement for 1.5 ha edge and interplanting will be met at this site (over 2 ha of planting is proposed);
- Seeds will be collected and propagated from the remnant so the likely timing for planting will be the 2018 planting season;

- Maintenance will be undertaken over a period of 5 years from the time completion of the planting; and
- The site will be protected in perpetuity by a covenant on the land title.

4.3.2 Procedure for addressing any additional terrestrial habitat loss effects

As set out in Table 4, the updated design achieves a slightly lower quantum of direct terrestrial habitat loss compared to the BOI design (0.06 ha). Should the area of terrestrial habitat loss increase relative to the BOI design (0.45 ha), then additional mitigation planting shall be undertaken. The quantum of mitigation shall be at a loss to gain ration of 1:3.3, as per the approximate ratio applied in condition G.46 a) i) a) (i.e. 1.5 ha of edge and inter-planting to address 0.45 ha of terrestrial habitat loss).

Updated ecological accounting details for terrestrial effects (and other effects) will be provided through the SSEMP's to ensure any balance of effects can be addressed in advance of Project completion. An audit report covering ecological effects accounting will be prepared and provided to GWRC at the end of the Project and will outline any additional mitigation work required and the timeframe for completing this.

4.3.3 Landscape and visual mitigation planting

The landscape and visual planting required by Condition G.46 c) is covered by the LUDP. The LUDP map set incorporates the ecological mitigation planting work and therefore the overall planting proposed for the Project.

5 WETLAND ECOLOGY EFFECTS MANAGEMENT AND MONITORING

5.1 Introduction

The only wetland that occurs within the Project footprint is the Ōtaki Railway Wetland. This wetland is an ecologically important feature that is dominated by raupo marsh with several other native plant species also common. The entire Ōtaki Railway Wetland will be impacted by construction. Measures to address effects on the Ōtaki Railway Wetland include reinstatement (rehabilitation and restoration) of areas of the wetland following construction, condsideration of hydrological changes (Condition G.33) a) iv)) and addressing residual habitat effects through like for like mitigation and non-like-for-like compensation.

An ecological site (terrrestrerial) is present at Mary Crest (outside the Designation) but with fringing and adjacent wet pasture with wetland vegetation features such as patches of raupo, carex and juncus species within the Designation. Condition G.33k) requires consideration of direct effects on native vegetation and effects on groundwater drawdown at the Mary Crest ecological site and the fringing wet pasture habitat.

In terms of addressing Consent Condition G.46 a) i) b) which requires the establishment of a minimum of 1.1 ha of landscaped and planted wetland habitat. Based on the consent conditions and the BOI documentation this is on the basis of an approximate total loss of around 0.5 ha of wetland habitat at the Ōtaki Railway Wetland site and a 2:1 compensation ratio. Wetland mitigation work to address this requirement will focus on like-for-like habitat creation in Kennedy Wetland (c. 0.2 ha) and also at Mary Crest (c. 1.7 ha, including both wetland and swamp forest planting). We note the Kennedy Wetland was 0.4 ha in size in the BOI design.

A suitably qualified ecologist will guide the design of the wetlands, develop appropriate planting plans, supervise their construction and planting and develop the maintenance and monitoring programme.

5.2 Minimising adverse effects

5.2.1 Management of the hydrology of the restored parts of the Ōtaki Railway Wetland

The rehabilitated and restored parts of the Ōtaki Railway Wetland are shown on EMP Drawing 0803 and comprise an 0.11 ha wetland on the eastern side of the alignment and an 0.19 ha area on the western side. A stormwater wetland is also shown and will treat road runoff prior to discharge to both the restored wetlands, which will have an attenuation function. Both the restored wetlands will continue to receive run-off from their catchments during rain events.

Restored wetlands will be lower than the existing wetland by around 1 m and the bottom lined to prevent groundwater loss. Low permeability soils will also be used to create an impermeable zone between the wetlands and the new Expressway embankments to prevent water from the wetland draining through the more permeable embankment materials. The restored wetland areas are

therefore expected to continue to be permanently wet, although water levels may temporarily fluctuate during rain events.

Water currently exits the wetland via a small surface channel at the southern end of the wetland. Once the Expressway is constructed, water will exit the southern end of the wetland via a culvert which will discharge to the constructed Kennedy Wetland (refer EMP Drawing 0803). The culvert will be positioned to ensure that the hydrological conditions of the restored Ōtaki Railway Wetland area will be similar to those that exist in the wetland at the present time.

5.2.2 Ground water at Mary Crest and the existing ecological site

The local road and expressway formations are on embankments elevated above the proposed stormwater, naturally wet ground and the groundwater surface. There will be no connection or outlet to drainage that is likely to lower the groundwater levels in this area.

The Project avoids the existing ecological site at Mary Crest (K235) which comprises a forest remnant. The proposal for the in Designation restoration work at Mary Crest is shown on EMP Drawing 0815. Seeds for the planting programme here will be sourced from the existing remnant and the proposed planting will link with the remnant and include riparian, swamp forest and low stature wetland planting units. The overall effect of the Project on the existing ecological site is expected to be positive.

5.3 Wetland rehabilitation and restoration

Condition G.34 a) iii) requires that this EMP cover the revegetation and mitigation strategy for the restored parts of the Ōtaki Railway Wetland. A detailed plan for the restoration of the Ōtaki Railway wetland area (and the Kennedy Wetland, see later) is being developed as part of the landscape detailed design and specification and will be provided in the appropriate SSEMP. The broad scheme for the site is shown on EMP Drawing 0803.

A total of 0.3 ha of wetland habitat will be rehabilitated and restored as described in Section 5.1.1.

The ecologist will also advise on species selection which is expected to focus on the main species already present in the Ōtaki Railway Wetland including:

- *Carex geminate;*
- *Carex virgate;*
- *Carex secta* Purei;
- *Cordyline australis* (Cabbage tree);
- *Eleocharis acuta* (Spike rush);
- *Eleocharis gracilis* (Slender spike-sedge);
- *Isolepis prolifer; and*
- *Typha orientalis* (Raupo).

Emergent canopy tree species such as pukatea (Laurelia novae-zealandia) and kahikatea (*Dacrycarpus dacrydioides*) will also be considered in the wetland restoration composition.

The site is within the works footprint so the rehabilitation and restoration work will occur as part of construction and with planting completed within 1 year of completion of earthworks, in accordance with Condition G.35B c).

5.4 Mitigation for wetland habitat loss

5.4.1 Like-for-like mitigation at Kennedy Wetland

The Kennedy Wetland will receive water from outflow of the remnant of the Ōtaki Railway Wetland. This is expected to provide permanent flow through the Kennedy Wetland and keep this wetland permanently wet.

A detailed plan for the Kennedy Wetland (wetland creation) will be developed as part of the landscape detailed design and specification and provided in the appropriate SSEMP. The broad scheme for the site is shown on EMP Drawing 0803. A total of 0.2 ha of wetland habitat will be created. This forms part of the 1.1 ha requirement for landscaped and planted indigenous wetland required by Condition G.46 a) i) b).

The ecologist will also advise on species selection which is expected to focus on the main species already present in the Ōtaki Railway Wetland including:

- *Carex geminate;*
- *Carex virgate;*
- *Carex secta* (Purei);
- *Cordyline australis* (Cabbage tree);
- *Eleocharis acuta* (Spike rush);
- *Eleocharis gracilis* (Slender spike-sedge);
- *Isolepis prolifer; and*
- *Typha orientalis* (Raupo).

The site is within the works footprint, so the rehabilitation and restoration work will occur as part of construction and with planting completed within 1 year of completion of earthworks, in accordance with Condition G.35B c).

5.4.2 Like for like mitigation at Mary Crest

The Mary Crest area presents the greatest opportunity for ecological mitigation on the Project. The area is adjacent to an existing puketea-kahikatea dominated swamp forest fragment that will be expanded through wetland mitigation plantings. Small areas within Mary Crest are also suitable for the recreation of raupo marsh wetland habitat and this will enable like-for-like mitigation for the loss of raupo-carex habitat within Ōtaki Railway Wetland.

It is proposed to create the new area of wetland adjacent to the Mary Crest bush in an area that is currently damp pasture. This work will comprise low stature wetland planting, which is considered like-for-like mitigation, and swamp forest which is considered non like-for-like compensation (and addressed in the following section).

A detailed plan for the Mary Crest wetland planting has been developed for the landscape detailed design and specification and will also be provided in the appropriate SSEMP. The broad plan is shown on EMP Drawing 0815. This plan seeks to be consistent with the intent of the Annexure B to the Joint Statement of Ecological experts dated 28 August 2013 (Condition G.46 a) i) c)) but has been developed based on a detailed site assessment and existing contour information.

Approximately 0.62 ha of low stature like-for-like wetland planting is proposed which will contribute to the 1.1 ha wetland mitigation requirement by Condition G.46 a)i)b)). Wetland planting works will be completed within 1 year of commencement of construction in this area in accordance with Condition G.35B c).

5.5 Compensation for wetland habitat loss

Non like-for-like compensation planting is proposed for the Mary Crest site in the form of swamp forest planting. A detailed plan for the Mary Crest wetland planting has been developed for the landscape detailed design and specification and will also be provided in the appropriate SSEMP. The broad plan is shown on EMP Drawing 0815. The swamp forest planting work broadly follows the concept as set out on Annexure B to the Joint Statement of Ecological experts dated 28 August 2013 (Condition G.46 a)i)c)) but has been refined to reflect Fletcher's design and site conditions and topography. Approximately 1.1 ha of swamp forest planting is proposed, which contributes to the overall wetland mitigation planting requirement (1.1 ha).

We note that the Mary Crest plan (EMP Drawing 0815) also includes non-wetland planting including riparian and terrestrial habitat. These areas are being planted in appropriate locations to optimise the biodiversity within the site and enhance linkages across multiple habitat types. These planting units will be managed and monitored as per the other ecological mitigation planting work on the Mary Crest Site and have been shown as ecological mitigation on Drawing 0815.

Swamp forest wetland compensation planting areas are outside of the works area and will be completed within 1 year of commencement of the works (Condition G.35B).

5.6 Post construction wetland monitoring

5.6.1 Wetland maintenance and monitoring

All wetland restoration, mitigation and compensation areas will be subject to a five year monitoring and maintenance programme.

Aquatic ecological conditions will be monitored at the constructed Kennedy Wetland and Mary Crest wetland areas for five years after completion to ensure that the wetlands achieve a level of aquatic ecological value equal to that of the impacted wetland.

Aquatic invertebrates are the most practical component of these ecosystems for monitoring, as invertebrate communities reflect the integrated effects of hydrological conditions, water quality and habitat suitability. It should be noted that precise relationships linking wetland invertebrate communities to specific environmental factors are lacking, but invertebrate data from the new

wetlands can be used for comparisons with established wetlands in the region (Suren and Sorrell, 2010).

Wetland invertebrate monitoring will comprise annual sample collection using a standardised method, such as the timed kick-net sampling method in Suren *et al.* (2011). Sampling will occur in the existing Ōtaki Railway Wetland and two other control wetlands on at least one occasion prior to construction to serve as "before" data for later comparison. The two control wetlands will also be sampled annually for a five year period in conjunction with the restored wetland sampling. Suitable control wetlands will be identified during the first baseline monitoring round.

Wetland vegetation cover and composition will be assessed during regular inspection monitoring (every 2 years) by assessing a number of vegetation plot indicators following Clarkson *et al.* 2003. The following indicators will be used:

- Canopy cover: % cover introduced vs. native canopy cover
- Understorey cover: % cover introduced vs. native cover
- Total species: % no. introduced spp. vs. native spp.
- Overall stress/dieback evaluation
- Evaluate any damage by introduced mammalian pests
- Evaluate any drought damage

Following inspection monitoring visits, adaptive management may be required in the form of weed management control and infill planting. Based on the extent of weed presence, an appropriate weed management regime will be employed (e.g. 2-3 times/year). Where any remedial actions are required, a programme and description of remedial actions shall be provided to the GWRC for certification. These actions shall be carried out as soon as practicable having regard to weather and appropriate planting seasons.

At the end of the five year maintenance period, revegetation success of the wetlands will be assessed. Overall criteria for planting success are an 80 % canopy cover, a self-sustaining structure and retention of >80% of the planted diversity. Where any remedial actions are required, a programme and description of remedial actions shall be provided to the GWRC for certification. These actions shall be carried out as soon as practicable having regard to weather and appropriate planting seasons.

5.6.2 Procedure for addressing any additional wetland habitat loss effects

As set out in Section 5.1, Fletcher's design has the same quantum of direct wetland habitat loss compared to the BOI design (0.5 ha). The quantum of mitigation shall be at a loss to gain ration of 1:2, as per the approximate ratio applied in Condition G.46 a) i) b) (i.e. 1.1 ha of planted indigenous wetland habitat).

As set out in Sections 5.4 and 5.5, the total quantum of wetland restoration, mitigation and compensation proposed comes to some 1.9 ha, easily exceeding the minimum required by the consent.

Updated ecological accounting details for wetland effects (and other effects) will be provided through the SSEMPs to ensure any balance of effects can be addressed in advance of Project completion. An audit report covering ecological effects accounting will be prepared and provided to

GWRC at the end of the Project and will outline any additional mitigation work required and the timeframe for completing this.

6 FRESHWATER ECOLOGY EFFECTS MANAGEMENT AND MONITORING

6.1 Introduction

Measures for managing freshwater ecology effects include minimising effects on habitats and fauna, habitat restoration (e.g. dotterel breeding habitat), like-for-like mitigation (new stream diversions) and ecological compensation to address residual habitat loss (in and out of Designation riparian restoration).

Condition G.46 b) requires at least 2601 linear metres of riparian planting as compensation for stream habitat loss as a result of the Project. The bulk of this riparian is being planned and undertaken at out of Designation sites by Opus on behalf of NZTA. A separate Management Plan is being prepared by Opus for this work and will be included as Appendix A. Summary information on the proposed planting and ecological accounting is provided in Section 6.5.

6.2 Minimising adverse effects

6.2.1 Minimising adverse effects on dotterels

Banded dotterel (Nationally vulnerable) are known to nest on exposed gravel beaches next to the Ōtaki River. Consent Condition G.38 d) requires that surveys for banded dotterels are undertaken in the vicinity of the proposed Ōtaki River bridge crossing immediately prior to and during bridge construction. Nesting habitat enhancement for dotterels is also required at a suitable site upstream of the proposed bridge and is addressed in Section 6.3.

Approximate timing for the commencement of bridge construction works is December 2017 (site establishment and clearance), which is within the breeding season for banded dotterel (July to January).

A banded dotterel management protocol will be set out in the respective SSEMP that shall include details on but is not limited to:

- Protocol for reducing the suitability of banded dotterel nesting habitat in the vicinity of the construction footprint to minimise the potential for effects on birds (and construction programme issues);
- A pre-construction survey of the works area to be undertaken by a suitably qualified avian ecologist no earlier than eight working days prior to any works being carried out, to locate any banded dotterel breeding or nesting sites. If banded dotterel breeding or nesting sites are found within a 50 metre radius of any construction area, construction activities within that 50 m radius shall be postponed until such time as all nests are abandoned or the chicks have fledged;
- Surveys to be undertaken during construction to monitor for birds that commence nesting during this time; and
- The protocol for reporting.

6.2.2 Minimising adverse effects on streams

Detailed design of the drainage systems for the Project, including cross drainage and stream diversions, is in progress and is unlikely to be finalised by the time this EMP is submitted for approval. However, the detailed design work that is currently in progress, will build on the work undertaken for the tender process and will likely achieve a significant reduction in the total effects on streams relative to the consented BOI design[1]. Specifically, Fletcher's design has achieved a comparative reduction in total effects on stream habitats of around 750 m by:

- Vertically lowering the alignment in several locations resulting in significantly less earthworks and a reduction in the overall alignment footprint relative to the specimen design; and
- Significantly reducing the quantum of stream diversions required.

The implementation of ecological compensation work for stream loss (Consent Condition G.46 b)) has been excluded from Fletcher's scope. However, ecological accounting for stream effects and compensation requirements will be an important component of this EMP to demonstrate that stream effects are in general accordance with or lower than that contemplated by the resource consents.

More detail on stream effects accounting is provided in Section 6.5. This will be a live process and will be regularly updated as the Project progresses.

6.2.3 Protection of migrating fish during construction

A range of native fish species have been identified in the streams crossing the Project. In-stream construction activities have the potential to impede the movement of migratory fish species. There are two peak migration periods for fish species relevant to the Project:

- Upstream migrations of juvenile shortfin and longfin eels, banded kokopu, short-jaw kokopu, and koaro, and downstream migrations of redfin bullies peak in spring and summer; and
- Upstream migrations of redfin bullies and downstream migrations of adult eels, koaro, and torrentfish peak in autumn during freshes (short-duration, low-magnitude floods).

In addition to these peak periods, there are lower-intensity migrations occurring throughout the year.

The Project crosses both intermittently flowing and permanently flowing streams and the requirements for managing in-stream works and fish passage will be different for these watercourse types. In summary:

- **Intermittent streams** – the use of these habitats and fish migration through the Project area will be constrained to periods when water is present and flow levels are high enough to allow fish passage. Construction schedules will consider peak migration periods and where possible in-stream construction activities in intermittent waterways will be undertaken in dry and drying periods when fish passage is either not possible or is likely to be minimal.

[1] NIWA 2013. Peka Peka to North Ōtaki: Aquatic Ecology TR12. For the stream effects comparison we have included stream loss that has potential ecological effects only for our Design and the Specimen Design. We have not included culverting or diverting relating to flood conveyance or wetland outlets.

- **Permanent streams** – in-stream construction activities that fully impede fish movements or divert flow will be scheduled as far as practicable during periods outside of the peak migration periods for the specific species known or likely to be present in any particular watercourse. Short-term in-stream works that partially impede flow may be undertaken during migration periods if:
    - few migratory native fish are present upstream and downstream of the construction site; and
    - the fish present are collected and relocated as specified in the Fish Rescue Plan (Section 6.2.7).

The particular requirements for managing construction effects on fish migration will be specific to each watercourse and the fish species present. A detailed schedule of in-stream works requirements for streams affected by the Project is included in Appendix E and is based on broad construction sequencing (in progress). This schedule will be live, updated as necessary and specific requirements included in the relevant SSEMP.

6.2.4 Minimise effects of temporary and permanent culverts, diversions and causeways

6.2.4.1 Permanent and temporary culverts

All permanent culverts on permanent or intermittent streams will require a specific construction methodology considering the nature of the habitat and fish species known or likely to be present. Detailed methods will be developed for and provided in the appropriate SSEMP. General considerations for permanent fish passage, native fish migration management and fish rescue are provided in Appendices D and F. Permanent culverts will incorporate fish passage as described in Section 6.2.6.

The specific methodology developed for construction of culverts on or to convey permanent and intermittent streams will consider:

- All culverts in permanent or intermittent waterbodies shall be constructed either by installing a diversion around the work area and installing the culvert in the dry channel, or by constructing the culverts adjacent to the stream and then diverting water in to the culvert on completion;
- A briefing will occur at the outset of construction to contractors by the Project Ecologist;
- Culvert installation shall be supervised through the construction phase (and signed-off) by Project Ecologist;
- During construction special attention shall be given to the protection of native fish within any section of stream being culverted;
- Where the existing channel is to be lost or drained as part of culvert installation, fish capture and transfer will be required prior to water loss as set out in Section 6.2.7; and
- At the livening of any culvert turbidity monitoring will be undertaken. If the turbidity level downstream of the diversion has not returned to levels within 10 % of the upstream of the culvert within 48 hours of livening then GWRC will be notified and an investigation will be carried out to address the source of sediment release. The monitoring method (i.e.

telemetry or hand-held meters) will be further defined and approval by the Manager GWRC prior to works.

Where temporary culverts are used, these shall be designed to meet the following criteria (in accordance with consent condition WS.12):

- To pass a 50 % AEP flood event without heading up (as assessed at the time of commencement of construction);
- Culverts will be installed 300 mm below stream bed level in order to provide a continuous wetted perimeter to facilitate the passage of native fish species; and
- The minimum size of any temporary culvert shall be not less than 600 mm in diameter.

6.2.4.2 Permanent diversions

A total of nine permanent stream diversions are proposed along the Project. Most of these are short in length and comprise minor re-alignments associated with and will occur in conjunction with culvert works. Longer diversions are proposed for Mangaone Stream, Gear Stream, Jewell Stream, Cavallo Stream and Edwin Stream. Preliminary details for each diversion are provided in the Schedule of Stream Works and effects provided in Appendix E. Detailed design for permanent stream diversions is in progress. In order to manage habitat effects the design will seek to match existing habitat types upstream. An ecologist will survey the existing stream bed for morphology and habitat characteristics to inform specific features to be incorporated into the new diversion. Details will be provided in the relevant SSEMP.

A specific works methodology will be developed for each diversion (or group of diversions for sites with similar characteristics) to address water quality and fish passage effects during construction. A general diversion works methodology is as follows. Note there will be different fish rescue requirements for watercourses where mudfish may be present (see Section 6.2.8):

1. Build the new stream alignment off line to maintain existing stream quality;
2. Establish the new stream bed and substrate with space for a hyporheic zone (at least 0.5m deep);
3. Create channel depth profile (noting above requirements) to mimic existing stream, in terms of final water depths, width and therefore velocities and tilt to ensure low flows are focussed;
4. Form stream banks as near as possible to the slope and material of the natural bank condition;
5. Ensure sufficient meanders are present in longer diversions;
6. Store and dispose of excavated material so that it does not contaminate either waterway;
7. Provide clean appropriately sized hard substrates in correct proportions and ensure water does not fall (as in water fall) such that fish passage is compromised;
8. Plant the immediate riparian vegetation prior to or as soon after as practicable the re connection;
9. Plant out the rest of the flood terrace (especially for stabilisation);
10. Ensure no rain events are forecast for the time of reconnection;

11. Prior to diversion of water, fish out and transfer eel and all fish caught. Use a holding tank while diversion to new stream is enacted. Release the fish into the stream either below or above the new connection, after re-connection;
12. Trap and release of fish ideally should be in the same day;
13. Immediately following fish removal break lower connection and then make and redirect stream in to new diversion;
14. Search and capture eel and fish on the ebbing water in the diverted reach;
15. Infill old channel with appropriate clean fill and excavated stream material, ensure diversion "wall" is water proofed; and
16. Monitor sediment discharge at the downstream end of the new diversion over the period of the livening works. Turbidity will be monitored over the duration of the livening works. If the turbidity level has not returned to within 10 % of the upstream level within 48 hours of the diversion livening then GWRC will be notified and an investigation will be carried out to address the source of the sediment release. The monitoring method (i.e. telemetry or hand-held meters) will be further defined and approval by the Manager GWRC prior to works.

The riparian margins of all stream diversions and any associated sections of disturbed stream will be planted with native species (refer items 8 and 9 above). Riparian planting will be in general accordance with the "riparian planting" unit as described in the LUDP for the project. Specific site details will be provided in the relevant SSEMP.

The ecologist will inspect the completed the diversion and provide written signoff that the diversion has been completed in accordance with the SSEMP.

6.2.4.3 Temporary diversions

Temporary diversions may be used for the construction of permanent culverts. A specific works methodology will be developed for each diversion (or group of diversions for sites with similar characteristics) to address water quality and fish passage effects during construction. A general diversion works methodology is as follows. Note there will be different fish rescue requirements for watercourses where mudfish may be present (see Section 6.2.8):

1. Construct and line the temporary diversion channel or for short term works establish pumps and piped diversions;
2. Ensure no rain events are forecast for the time of the works;
3. Prior to diversion of water, isolate (with stop nets) and fish out the section of the stream to be de-watered and transfer eel and all fish caught;
4. Release the fish into the stream either below or above the works area;
5. Re-divert stream flows at the completion of the works; and
6. Monitor sediment discharge at the downstream end of the new diversion over the period of the works. Turbidity will be monitored using hand held meters over the duration of the livening works. If the turbidity level has not returned to within 10 % of the upstream level within 48 hours of the diversion livening then GWRC will be notified and an investigation will be carried out to address the source of the sediment release.

If works are to occur over multiple days then stop nets may need to be re-established and the reach fished out each morning before works can commence.

6.2.4.4 Causeways

Causeways may be used to facilitate the construction of the Ōtaki River Bridge and potentially at the Ōtaki Railway wetland. The use of a causeway is unlikely exacerbate ecological effects at the Ōtaki Railway Wetland site, almost all of which will be impacted by construction and with parts subsequently restored.

The details of any causeway will be provided in the relevant SSEMP in accordance with Condition 25 ac) and will be developed in consultation with an ecologist. Key considerations will be to minimise the effects of temporary causeways on fish passage, river habitat and water quality (Conditions G.33 a) iii) and G.33 l)).

6.2.4.5 Reinstatement

Unless otherwise agreed in writing with GWRC, upon the completion of any temporary in-stream works, the stream bed and margins will, as far as practicable, be restored to a state that closely matches the upstream and downstream riparian and in-stream habitats and visual appearance.

6.2.5 Sediment and contaminant management during construction

During construction, activities on and near stream banks and in channels (including the installation of culverts, bridges and fords) and stream-channel realignment, may increase fine-sediment and contaminant input through run-off, bank erosion and bank failure, as well as spills and leakage from stockpiles and vehicles. In addition to local sediments, potential contaminants include lubricants, engine oils, fuels, concrete, grout, detergent, paint, solvent, metal, glass and wood debris.

Liquid contaminants that reach streams may be rapidly transported downstream and/or into the underlying aquifers where removal or neutralisation is difficult or impossible. Construction vehicles in stream channels and the installation and use of temporary fords will alter natural substrate and mobilise fine sediment. These potential adverse effects of construction on water quality and in-stream habitat will need to be prevented or minimised. The Draft Construction Environmental Management Plan (CEMP) addresses the potential effects of the Expressway construction on waterways in the Project area.

6.2.6 Provision for fish passage in new culverts

It is assumed that each waterway that crosses the Expressway, and that drains a catchment extending from the coast to the Tararua foothills, is a migration route for one or more native fish species. The fact that most of the streams have intermittent reaches at SH1 does not preclude their use by native fish and culverts will provide for fish passage between upstream tributaries and the coastal plain during flowing periods. In contrast, several waterways in the Project area are very short, and lack any connection to upstream tributaries or to the coast and primarily have a flood conveyance purpose and fish passage is not required.

The Ōtaki River and Waitohu and Mangaone Streams will be crossed with bridges, which will not create migration barriers.

Fish passage will be designed to be suitable for the local suite of migratory fish, under a range of flows. At least five catchments in the Project area are inhabited by native fish with moderate to low climbing ability, and fish passage designed for non-climbers or poor climbers will be required at the Expressway crossing points.

Detailed design of Project culverts is in progress and will be in accordance with Condition WS.4 of the resource consents and the Principal's Requirement's (PR's). Culvert dimensions, grades, inverts, and improvements for fish passage (e.g., baffles, aprons, and resting pools) will also be designed in general accordance with the guidelines developed for New Zealand fish species (Boubée *et al.* 1999, 2000, Stevenson & Baker 2009).

A detailed schedule of culverts and fish passage design requirements is included in Appendix D and will be updated as the design progresses. In general our design approach for fish passage is summarised as follows:

- Fish passage through the box culverts generally comprises nominal embedment below existing stream bed level with either in-situ gravel bed material allowed to accumulate where the gradients allow and grouted cobbles where gradients are steeper. For box culverts a grouted low flow channel will be provided through the aprons and within the culverts such that during periods of low flow there will be a concentrated depth of flow to facilitate and enable fish passage.
- For circular culverts on intermittent streams where upstream habitat is limited, no specific fish passage enhancements are needed other than ensuring culvert inverts are installed below the existing bed level (nominally 150 mm lower);
- For circular culverts on permanent and intermittent streams and where favourable habitat is present upstream, spat ropes will be used within the pipe for fish passage. The ropes extend onto the inlet and outlet aprons of the culverts and a minimum of three ropes will be installed in each culvert. The invert level of these culverts is set below the natural bed level of the watercourse (nominally 150 mm lower) at the inlet and outlet ends. The spat ropes will include knots at 1 m intervals to provide small velocity checks, assist in creating a wetted margin and assist in trapping natural bed sediments within the culvert; and
- Energy dissipation structures or erosion protection structures at culvert inlets and outlets, will not impede fish passage as these will be set at or below stream bed level to allow the voids to infill with deposited stream bed material and natural substrate.

A specific design drawing will be prepared for each culvert where fish passage is required and will be included in the drainage design report for the Project. Fish passage details will also be included in the relevant SSEMP.

The fish passage scheme connecting the Kennedy and Ōtaki Railway Wetland to the Mangapouri Stream for eels includes two outlet structures with vertical drops. The fish passage solution for these particular potential barriers is in progress but may involve spat ropes/and or internal ramps. Details will be confirmed in the SSEMP for this site.

Monitoring to ensure that fish passage through Expressway culverts is appropriately provided and maintained is described in Section 6.6.4.1.

6.2.7 Fish rescue and relocation

A Fish Rescue and Relocation Plan is required to guide all work in any permanent or intermittent water body (including the Ōtaki Railway Wetland) that is to be diverted or reclaimed (including temporary diversion for culvert placement).

A site specific Fish Rescue and Relocation Plan for the Project is included as a schedule in Appendix F to this EMP and based on known or likely species presence and habitat types. Broad methodologies to be used on the Project are detailed as follows. Site specific methodologies will be outlined in the appropriate SSEMP's.

Note the specific approach to watercourses potentially supporting mudfish in the following section and also that fish rescue processes will integrate with the diversion construction process addressed in Section 6.2.4.2.

The primary methods for capturing fish within wetland areas and stream environments will be netting with baited nets set overnight, and electric fishing. The general fishing procedure will be as follows.

- A stop net will be deployed across the channel at the upstream and downstream ends of the works area at the commencement of the fish rescue operation to prevent fish from re-colonising the works areas. Stop nets will likely comprise shade cloth mesh supported by standards and wire. Stop nets will remain in place until a diversion at any particular site is livened;
- In wetland areas and non-wade-able streams baited fyke nets and gee minnow traps will be placed throughout the isolated section of water course. The fishing effort (number of nets) will vary according to the area being fished. Nets will be left over night and cleared the next morning. If high number of fish are encountered following second night of trapping further trapping may be required. Subsequent nights netting will be undertaken until the catch rate is below 50 % of the previous pass or less than 10 individual fish captured;
- In wade-able streams the entire length of stream will be electric fished by qualified technicians with repeat passes undertaken until the catch rate is below 50% of the previous pass or less than 10 individual fish captured;
- A freshwater ecologist will be present on site at the time of dewatering the stream or the pond environments to ensure that any remaining fish are captured and relocated.
- All indigenous fish recovered will be transported and released to the appropriate relocation site (described in Appendix F);
- Appropriate handling methods will be used to minimise stress to the fish. Fish will be held in covered bins that will be regularly refreshed with stream water and transferred and released within 1 hour of being caught. Bubblers will be used if necessary to prevent asphyxiation;
- Exotic species captured through fish rescue exercises will not be transferred. Any exotic fish species captured will be euthanized humanely and disposed of appropriately; and
- Records of all fish relocated will be kept and provided in the written statement along with details on monitoring methodology, release location and monitoring dates.

6.2.8 Mudfish survey and management

Consent Condition G.40 requires that a mudfish survey is undertaken at potential mudfish habitats traversed by the Project. Brown mudfish typically inhabit intermittently flowing waterways and potential habitats for mudfish and survey locations are shown on the EMP drawings.

The general approach to managing mudfish for the Project will comprise a comprehensive survey prior to construction commencing (and when water is present in potential intermittent habitats) followed by specific fish rescue and relocation exercise where mudfish presence is confirmed. Where mudfish are not present, the general fish rescue and relocation procedure will apply.

In terms of the survey and capture methodology, this will be net based using preferentially Gee-minnow traps in accordance with the national protocol. Minimum survey effort will be 20 Gee minnow traps per site with fishing occurring over two consecutive nights. Consent Condition G.40 refers to the use of fyke nets. Fyke nets are generally too large to use effectively in intermittent waterways and will only be used if habitat is suitable. If appropriate, fine mesh fyke nets with an exclusion chamber will be deployed.

Mudfish captured in the initial survey and in any specific fish rescue trapping exercise will be released to alternative and appropriate habitats within the same water body. The cleared site will only be isolated with stop nets if the particular works in that watercourse are scheduled to occur immediately following the fishing.

6.3 Rehabilitation and restoration

6.3.1 Restoration of dotterel breeding habitat

Condition G.46A requires that dotterel nesting habitat is enhanced in an area upstream of the Ōtaki River Bridge prior to bridge construction (scheduled to commence in December 2017). In summary this work will involve selecting a potentially suitable nesting site(s) and enhancing these areas for dotterel nesting through the control of woody weeds at that site prior to the dotterel breeding season (July to January) and during the bridge works. The detail of the proposed habitat enhancement work will be included in the relevant SSEMP but will include:

- Site survey and confirmation of the location and extent of the enhancement area (September/October 2017);
- Preparation of a woody weed/willow control plan for the selected area;
- Implementation of the plan leading up to construction commencing in December 2017; and
- Monthly monitoring and inspection throughout the bridge construction period.

6.4 Effects mitigation

6.4.1 Diversion channel design

Some like-for-like mitigation will be undertaken to replace stream habitat loss in the form of constructed stream diversion channels. The detailed design of diversion channels is in progress and seeks to match existing habitat types upstream as practical. Some general principles are provided in

Section 6.2.4 and ecological requirements will be advised to design engineers for each site following initial (baseline) stream macroinvertebrate and fish surveys.

Full details for each diversion channel will be provided in the relevant SSEMP. Details will address the requirements of Condition 25 i) and include fish passage methods, fish rescue and relocation, seasonal migration considerations, stream profile, bed substrates and habitat types and riparian planting.

6.5 Stream ecological compensation

Condition G.46 b) requires at least 2,601 linear metres of riparian planting as compensation for stream habitat loss as a result of the Project. The bulk of this riparian is being planned and undertaken at out of Designation sites by Opus on behalf of NZTA. A separate Management Plan is being prepared by Opus for this work and will be included in Appendix A to this EMP.

This plan aims to achieve the full 2,601 linear metres requirement focussing on riparian retirement, fencing and restoration planting on Jewell Stream, mostly downstream of the Designation. Full details are provided in Appendix A.

A detailed breakdown of stream effects for Fletcher's design and associated compensation requirements based on the consented compensation ratios is provided in Appendix G. At this point in the design phase stream effects are less than the BOI design, and therefore the 2,601 lineal meters is more than adequate to address effects.

Stream ecological effects and compensation accounting will be a live process as the detailed design develops and construction progresses. Updated ecological accounting details for stream effects (and other effects) will be provided through the SSEMP's to ensure any balance of effects can be addressed in advance of Project completion. An audit report covering ecological effects accounting will be prepared and provided to GWRC at the end of the Project and will outline any additional compensation work required and the timeframe for completing this.

6.6 Stream monitoring and response

6.6.1 Monitoring sites

A site inspection was undertaken in July 2017 to identify appropriate monitoring sites and confirm monitoring methodologies. Access restrictions meant that sites could not be confirmed on the Waitohu Stream or the upstream side of the Project on Mangaone Stream. Site locations will be confirmed in a subsequent amendment to this EMP, which will include an update to Table 5 and a new map in the drawing set showing monitoring locations. Jewell Stream was selected as the intermittent stream to be included in the monitoring programme.

Site locations are described in Table 5 along with brief comments on monitoring methods. Coordinates represent the proposed water quality sampling point. Macroinvertebrate, deposited sediment and fish survey reaches would generally extend upstream from the marked point at sites upstream of the alignment and downstream from the downstream sites. Coordinates for the exact survey reaches will be collected during the first survey round.

Table 5: Stream monitoring locations and method summary

Site	Coordinates (NZTM)		Description and notes
	Northing	Easting	
Waitohu upstream	TBC	TBC	TBC
Waitohu downstream	TBC	TBC	TBC
Mangapouri upstream	TBC	TBC	50 m upstream of County Rd. Modified stream habitat with banks and bed lining. Macroinvertebrate sampling to follow protocol C2 to be comparable to downstream site. Standard 150 m EFM survey for fish. SAM2 for deposited sediment.
Mangapouri upstream	TBC	TBC	20 m downstream of SH1. Hard bottomed stream but macroinvertebrate sampling to use Protocol C2 to match upstream site. Standard 150 m EFM survey for fish. SAM2 for deposited sediment.
Ōtaki upstream	TBC	TBC	500 m upstream of the proposed bridge site. Macroinvertebrate protocol C1 undertaken at first riffle upstream of the bridge. Deposited sediment at the first run, SAM2. EFM survey to cover a 150 m^2 area in the wade-able edge as opposed to the entire river cross section.
Ōtaki downstream	TBC	TBC	500 m downstream of the proposed bridge site. Macroinvertebrate protocol C1 undertaken at first riffle downstream of the proposed bridge. Deposited sediment at the first run, SAM2. EFM survey to cover a 150 m^2 area in the wade-able edge as opposed to the entire river cross section.
Mangaone upstream	TBC	TBC	TBC
Mangaone downstream	TBC	TBC	100 m downstream of western link road crossing. Macroinvertebrate protocol C1 undertaken at first riffle downstream of the western link road crossing. Deposited sediment at the first run, SAM2. Standard 150 m EFM survey for fish
Jewell upstream	TBC	TBC	50 m upstream of the existing SH1 culvert. Macroinvertebrate protocol C1 undertaken at first riffle upstream of the water quality sampling point. Deposited sediment at the first run, SAM2. Standard 150 m EFM survey for fish.
Jewell downstream	TBC	TBC	250 m downstream of the alignment, downstream of the confluence with Edwin Stream and at the edge of the Designation. Macroinvertebrate protocol C1 undertaken at first riffle downstream of the water

			quality sampling point. Deposited sediment at the first run, SAM2. Standard 150 m EFM survey for fish.

6.6.2 Pre-construction monitoring

6.6.2.1 Macroinvertebrate monitoring

Baseline macroinvertebrate sampling will be undertaken at proposed construction phase monitoring locations (to be established) in Ōtaki River and Waitohu, Mangapouri, Mangaone and Jewell Streams (if water is present). This will be undertaken on two occasions prior to specific construction impacts occurring on those streams, ideally once during winter (June to August) and once during summer (December to March) to provide a seasonal aspect to the data. The timing and frequency of the baseline sampling will be dependent on gaining access to suitable sites. The data will provide a baseline from which to assess the data collated during construction monitoring.

Sampling will be in accordance with Protocols C1 (hard bottomed, quantitative) or C2 (soft bottomed, semi-quantitative) of the standard national protocol (Stark *et al.* 2001) with three replicate samples collected at sites upstream and downstream of the works footprint on each of the five watercourses. Samples will be processed in accordance with standard protocol P3 (full count with a sub-sampling option).

6.6.3 Construction phase routine monitoring

Construction phase routine monitoring will commence when construction commences and finish when construction activities affecting any given waterway are complete.

Water quality and biota need to be monitored in waterways during the construction phase to ensure that construction activities are not having adverse effects on aquatic ecosystems. This monitoring will take place in phase with construction activities, i.e., when construction is underway near a major waterway, the waterway will be monitored until the construction is complete.

Construction monitoring will be carried out at the Ōtaki River and Waitohu, Mangapouri and Mangaone Streams, and at Jewell Stream (an intermittent waterway with moderate ecological-values) during periods when flowing water is present.

Construction effects on the above ecological variables are to be identified on the basis of comparisons between sites upstream of and within or immediately downstream of the construction sites on the 5 waterways. The upstream and downstream sites used for ecological monitoring on the Ōtaki River and Waitohu, Mangapouri and Mangaone Streams should be the same areas used for pre-construction macroinvertebrate monitoring.

Fine sediment deposits and oil-and-grease will be monitored monthly, and macroinvertebrates and fish will be monitored quarterly.

6.6.3.1 Sedimentation

Fine sediment deposition resulting from construction activities poses a risk to aquatic ecosystems. Fine sediment deposition can be measured rapidly in the field. Procedures for monitoring fine sediment deposition and guidelines for interpreting the measurement data have been developed for New Zealand streams (Clapcott *et al.* 2011). These procedures and guidelines are for "hard-bottomed" streams with gravel, cobble, and boulder-dominated beds.

Sedimentation monitoring will follow Sediment Assessment Method 2 – In-stream visual estimate of % sediment cover (Clapcott *et al.* 2011) which includes a minimum of 20 estimates over a reach of run habitat at each site. Our initial site inspection has confirmed this method is appropriate for use in all five watercourses to be monitored.

This assessment will be completed monthly at sites upstream and downstream of the works on each monitoring occasion. The trigger level for adverse changes in visual estimates of sediment coverage will be statistically significant increases in the mean value for each sampled reach, which persists for three months or more. Exceedances of trigger will result in an assessment of the cause of the effect including any remedial and/or mitigation measures. The outcomes of the assessment will be provided in the quarterly report to Council.

6.6.3.2 Oil and grease

Oil and grease from construction equipment can harm aquatic organisms, but they are not detected by turbidity loggers. Therefore, regular grab sampling and analysis is required.

Standard procedures will be used for oil-and- grease sample collection, and the samples will be analysed by a certified analytical laboratory.

Where laboratory testing identifies elevated levels at the downstream site compared to upstream a review of the works in progress will be undertaken to identify the source of the contamination. Management processes will be modified to prevent a similar occurrence in the future and a report be prepared for the consent authority outlining the nature of the breach, any immediate actions taken to limit further discharge, and changes to practices to ensure that such an occurrence does not happen in the future. The outcomes of the assessment will be provided in the quarterly report to Council.

6.6.3.3 Macroinvertebrates

Macroinvertebrate monitoring will consist of three replicate samples collected using the Ministry for the Environment standard protocols for semi-quantitative sampling in hard and soft-bottomed streams (Protocol C1 and C2; Stark *et al.* 2001). Invertebrate samples will be processed using the standard protocols for fixed counts (Protocol P2; Stark *et al.* 2001).

Exceedances of the following triggers will result in an assessment of the cause of the effect including any remedial and/or mitigation measures. The outcomes of the assessment will be provided in the quarterly report to Council:

- A decline in the Quantitative Macro-invertebrate Community Index (QMCI) score of 1.5 or greater from the corresponding upstream monitoring site or baseline monitoring scores; or

- A decline of greater than 20 % in sensitive invertebrate taxa (in this case taxa with a QMCI score of ≥ 5) compared to the upstream monitoring site or baseline monitoring scores.

6.6.3.4 Fish

Quarterly fish monitoring as required by Condition G.41 b) will follow the standardised electric fishing protocol that has been developed for estimating the diversity and relative abundance of fish species in New Zealand waterways (Joy *et al.* 2013), aside from at Ōtaki River sites. Ōtaki River fish survey work will comprise an electric fishing survey of a set 150 m^2 wade-able area at matching upstream and downstream sites.

Exceedances of the following triggers will result in an assessment of the cause of the effect including any remedial and/or mitigation measures. The outcomes of the assessment will be provided in the quarterly report to Council:

- A difference in species diversity (number of taxa) between matching upstream and downstream sites; and/or
- A 20 % lower abundance of any native species at the downstream site compared to upstream.

6.6.3.5 In-stream works monitoring

In-stream works areas shall be regularly inspected and maintained in accordance with Consent Condition WS.10 to ensure that:

- The waterway within the culverts remains substantially clear of debris during construction;
- Any erosion of the stream banks or bed that is attributable to, and is within 20 m up or downstream of, the stream works authorised by this consent is remedied as soon as practicable by the consent holder; and
- Fish passage through the structure or any new permanent diversion is not impeded.

These inspections will be added to the Erosion and Sediment Control Plan for these works.

For diversion works, verification shall be provided in writing by an engineer and aquatic ecologist that the permanent stream diversions have been completed in accordance with the relevant SSEMP stream diversion plan.

6.6.4 Construction phase event based monitoring

Construction phase event based monitoring will commence when construction commences and finish when construction activities affecting any given waterway are complete.

This section outlines the monitoring to be undertaken during construction in response to rainfall and turbidity trigger exceedances. In addition, monitoring and reporting will be triggered In the event of a failure of an ESC device or storm exceedance of the device design volume, in which case the procedure outlined in Figure 1 below will be followed in accordance with Condition E.4. The approach to erosion and sediment control is provided in the Erosion and Sediment Control Plan (ESCP), which

should be consulted for the overall process and details of the approach and methods. Details of the stream monitoring variables, triggers and methods are set out in the following sections.

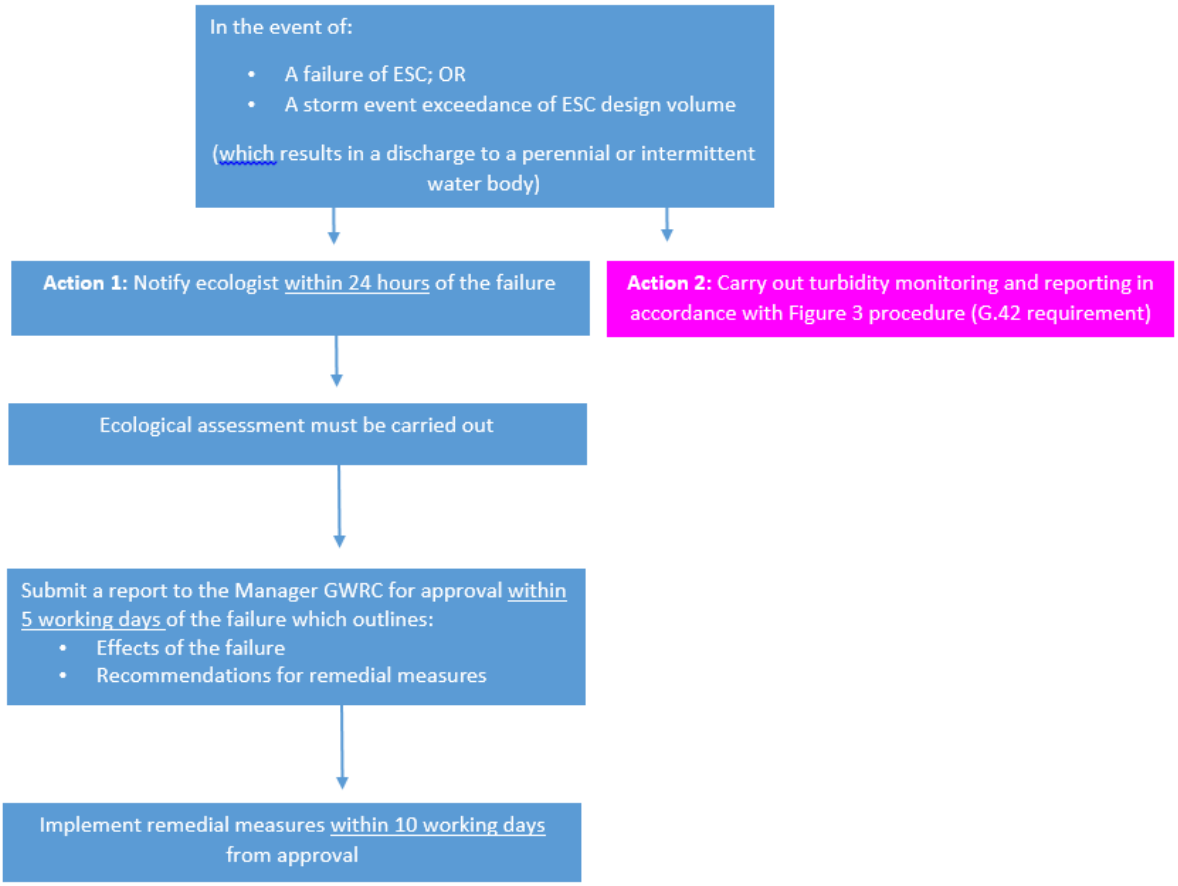

Figure 1: Triggered actions in the event of ESC failure (Condition E.4)

6.6.4.1 Rainfall

The Project will record actual rainfall records for the alignment through on site rain gauges. It is recognised that this rainfall is variable throughout the Project and two rainfall gauges will be necessary for this purpose. This rainfall record will hence be based on two gauges utilising existing and newly established gauges as required.

Rainfall triggers are set as:

- 7mm over any 1 hour period; or
- 20 mm over any 24 hour period

The rain gauges will be monitored (and telemetered) to allow the determination of such triggers to be established. The procedure to follow in the event of a rainfall trigger is set out below in Figure 2 which is required by Condition G.42.

6.6.4.2 Turbidity

Turbidity will be used as the key parameter for monitoring construction effects on waterways, and trigger levels for construction effects will be based on turbidity.

Turbidity monitoring will be carried out immediately following a rainfall trigger exceedance, and/or in the event of a dirty water discharge to water as per E.4 (Figure 2), and will be repeated at 24 hours and 48 hours from the trigger. Figure 2 below outlines the full process to be followed in accordance with G.42.

The monitoring method within each of the five main watercourses (Waitohu, Ōtaki River, Mangaone, Mangapouri, and the Jewell stream) will be determined prior to the earthworks phase within each of these catchments. The confirmed monitoring method (i.e. hand-held turbidity or telemetry) will be submitted to the Manager GWRC for written approval prior to commencement of works, or be included in the relevant SSEMP for each area.

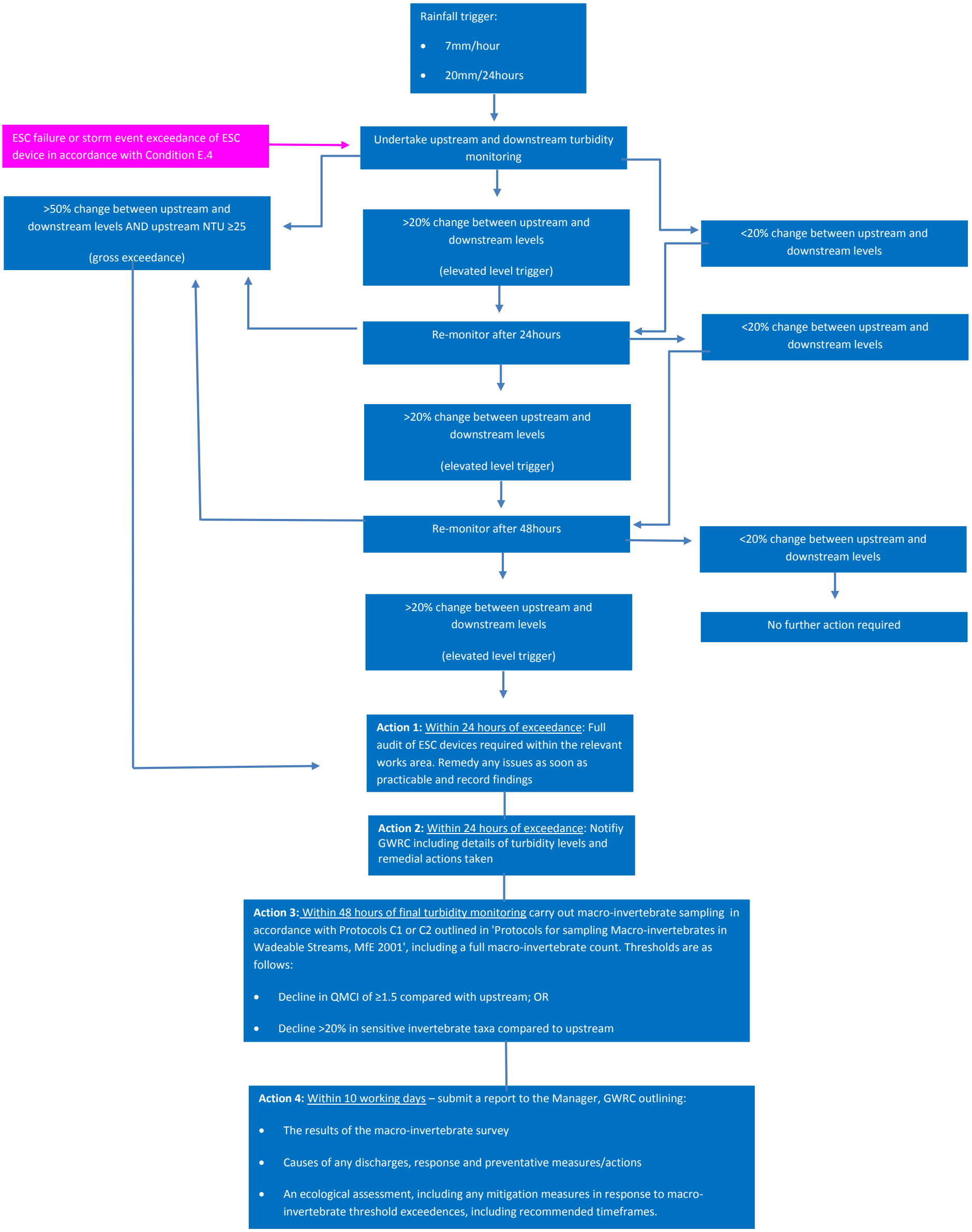

Figure 2: Condition G.42 Adaptive Management and Monitoring Procedure

6.6.5 Post construction monitoring

Post-construction monitoring shall be undertaken for a two-year period to ensure that water quality, biotic communities and fish passage are not adversely affected by Expressway operation. Monitoring of the planted riparian buffers shall be undertaken over a period of 5 years from the time completion of the mitigation is due, in accordance with Condition G.35B.

6.6.5.1 Stream habitat quality monitoring

The post-construction monitoring will take place at the same five waterways listed above for construction monitoring, using the same paired sites. The site-pairs will continue to serve as control-impact sites for identifying Expressway effects. Quarterly monitoring of fine sediment deposits, aquatic macroinvertebrates and fish will be sufficient for detecting Expressway effects, if any occur.

Data will be analysed following each quarterly monitoring round. The triggers for an assessment of effects and management responses will be the same as per the during construction monitoring and will be reported to Council. The two-year period will be followed by a full review to determine whether remedial measures are needed, or continued monitoring is necessary.

6.6.5.2 Fish passage monitoring

Inspection of fish-passage culverts by an ecologist one and four years after installation is required. Inadequate culvert maintenance is considered a major cause of fish passage problems. Regular culvert inspection and maintenance is recommended in virtually all fish passage guidelines (e.g., Boubée et al. 1999, Stevenson and Baker 2009). The inspections will focus on aspects such as debris and sediment blockage, and erosion and scouring.

In accordance with Condition WS.9 the monitoring shall be undertaken by an appropriately qualified and experienced aquatic ecologist and an appropriately qualified and experienced engineer and include:

- A visual inspection of all structures and works (including new permanent diversions) where fish passage is required, one year after installation; and
- A visual inspection of all structures and works (including new permanent diversions) where fish passage is required, four years after installation.

The visual inspections will determine the following:

- That the substrate bed of the water body is being retained within the culverts, pipes and new stream channels, or appropriate baffle or rock fixtures are in place;
- Whether there are any signs of erosion or scour of the stream bed or banks around the structures/works/depositions;
- The condition of the structures/works;
- That stream flow velocities are not increased in any areas within the structures/works or upstream/downstream of the structures/works that could compromise fish passage (e.g. baffles and rock protection are adequate and in good condition); and

- Whether there is debris that could block the passage of fish or increase velocities.

If it is found that fish passage may be restricted, inspections and appropriate remedial actions shall be repeated by the consent holder (for the specific structure/area of works/scour protection where the restriction occurs) annually until GWRC is satisfied that fish passage is being appropriately provided for.

A joint report from a suitably qualified and experienced ecologist and a suitably qualified and experienced engineer will be submitted to GWRC within 1 month of undertaking the inspections described above. Any measures/works required to address any actual or potential effects on fish passage will be completed within three months of submitting the report to GWRC.

6.6.5.3 Planted riparian buffer monitoring

The planted riparian buffers included in Fletcher's scope require biannual maintenance and inspection for five years after planting. By five years, planted areas should have matured sufficient for canopy cover to be self-sustaining.

Monitoring will include plantings surveys of plantings for five years to:

- Identify any instances of plant mortality and possible causes, particularly pest animal browse;
- Identify weeds that need controlling;
- Identify fences that need repairing;
- Make recommendations for infill planting (failed specimens will be replanted as necessary to meet target canopy closure of 80 %); and
- Make recommendations for pest animal control if required.

Ongoing management of the riparian plantings will include the following:

- Invasive weed control is to be undertaken twice annually during spring and autumn for two years and once annually in spring thereafter or as required; and
- Any plants which failed to establish during Year 1 will be replaced in the planting season of Year 2 with species which have proven to be successful.

7 ONGOING PROTECTION OF ECOLOGICAL MITIGATION AREAS

Mitigation work is being undertaken both within the designation boundary (e.g. Ōtaki Railway Wetland, Kennedy Wetland, Mary Crest wetland and swamp forest) and outside of the Designation boundary (e.g. riparian restoration planting along Jewell Stream).

Areas that will remain inside the designation and under Transport Agency ownership in the long term do not require any further legal protection (including features that provide for functioning of the Expressway such as wetlands used for flood attenuation). Those areas of mitigation on land to be disposed of once the project is complete will be legally protected prior to disposal through a legal encumbrance such as a covenant on the title. QEII covenants may be used as a long-term protection tool and this is being pursued for the out of Designation terrestrial mitigation.

The ongoing protection of areas of out of the Designation such as stream ecological mitigation and compensation is being investigated by NZTA. A report will be provided to GWRC to demonstrate how permanent protection will be achieved.

8 REPORTING

Reporting requirements specific to the activities addressed in this EMP are included throughout the document as appropriate.

Specific reporting requirements include:

- Submission of all monitoring results collected in accordance with this EMP to GWRC on a quarterly basis;
- All activities undertaken in accordance with this EMP will be summarised and presented in an annual report and submitted to GWRC by 30 June each year;
- Updates to the ecological effects accounting for wetland, terrestrial and aquatic ecology will be provided through the SSEMP's;
- An audit report covering ecological effects accounting (for wetland, terrestrial and aquatic ecology effects and mitigation/compensation) will be prepared and provided to GWRC at the end of the Project; and
- A report to GWRC detailing the ongoing legal protection of mitigation areas, including areas within the current Designation but potentially to be disposed by NZTA at the end of the Project and areas of ecological mitigation outside of the Designation.

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APPENDIX A: OUT OF DESIGNATION ECOLOGICAL MITIGATION PLANS

Peka Peka to Ōtaki Project

Riparian and Terrestrial Planting - Outside Designation Management Plan

Appendix to Ecological Management Plan

Peka Peka to Ōtaki Project

Riparian and Terrestrial Planting - Outside Designation Management Plan

Appendix to Ecological Management Plan

Opus International Consultants Ltd
Wellington Environmental Office
L10, Majestic Centre, 100 Willis St
PO Box 12 003, Thorndon, Wellington 6144
New Zealand

Telephone: +64 4 471 7000
Facsimile: +64 4 499 3699

Date:
Reference:
Status:

Contents

Authorisation and Revision Record

Detail	Approved By	Revision	Date

Certification Record

Revision	Action	Name	Position	Date	Signature
	Approved by:				
	On behalf of GWRC				

Consent Compliance Framework

This MPMP is for the riparian planting component of the EMP. The BOI conditions do not refer to a separate MPMP document, but it must be in accordance with the relevant EMP conditions. The table below shows those EMP conditions that are relevant, including a reference to the section of this MPMP where details are provided.

Reference	Summary of EMP requirement relevant to MPMP	Section
G.15	Annual reporting requirements	
G.31	EMP submission must be within 20 working days prior to construction commencing	
G.32	States the purpose of the EMP and that the EMP must be prepared by a suitability qualified and experienced and ecologist and finalised in consultation with Nga Hapu o Ōtaki and Kapiti City District Council (KCDC). Construction must not commence until the consent holder has received the Manager's written certification of the EMP	
G.33	EMP requirements in relation to: Effects minimisation Compliance with management triggers and thresholds Habitat offset mitigation Monitoring details Remedial/response actions	
G.34	Requirement for the EMP to include a revegetation and mitigation strategy that includes a 5 year maintenance period, stock exclusion, reviews and programme for remedial actions where required	
G.35A	Requirement for ongoing legal protection of all ecological mitigation areas	
G. 35B	Requirement for mitigation works to be staged to minimise lag between effects and mitigation (lag < 1 year)	
G. 36	Requirement for the EMP to be consistent with LUDP	
G.37	Requirement for submission of EMP to KCDC (for comment) at least 15 days prior to EMP submission to GWRC	
G. 38	Monitoring shall be in accordance with EMP as required by condition G.33g in order to: (e) Monitor vegetation and freshwater ecology following project completion to confirm mitigation requirements	
G.43	Post-construction monitoring requirements including: Mitigation areas established under Condition G.46 The need for 5-years of post-construction monitoring	

	Aquatic ecology monitoring including (iii) 5 years of riparian buffer monitoring	
G.44	Requirements for all ecological monitoring to be undertaken by suitably qualified and experienced ecologists and inspection and reporting requirements for monitoring results	
G.45	Response requirements for exceedance of trigger levels for any monitoring limit or management trigger level set in the EMP during or post-construction (exclusive of turbidity)	
G.46	Ecological mitigation requirements including: b) Riparian planting shall be a minimum of 2,601 lineal metres at least 20 m width either side of the bank	
G. 47	Requirements to ensure terrestrial, wetland, and riparian habitat reflects similar indigenous ecosystem types to what is being replaced	

1 Introduction

1.1 Project background

This Mitigation Planting Outside Designation Management Plan (MPMP) has been developed for the State Highway 1 Peka Peka to Ōtaki (PP2O) Expressway. Works will occur over a 200 week period from September 2017. The works will entail construction of a 12km, 4-lane Expressway, consisting of:

- 1.4M m³ Earthworks
- 9 km local road
- 10 No. Bridges, including 330m, Ōtaki River Crossing
- Ōtaki Intersection - split
- East-West connections – Ōtaki, Te Horo
- Grade separation – Taylors Road
- 1.6 km railway realignment

The works will follow a general programme of enabling works and site establishment, followed by rail realignment and bridge construction and then road construction.

The key project parameters are given in Table 1.

Table 1: Contract details

Contract Detail	
Project Name	Peka Peka to Ōtaki Expressway
Nature of project	13 kms of new expressway and 10 new bridges
State Highway Classification	SH 1
Commencement	September 2017
Project End Date	07 January 2021
Project Manager	Craig Pitchford (NZTA)
Principals advisor	Ron McFadyen (Opus)
Contractor	Fletcher Construction
Contract Manager	John Palm (Fletcher)
Councils with Jurisdiction	Greater Wellington Regional Council (GWRC) Kapiti Coast District Council (KCDC)

1.2 MPMP Purpose

This management plan is intended to ensure that the riparian planting required under condition G.46(b) will comply with the Board of Inquiry (BOI) resource consent conditions. The BOI conditions do not require a separate management plan, so this plan should be considered as an

appendix to—and part of—the overall Ecological Management Plan (EMP) for the purposes of complying with the conditions. This MPMP has been prepared as a standalone management document to be certified separately from the main EMP for practical reasons, as the riparian planting will be done under a separate contract to the main contractor.

The purpose of this MPMP is to set out how [insert contractor name] intends to achieve compliance with the riparian planting related conditions of Resource Consents [insert reference]

Resource Consent Condition G.46(b) requires:

G46.(b) *Riparian planting shall be a minimum of 2601 linear metres of planting to a minimum of 20m each side of the Water Body, unless agreed otherwise by the Manager.*

Our overarching goal is to achieve a no net loss of biodiversity values affected by the Project and to therefore align with the Transport Agency's Ecological Resources Objective E2.

1.3 MPMP Scope

This MPMP forms part of the EMP and addresses the riparian mitigation planting required by condition G.46(b). The scope of this MPMP is broadly:

- Location of works
- Species lists, Planting densities and spacings, Plant schedule
- Methodology
- Maintenance regime
- Monitoring

1.3.1 Ngā Hapū o Ōtaki

Ngā Hapū o Ōtaki and NZTA are currently in the final stages of agreeing a Mitigation Plan. The Mitigation Plan that seeks to provide NHoŌ with the ability to exercise Kaitiatanga over its traditional lands in respect of Expressway design and construction. The Mitigation Plan also requires the preparation and implementation of a Cultural Monitoring Plan. The Cultural Monitoring plan will be complimentary to the EMP and where possible will be aligned, for example the location of monitoring points. Once the Cultural Monitoring Plan has been prepared an assessment of the Cultural Monitoring Plan and the EMP (including this MPMP) will be undertaken to determine if the EMP requires any amendment.

1.3.2 KCDC

As the MPMP is part of the EMP, a draft is required to be provided to KCDC (condition G.37). The purpose of this is to ensure that relevant requirements of the EMP are reflected in the Landscape Urban Design Plan. This includes such matters as the identification of suitable plant species for rehabilitation activities, mitigation planting requirements and areas of high ecological value.

1.4 Document structure

- Section 1 – Introduction

- Section 2 – Ecological values and effects
- Section 3 – Ecological mitigation strategy and framework
- Section 4 – Planting and grassing specification

2 Ecological values and effects

2.1 Ecological context and values

Ecological values within and around the designation are described in detail in the documentation supporting the Environmental Protection Agency (EPA) application for the project and in the evidence and conferencing documents prepared through the Board of Inquiry (BOI) process. Ecological values are therefore only summarised here. The locations of important ecological values are shown on the Ecology Layout Plans (Drawings DG-CE-0801 to 0817) provided as Appendix A.

The expressway alignment passes through a highly modified landscape that is now dominated by agriculture, and to a lesser extent horticulture, viticulture and urban/suburban landuse. Correspondingly, indigenous habitats and vegetation have been significantly reduced from their former extent with only 1.7% of indigenous vegetation cover and 1.3% of wetlands now remaining. What does remain is ecologically significant (

Table 1) and therefore warrants efforts to both minimise adverse effects and to appropriately mitigate for effects that cannot be avoided.

Table 1: Areal or lineal extent of each broad habitat category and nationally 'Threatened' 'At Risk' or legally protected species that are known or likely to be present within each habitat type

Habitat types with significant ecological values within the designation	Associated nationally 'Threatened', 'At Risk' or legally protected species that are known to be present or likely present	Total ha / km
Farmland/Duneland	NZ pipit	Approx. 27 ha
Mature native forest and groups of trees	Native lizards, land snails, peripatus	0.39 ha
Braided river bank	Banded dotterel	Unknown area (surveys required)
Freshwater wetland	None known to be present but spotless crake, marsh crake and Australasian bittern could potentially be present	0.8 ha
Waterways	Longfin eel, kaoro, inanga, red-fin bully, giant kokopu, shortjaw kokopu, torrentfish, lamprey and brown mudfish	2.84 km

2.2 Effects

Potential adverse effects associated with the construction and operations of PP2O will primarily occur through habitat loss associated with vegetation clearance, earthworks and stream culverting

and diversions. Ongoing indirect effects on remaining habitat in close proximity to the preferred alignment are also expected. Potential effects on ecological values associated with the project include:

- damage to remaining areas of native bush habitat immediately adjacent to the Project footprint as a result of construction activities;
- edge effects due to the loss of bush from the edges of Hautere Bush F, Cottle's Bush and bush to south of Te Hapua Road;
- potential adverse effects on peripatus through habitat loss and/or edge effects;
- potential adverse effects on lizards and the 'Nationally Critical' *Powelliphanta traversii Ōtakia* (herein Ōtaki Snail) due to habitat loss and edge effects;
- disturbance to NZ pipit populations south of Mary Crest and in the dune areas north of Ōtaki;
- disturbance to nesting Banded Dotterels in the vicinity of the Ōtaki Bridge crossing;
- potential effects on the hydrology of the remaining part of the Ōtaki Railway Wetland;
- loss of c.0.5ha of habitat from the Ōtaki Railway Wetland;
- adverse effects on aquatic life due to sediment and contaminant discharges to watercourses during construction;
- adverse effects on fish passage during, and as a result of, construction activities;
- impediment of fish passage by various new culverts installed along the expressway; and
- the loss of waterway habitat due to installation of culverts and stream diversions at various locations along the Project.

3 Ecological mitigation strategy and framework

3.1 EMP general approach and guiding principles

The general approach to managing ecological effects was established through the Designation/ consent BIO process and the associated consent level design (prepared by Opus, URS and Holmes Consulting) and this is reflected in the Designation and Resource Consent conditions.

Opus and NIWA scientists addressed ecological matters and effects management using the mitigation hierarchy approach as set out in the Standard on Biodiversity Offsets published by the Business and Biodiversity Offsets Programme (BBOP) in 2012. The BBOP (2012) ecological mitigation hierarchy is set out in Table 3. The EMP follows the same effects mitigation hierarchy framework and sets out avoidance, minimisation, rehabilitation and limited offset mitigation measures.

This MPMP is primarily concerned with the new areas of stream riparian planting that are part of the measures to offset the balance of the habitat loss effects (residual effects) as a result of the Project.

Table 3: Ecological mitigation hierarchy

Hierarchy	Details
1) Avoidance	Measures taken to avoid creating impacts from the outset, such as careful spatial or temporal placement of elements of infrastructure, in order to completely avoid impacts on certain components of biodiversity.

2) Minimisation	Measures taken to reduce the duration, intensity and / or extent of impacts (including direct, indirect and cumulative impacts, as appropriate) that cannot be completely avoided, as far as is practically feasible.
3) Rehabilitation / Restoration	Measures taken to rehabilitate degraded ecosystems or restore cleared ecosystems following exposure to impacts that cannot be completely avoided and/ or minimised.
4) Offset	Measures taken to compensate for any residual significant, adverse impacts that cannot be avoided, minimised and / or rehabilitated or restored, in order to achieve no net loss or a net gain of biodiversity. Offsets can take the form of positive management interventions such as restoration of degraded habitat, arrested degradation or averted risk, protecting areas where there is imminent or projected loss of biodiversity.

4 Planting and grassing specification

4.1 General

This section of the Specification relates to the works for the installation and maintenance of the planting and grassing. This includes, but is not necessarily limited to:

- Specifications and Documents
- Contractor qualifications
- Timing of grassing and planting
- Quality of trees and plants
- Weed Control
- Topsoil and Compost
- Planting Layout
- Planting Technique and Fertiliser
- Staking and Ties
- Watering
- Grassing
- Landscape Maintenance
- Monthly Establishment Report
- Weed and Grass Control
- Replacement of Plants
- Completion and Finishing
- Grass and Planting Acceptance Criteria

4.2 Specifications and Documents

Works shall comply with the relevant requirements of the standard Specifications together with the following further provisions in this section:

a. NZS 4404 Methods of testing soils for civil engineering purposes
b. NZS 4454 Composts, soil conditioners and mulchers

4.3 Contractor Qualifications

All planting required shall be undertaken and completed in accordance with accepted practices by a Landscape Contractor who has current membership of the Landscape Industries Association of

New Zealand or Nursery and Garden Industry Association, hold a Level 4 amenity turn or horticultural qualification and demonstrate relevant experience and knowledge.

4.4 Timing of Grassing and Planting

Work shall only be undertaken when the weather is suitable i.e. mild, dull and moist, and when the ground is moist and workable. All planting and grassing operations shall be suspended during periods of severe frosts, drought, water logging or persistent drying winds.

Planting and grassing shall only take place from 1 April to 30 September. If construction delays occur and planting and grassing is required outside of this season then the Contractor shall seek advice and instructions from the Engineer before proceeding.

1.1 Quality of Trees and Plants

All trees and plant material shall be first class specimens of nursery stock, true to name and type, with well-developed and well-shaped trunks or stems and head.

All trees and plants shall be healthy, vigorous and free of disease, injury, parasites or insects and shall not be pot-bound. They shall be well hardened off to cope with the climatic conditions of the site. Trees and plants not hardened off with soft growth.

All root masses shall retain their shape and hold together when removed from their containers.

Plants shall be handled with care at all times and lifted by the container. Plants shall be true to botanical name, quantity and grade, as specified on the Drawings. Plants shall not be substituted without the Engineers approval.

During transportation of the plants to the site, the Contractor shall ensure that adequate protection is given to plants. All plants must be kept adequately watered and located in a position where plants will not be subject to stress.

Plants will be subject to inspection by the Contractor and Engineer. Any plants not meeting Specification standard will not be accepted. Rejected plants shall be removed from the site within 48 hours and replaced at the Contractor's expense.

1.2 Weed Control

All areas to be planted and grass areas shall be entirely free of grass, plant pests and nuisance weed species. If herbicidal eradication is required the Contractor shall notify the Engineer at least one week prior to all spraying activities.

Details to be advised include: the area to be sprayed, materials to be used, the name of the Spraying Contractor, and when the areas will be sprayed. A registered Spraying Contractor shall be on site and controlling the spraying operation at all times. The Spraying Contractor shall be a Registered Chemical Applicator with current A and B Certificates. Spraying activities shall meet the requirements of the controlling local authority.

Herbicide application general: Apply using protective clothing, in dry, still-air conditions to the spray Manufacturer's requirements. The Contractor shall be responsible for reinstating any damage caused by drift of spray.

1.3 Topsoil and Compost

Imported first class topsoil shall meet NZS 4402 and NZS 4454, be of good quality, free draining, free of perennial weeds, undecomposed or partly decomposed organic matter and debris and capable of sustaining the required plant growth.

The imported topsoil shall have a soil pH of between 5.5 and 7.5 and contain less than 5% by dry weight of solid detritus and debris. The stone content shall be less than 10% by dry weight. The topsoil shall not contain any object larger in dimension than 20mm.

The clay content shall not exceed 25% by dry weight and have an organic content by dry content of between 7% and 20%.

All composts shall be pasteurised composted composts free from harmful chemicals, grass and weed growth complying with the requirements of NZS 4454 "Composts, soil conditioners and mulches" Living Earth 'Ultrasoil' or similar approved is acceptable. The Contractor to supply samples to the Engineer for approval. Compost not approved prior to delivery to site will not be accepted.

The Engineer may request soil tests to confirm that the topsoil complies with this Specification. Testing, by an approved laboratory, shall include pH, phosphorus, extractable cations, cation exchange capacity, total base saturation plus any recommendations for bringing the topsoil up to the required standards. Topsoil testing shall be at the Contractor's expense.

1.4 Planting Layout

The Contractor shall be thoroughly familiar with the drawing requirements and layout. Plants shall be located and placed at the spacing shown on the planting plans. The Engineer shall inspect the plant quality and locations once plants have been laid out in position prior to planting. The Engineer may require minor refinement to the design with adjustments to lines, levels and groupings of shrubs, groundcover as the planting proceeds.

In areas of block planting, plants shall be spaced so that when established they will completely and evenly fill the areas indicated, unless otherwise specified. Plants shall be spaced around the perimeter first to define the extent of the area to be filled by each species. The remaining plants shall then be used to fill the centre of the area in an informal manner avoiding straight lines and regular geometric patterns, unless otherwise specified Plant layout is to be confirmed by the Engineer prior to planting.

1.5 Planting Technique and Fertilizer

Prepare holes for plants in a manner and to dimensions required by the particular specimen. The planting holes are to be approximately twice the width and one and a half times the depth of the rootball. Where the plant rootball depth exceeds the depth of the topsoil (400mm), continue down

into the subsoil a further 150mm, breaking it up and mixing in the topsoil mix before placing. Base and sides of the hole are to be well shattered.

Plants are to be thoroughly watered prior to planting. Do not remove container until planting. Trim damaged roots and score the sides of matted root balls with a sharp instrument. Place plant with its roots well spread out and hanging downwards, roots should not be bent or distorted in any way. AGPRO Controlled Release Fertiliser Tablets "Tree and Shrub" grade or approved equivalent must be applied at the time of planting. Fertiliser tablets must be placed close to but not in contact with the roots in the bottom of the planting hole. Tablets shall be used at the rate of specified by the Manufacturer;

Backfill in with the topsoil mix in 150mm layers, compact each layer firmly to a level that will allow the top of the root ball to finish flush with surrounding ground. Water-in immediately after planting to the saturation level of surrounding soil.

1.6 Staking and Ties

All trees, shall be staked vertically with two stakes in accordance with the details. Tie trees at 2/3 the height of the main stem leaving enough play for a small amount of natural movement.

All stakes shall be untreated hardwood. Size/length: 50mm x 50mm, length to suit tree/plant size. Ties shall be 40mm wide black flexible rubber ties, or other such approved material that does not cause abrasion to the trees. All stakes to be painted black with an approved acrylic paint, to ensure total coverage.

1.7 Watering

During the planting period it shall be the Contractor's responsibility to ensure the plants receive sufficient water to maintain healthy growth.

1.8 Grassing

The turf shall be supplied from an approved supplier with the following qualities:

a. A seed mix appropriate to local environmental conditions and for high intensity public use. The Contractor is to supply the details of the turf mix to the Engineer for approval prior to ordering the turf.
b. A consistent depth (approx. 20mm) and width (approx. 450mm) and of consistent length
c. Sufficiently fibrous that it holds together when handled but without excessive thatch
d. Should be grown on a similar soil type to the soil to be used on the lawns
e. Free of broadleaved weeds, pos. annual plants, disease and/or pest activity or scars at the time of harvesting

1.9 Monthly Establishment Report

An accurate and up to date monthly report, on plant condition and establishment works undertaken, shall be submitted to the Engineer within five days of the end of each month.

Information to be provided in this report shall include the date that works were carried out and any types of work, as noted in the above clauses, to aid establishment of landscape areas and berms. Unforeseen damage, for example vandalism, plant losses, shall be reported to the Engineer at the time of inspection.

Any unreported damage or plant losses will be deemed the responsibility of the Contractor

An example of a typical Monthly Landscape Maintenance Report is included in the Appendix B to this Specification.

1.10 Weed and Grass Control

For the entire maintenance period all grassed, mulched and planted areas and specimen trees shall be maintained for the entire area of plantings shall be kept free of nuisance weeds and plant pest species. For weed control the Contractor may elect to use spray or manual means, as approved by the Engineer. All weed eradication shall comply with the spraying requirements of this Specification.

1.11 Replacement of Plants

A specified inspection will be held three weeks prior to the end of the maintenance period to inspect requirements for replacement plants. All plants deemed by the Engineer as dead, defective or unhealthy are to be removed and replacements supplied and planted at the Contractor's expense, within three weeks from the inspection date.

Throughout the maintenance period replacement planting shall be made during the planting season immediately following their loss or on discovery. When replacement planting takes place in the last 2 months of the maintenance period an additional 3 months may apply as determined by the Engineer to ensure healthy establishment of plants or trees.

Plants damaged by wilful vandalism or lost by theft shall be replaced at the expense of the Principal. This work shall be at scheduled rates and be confirmed by the Engineer prior to implementation. Plant loss due to vandalism which has not been reported to the Engineer and recorded in the 'Monthly Establishment Report' shall be assumed to be result of planting operations and replacement shall be at the Contractor's cost.

Where it is identified that plant failure is due to the Contractor's spraying of herbicide replacement will also be at the Contractor's expense.

Establishment rate required at the end of the maintenance period:

- 100% for all specimen trees (80L)
- 100% for, PB3 and PB5 plants

All replacement plants shall be to the same grade as originally planted, and be the same species and position as the removed plant, unless otherwise approved or directed by the Engineer. Replacement plants and planting shall conform to this Specification.

1.12 Completion and Finishing

At completion of the maintenance period, the work shall be left in good condition, the whole site cleared of rubbish, plastic bags and debris and any damage made good to the satisfaction of the Engineer.

1.13 Grass and Planting Acceptance Criteria

At the end of the 12 month maintenance period the following minimum standards must be met:

- The grass shall be an even vigorous sward of vegetation at a uniform height with a healthy colour throughout.
- The ground surface shall be free from hollows arising from uneven consolidation of the ground and from stones or similar debris. There shall be no bare area greater than 30mm in diameter and shall have less than 5% of this area in non-specified grasses and weeds
- All planted areas shall be weed free and mulched with the specified mulch to the specified depths. No perennial grass weeds will be accepted in mulched garden bed areas
- Trees and plantings shall be well formed, vigorous and healthy, free of disease and free of dead growth and dead flowers, upright and planted so that the soil level is the same as was in the container and without roots exposed.
- Trees and plants shall be located as originally specified.
- Plant growth shall be trimmed to the extent and height required to ensure vigorous growth.
- All tree stakes and ties shall be intact and correctly installed, including paint finish.
- If, in the opinion of the Engineer, any tree stakes can be removed at the end of the maintenance period the Contractor is to allow for the removal of the entire stakes and ties without damaging the trees, the backfilling of the stake holes with compacted topsoil mix, to be watered in, and additional mulch as required to meet depth standards.

Appendix

Jewell Stream, Te Horo

Riparian Enhancement Plan

Rachel Dickinson and James Callan, 76 Derham Road, Te Horo

Prepared By

Colin Stace
Senior Rural Consultant

Reviewed By

Roger MacGibbon
Design Team Leader

Opus International Consultants Ltd

Napier Office
Opus House, 6 Ossian Street
Private Bag 6019, Napier 4142
New Zealand

Telephone: +64 6 833 5100
Facsimile: +64 6 835 0881

Date: April 2017
Reference: 5-c2771.00
Status: Final

Contents

1. Property Details

Owner(s): Rachel Elizabeth Dickinson and James Andrew Gleeson Callan	
Contacts: ph. 027 717 8481	
Legal Description: Lot 2 Deposited Plan 331270	**Area:** 3.6482 ha
Title: WN49C/706	**Valuation Number:** 14881-42503

Property location and planting sites

2. Purpose of this Plan

The resource consent conditions for the construction of the 13km Peka Peka to Otaki (PP2O) section of the Kapiti Expressway require that at least 2601 lineal metres of stream length undergo riparian fencing and restorative planting as compensation for stream sections that will be altered by the Expressway construction.

Because of significant flooding issues on the Mangaone Stream especially downstream of State Highway 1, which additional riparian planting would likely exacerbate, and because contiguous or near-contiguous riparian restoration along a single stream is likely to be of greater ecological value to aquatic life than small patches over several streams, agreement was reached between the NZ Transport Agency and Greater Wellington Regional Council that riparian restoration effort would be focused on the Jewell Stream as a priority.

The Jewell Stream is likely to provide the best ecological return from riparian restoration because:

i. Riparian planting along both sides of Jewell Stream is not likely to exacerbate flooding to the same extent as would be the case along the lower Mangaone Stream.
ii. Jewell Stream would appear to carry the largest water volume of the ephemeral streams in the area and it flows permanently for a longer duration during summer.
iii. It flows through the area known as Mary Crest where a remnant wetland area is proposed for significant restoration as part of the Expressway mitigation. The collective ecological value of the wetland and riparian restoration effort will be greater if they are physically linked.
iv. At least one barrier to fish passage exists along the Jewell – a concrete culvert sump structure between SH 1 and the railway line – which, if removed, would open up the entire upper catchment to fish usage.
v. The Jewell Stream joins the Mangaone Stream near its river mouth. The Mangaone Stream has a natural, passable river mouth and is known to be inhabited by native fish species. Enhancement of the Jewell Stream will significantly increase the available habitat for native fish species.
vi. A considerable length (greater than 5km) of the Jewell would benefit from riparian fencing and planting.

The objective is to generate 2601 stream length metres of riparian retirement with 5 metres (or more) between the stream channel and fence on each side of the stream, planted with native vegetation suitable to provide shade to the stream channel and create improved habitat for aquatic life.

Landowners along Jewell Stream have been approached to see if they were prepared to offer their stream margins for fencing off and planting. The NZ Transport Agency has offered to pay for the fencing, planting and 5 years of maintenance in return for a covenant which will be placed on each restored area to ensure the plants and fence remain intact into the future. Property owners who have indicated an interest in offering their stream margins for restoration have each had a riparian enhancement plan produced for their consideration.

This Riparian Enhancement Plan provides the fencing details (fence route and design), plant prescription (species, grades), site preparation (removal of weed species and methods to be used), and a five year post-planting maintenance programme for the property of Rachel Dickinson and James Callan at 76 Derham Road, Te Horo.

3. Overview (refer Plan P205, Appendix A)

The Jewell Stream flows through the central property in a westerly direction, and both left and right banks of the stream are within the property. A small tributary stream and wetland adjoins the main channel in the central-northern property (refer Fig.1).

Fig. 1 Wetland adjoining central stream.

Fig. 2 Main crossing and existing gate on true left Bank.

Within the southern and central property approximately 150 m of new post and batten fencing has been erected adjacent the true left bank of the stream. One stock gate is located in this fence line adjacent the main crossing in the central property (Fig. 2). The fence line forms a 5 m wide riparian margin and also incorporates an extension area parallel to the access road, adjacent the true left downstream abutment of the access road bridge on the south-eastern boundary (Fig. 3).

Fig. 3 Stone bund on true right bank by access road bridge; extension area by road in background.

Fig. 4 Proposed fence replacement, true left bank central-northern property.

On the true right bank of the stream downstream of the access road bridge, a 60 m section of stream bank is currently unfenced and forms part of the residential garden area not subject to stock grazing. A small stone bund around 300 mm high has been formed along this section (by a previous owner), approximately 5 m from the stream edge, to provide a measure of flood protection. Downstream of

this section, a further 68 m of stream bank adjacent the main crossing is currently unfenced, and connects with a side fence that encloses the central-northern wetland and tributary.

Fig. 5 Stream channel at northern foot bridge, looking downstream: note blackberry.

Fig. 6 Proposed planting area at NW end of property.

At the NW end of new fencing on the true left bank, current fencing is in a dilapidated state and due for replacement (Fig 4). There is also scope to include a narrow section of paddock within proposed works, to create an extended riparian planting area up to 17 m wide. This would involve running a fence line across the paddock to connect with an existing fence along the drain on the south-west side of the paddock, as well as some extension to existing road fencing and a connecting section to the north-western boundary.

Summary of enhancement works

Length of channel	301 m	Both banks
New fencing	160 m, 9 wire post & batten	
Available planting Area	4,355 square meters	
Estimated number of plants	2330 – native trees, shrubs and wetland species	

4. Fencing Works

Line Preparation

- Existing fencing adjacent the true left bank of the stream at the north-western end of the property (Fig 4) will be removed. Any recoverable materials the Landowner may wish to retain will be stockpiled at their direction. Unwanted materials will be disposed of off-site.
- A section of sheep netting fence approximately 60 m long on the true right bank of the stream, adjacent the stone bund at the eastern end of the property (Fig 3) will be removed.

Fence Construction

- New fencing will consist of a 9 wire post and batten fence, with posts at 4 m spacing and three battens between posts.

- A pedestrian gate will be installed at the northern end (refer map Section 9), and a stock gate will be installed on the north-east side of the main crossing.
- Inclined stays will not be used on the paddock side of new fences to prevent goat access to planting areas. Angle posts will otherwise be stayed with a breast block, a horizontal stay.

NOTE: a buried cable warning notice is displayed on the existing fence line towards the eastern side of the property, approximately 50 m away from a transformer located by the access road on the eastern boundary. Verification of cable alignment and depth will be required before any subsoil disturbing activity is carried out in the vicinity, and along new fence construction proposed to the west of this area.

5. Planting Activities

Site Preparation

- Invasive weed control will be applied during the spring and summer preceding planting, to control blackberry and convolvulus in particular.
- For initial control of blackberry, stems will be cut 20 mm above ground level, followed by immediate application of a 3-5 mm layer of Vigilant™ gel on the cut surface. For multi-stemmed plants at least 80 percent of stems, including all main stems, will be treated.
- Suitable organic herbicides such as '*Green Assassin*' or '*Weedfree Rapid*' will be used for knock down of herbaceous weeds.
- Before completion of new fencing, the Landowner is encouraged to graze blackberry and rank grass growth in the planting area. This would be a one-off activity and stock should be withdrawn from the site if stream bank treading damage becomes evident.
- Existing willow trees and an alder at the northern end will be retained, dead willow tress (8-10) and a eucalyptus tree will be removed. Windfall on the northern boundary fence will be removed.

Pest Animal Control

- Rabbits are present in low to moderate numbers throughout the property. Given the number and proximity of neighbouring properties there is limited opportunity to apply pest control activities such as poisoning or night shooting. Protective sleeves or repellents will otherwise be used to deter rabbit browsing of new plantings.

Pre-release & Planting

- Planting spots approximately 1 m in diameter will brush cut no more than two weeks before planting.
- Plant spacing will generally be no greater than 1.5 x 1.5 m for most species, while some wetland genera such as *Carex* and *Cyperus* will be at closer spacings.
- All plants will be 1 L potted stock, or similar grade, and will be planted in holes slightly larger than the root ball, with any spiralled roots removed. All plant pots or other packaging will be removed off site.

- A planting list of species is set out in Appendix B. Plant stock will be sought as eco-sourced material from within the Foxton Ecological District- 31.02.[1]
- Layout will generally follow the siting indicated in the list. A 5 m corridor adjacent the main bridge site and stock gates (central channel section) will be left unplanted to facilitate controlled stock movement between the adjacent NE and SW paddocks.

Plant Maintenance

- Each plant will be released (control of competing vegetation within an 800-1000mm radius) in in the spring and mid-summer for up to five years.
- Weed control will use brush cutting or similar mechanical means to cut emergent blackberry shoots close to the ground.
- Blackberry shoots will be cut before they exceed 200 mm height; up to three cuts will be required under spring growth conditions, and at least two cuts under late summer /autumn growth conditions.
- Any other resurgent or invasive weeds will also be controlled concurrently, either with slashing / brush cutting or suitable organic herbicides such as *Green Assassin* or *Weedfree Rapid*.
- Sites will be monitored for resurgent or invasive weeds during the five year establishment period, and weed control will be applied as required.

6. Programme Management

- All works will be performed by suitably qualified and experienced operators contracted to Opus (on behalf of the NZ Transport Agency) and supervised by experienced Opus staff. Property work areas, including access routes, will be determined in advance of site activity, in consultation with the Landowner.
- The Contractor will give adequate notice of timing for entry to the property, and will comply with Landowner requirements in regard to factors such as stock management, vehicle access and Health and Safety obligations.
- Opus staff will maintain contact with Contractors on a regular basis, including periodic site inspections as works progress.
- Any Landowner concerns that may arise about progress of works or Contractor activity should be communicated to the designated Opus Project Manager at the earliest opportunity. If necessary, a hold-point on works can be applied until matters of concern are resolved.

7. Timetable

7. Activity	Timing	Responsibility	Supervision
Invasive weed control	Feb - March 2018	Contractor	Opus
Existing fence removal	April 2018	Contractor	Opus
Construct new fence	April 2018	Contractor	Opus
Pre-plant spot spray	May 2018	Contractor	Opus

[1] Ecological Regions and Districts of New Zealand (1987) NZ Dept. of Conservation

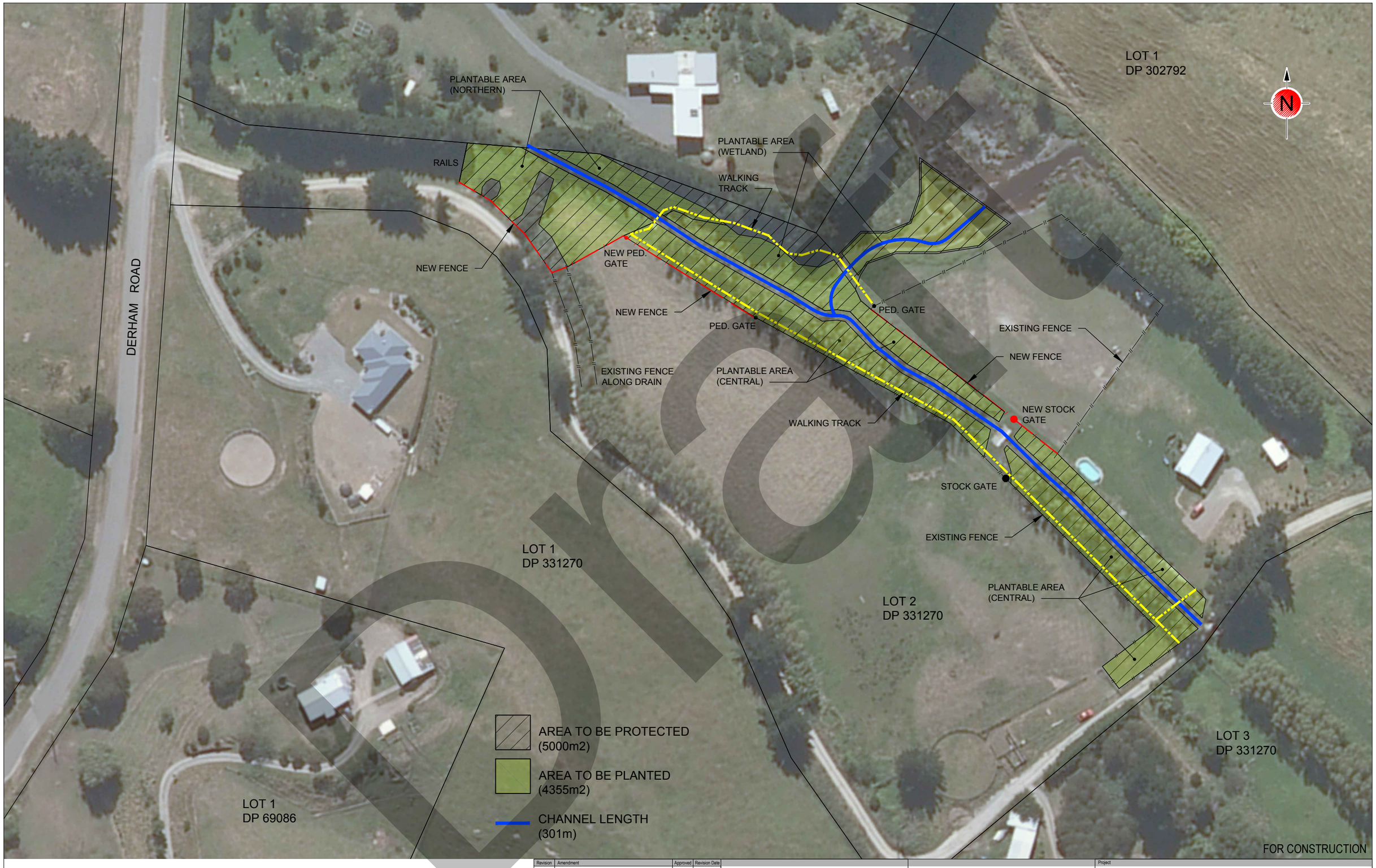
Planting	June 2018	Contractor	Opus
Releasing	Oct 2018 & Feb2019	Contractor	Opus
Releasing	Oct 2018 & Feb2020	Contractor	Opus
Releasing	Oct 2020 & Feb2021	Contractor	Opus
Maintenance	Oct 2021 & Feb2022	Contractor	Opus
Maintenance	Oct 2022 & Feb2023	Contractor	Opus

Note: this timing indicative, specific dates will be confirmed prior to commencement of works.

8. Review and Update

- The Riparian Enhancement Plan will be monitored and reviewed annually by Opus, in consultation with the Landowner and NZTA. Any major changes will be documented and an amended plan will be submitted to NZTA for approval.
- Any channel management issues arising, which affect stream bank integrity such that establishment of plantings may be threatened, will be addressed on a situation-by-situation basis within the five year establishment period.

APPENDIX A



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Revision	Amendment	Approved	Revision Date
1	ISSUED FOR CONSTRUCTION	R.M.	3/02/2017
2	CHANNEL LENGTH ADDED	R.M.	11/04/2017

NZ TRANSPORT AGENCY
WAKA KOTAHI

OPUS
Wellington Office
+64 4 471 7000
PO Box 12-003
Wellington 6144
New Zealand

Designed	Approved	Approved Date
R. MACGIBBON	R.McFADYEN	03/02/2017
Drawn	Scales	
B. CRAIG	1:1000	

Project
NEW ZEALAND TRANSPORT AGENCY
S.H.1 REGION 9 R.S.995/2.738 - 15.423
PEKA PEKA TO OTAKI (PP2O) EXPRESSWAY - SPECIMAN DESIGN

Sheet
RIPARIAN PLANTING - PROPERTY 5
DICKINSON & CALLAN, 76 DERHAM ROAD, TE HORO

Project No.	Sheet. No.	Revision
5-C2771.00	P205	2

Original Sheet Size A3 [420x297] Plot Date 2017-04-11 at 9:30:25 a.m. Path P:\projects\5-C2771.00 PP2O Specimen Design\500 Technical\501 Drawings\03 CAD\01_DWGS\Property\Riparian Planting\Drawings\5-C2771.00_P201-212.dwg P205

APPENDIX B

Appendix B – Species List

Species	Common Name	Streamside	Central	Fenceline	TOTAL
Aristotelia serrata	makomako, wineberry	25	100	25	150
Austroderia toetoe	toetoe	125	75	25	225
Carpodetus serratus	putaputaweta	0	30	0	30
Carex germinata	rautahi, cutty grass	50	50	25	125
Carex secta	pukio	125	50	25	200
Coprosma robusta	karamu	25	150	25	200
Cordyline australis	ti kouka, cabbage tree	25	75	25	125
Cyperus ustulatus	upokotangata	125	25	0	150
Dacrycarpus dacrydioides	kahikatea	25	0	0	25
Dodonaea viscosa	akeake	0	100	25	125
Hebe stricta	koromiko	0	50	25	75
Kunzea ericoides	kanuka	0	100	0	100
Leptospermum scoparium	manuka	50	100	50	200
Melicytus ramiflorus	whiteywood	0	50	0	50
Phormium tenax	harakeke	150	150	0	300
Pittosporum eugenioides	tarata, lemonwood	0	50	0	50
Pittosporum tenuifolium	kohuhu	0	150	0	150
Plagianthus regius	manatu, ribbonwood	0	25	0	25
Sophora microphylla	kowhai	0	25	0	25
Total		725	1355	250	**2330**

Jewell Stream, Te Horo

Riparian Enhancement Plan

Samantha & Wayne Hart, 66 Morrison Road, Te Horo

Prepared By

Colin Stace
Senior Rural Consultant

Reviewed By

Roger MacGibbon
Design Team Leader

Opus International Consultants Ltd

Napier Office
Opus House, 6 Ossian Street
Private Bag 6019, Napier 4142
New Zealand

Telephone: +64 6 349 6600
Facsimile: +64 6 348 4601

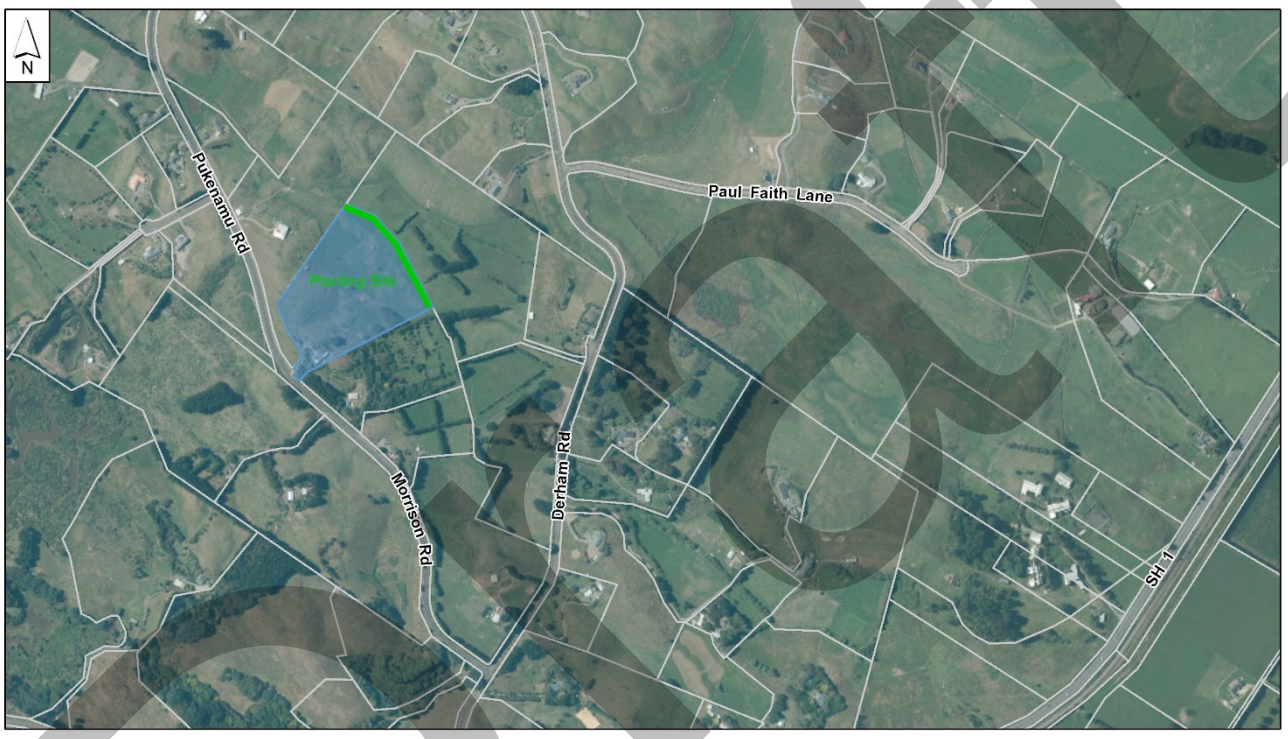
Date: April 2017
Reference: 5-c2771.00
Status: Final

Contents

1. Property Details

Owner(s): Samantha Jane Noakes, Sonia Maire Baker, Wayne Basil Hart	
Contacts: ph. 021 157 7290; email sampam@hotmail.com	
Legal Description: Lot 1 Deposited Plan 80617	**Area:** 4.594 ha
Title: WN47B/25	**Valuation Number:** 14890-00424

Property location and planting site



2. Purpose of this Plan

The resource consent conditions for the construction of the 13km Peka Peka to Otaki (PP2O) section of the Kapiti Expressway require that at least 2601 lineal metres of stream length undergo riparian fencing and restorative planting as compensation for stream sections that will be altered by the Expressway construction.

Because of significant flooding issues on the Mangaone Stream especially downstream of State Highway 1, which additional riparian planting would likely exacerbate, and because contiguous or near-contiguous riparian restoration along a single stream is likely to be of greater ecological value to aquatic life than small patches over several streams, agreement was reached between the NZ Transport Agency and Greater Wellington Regional Council that riparian restoration effort would be focused on the Jewell Stream as a priority.

The Jewell Stream is likely to provide the best ecological return from riparian restoration because:

Riparian planting along both sides of Jewell Stream is not likely to exacerbate flooding to the same extent as would be the case along the lower Mangaone Stream.

Jewell Stream would appear to carry the largest water volume of the ephemeral streams in the area and it flows permanently for a longer duration during summer.

It flows through the area known as Mary Crest where a remnant wetland area is proposed for significant restoration as part of the Expressway mitigation. The collective ecological value of the wetland and riparian restoration effort will be greater if they are physically linked.

At least one barrier to fish passage exists along the Jewell – a concrete culvert sump structure between SH 1 and the railway line – which, if removed, would open up the entire upper catchment to fish usage.

The Jewell Stream joins the Mangaone Stream near its river mouth. The Mangaone Stream has a natural, passable river mouth and is known to be inhabited by native fish species. Enhancement of the Jewell Stream will significantly increase the available habitat for native fish species.

A considerable length (greater than 5km) of the Jewell would benefit from riparian fencing and planting.

The objective is to generate 2601 stream length metres of riparian retirement with 5 metres (or more) between the stream channel and fence on each side of the stream, planted with native vegetation suitable to provide shade to the stream channel and create improved habitat for aquatic life.

Landowners along Jewell Stream have been approached to see if they were prepared to offer their stream margins for fencing off and planting. The NZ Transport Agency has offered to pay for the fencing, planting and 5 years of maintenance in return for a covenant which will be placed on each restored area to ensure the plants and fence remain intact into the future. Property owners who have indicated an interest in offering their stream margins for restoration have each had a riparian enhancement plan produced for their consideration.

This Riparian Enhancement Plan provides the fencing details (fence route and design), plant prescription (species, grades), site preparation (removal of weed species and methods to be used), and a five year post-planting maintenance programme for the property of Samantha and Wayne Hart at 66 Morrison Road, Te Horo.

3. Overview (refer Plan P208, Appendix A)

The Jewell Stream flows westwards adjacent to the property's north-eastern boundary, and both banks of the stream fall within the property. The existing boundary fence (refer Fig.1) is in an aged and dilapidated condition, and replacement works are addressed under a proposed plan for the neighbouring (Lansbury) property. The true left bank of the stream is generally unfenced, except for a 50 m section in the central property, approximately 3 m off the stream channel.

Fig. 1 Central riparian enhancement area; additional works are proposed for neighbouring property on opposite (true right) bank.

Fig 2. Eastern end of enhancement area: fence line will be inset to exiting gateway, willow to be removed under plan for neighbouring property.

Construction of a new 8-wire post and batten fence is proposed, to create a 5 m wide riparian planting margin on the true left bank of the stream. To accommodate an existing gateway at the southern (upstream) end of the site 8 m of the fence line will be inset, with a reduced riparian margin width of 2 m (Fig.2).

Fig. 3 Central bridge and drain: to be railed as an maintenance access point.

Fig. 4 Willow for removal at north-west end of enhancement area.

A major drain discharges to the stream in the central segment of the proposed enhancement area, and is bridged adjacent a subdivision fence gateway (Fig. 3). This section of fence will comprise a set of 5 m (detachable) rails, to provide a stock barrier on one side of the bridge and allow machine

access if required for drain maintenance purposes. General channel maintenance, when and if required, can otherwise be undertaken with a long-reach excavator. Local contractors currently undertake such work with the GWRC Flood Protection group, and a suitable contact is Carl Gibson (Tel 021 428 267) operating both long-reach and standard reach excavators. Note: before undertaking any form of channel excavation work the landowners will consult with GWRC Consents staff.

An established willow tree in the north-west section of the enhancement area requires removal (fig. 4), and semi-mature willow in the southern section of channel will be addressed under the proposed plan for the neighbouring (Lansbury) property. A total planting area of 2,060 m^2 is available within the site, however a 4 m maintenance access will be allowed for where the main drain discharges to the stream, and the effective planting area is around 2,040 m^2.

Summary of enhancement works

Length of channel	250 m	Both banks
New fencing	244 m, 8 wire post & batten, one wire electrified	
Available planting Area	2,060 square meters	
Estimated number of plants	1240 – native trees, shrubs and wetland species	

4. Fencing Works

Line Preparation

- The existing 50 m fence will be removed. Recoverable materials the Landowner may wish to retain, such as posts, will be stockpiled at their direction. Any unwanted materials will be disposed of off-site.

Fence Construction

- New fencing will consist of an 8 wire post and batten fence, with posts spaced at 4m and three battens between posts. One wire will be electrified at approximately 500 mm above ground level, to control goats.

- To enable to Landowner to isolate sections of electrified fence as required, depending on stock management requirements in adjoining paddocks, at least four cutout switches will be installed

- The south end of the fence line will be inset to accommodate an existing gateway (refer Plan P208, Appendix A).

5. Planting Activities

Site Preparation

- Invasive weed control with suitable herbicide (e.g. triclopyr) will be applied during the spring and summer preceding planting, for spot control of blackberry and bindweeds in particular.

- The willow tree in the north-western section of channel will be removed. Removal method will be motor-manual and stumps will be treated with a suitable herbicide (e.g. glyphosate).

Pest Animal Control

- Rabbits are present in low to moderate numbers throughout the property. Given the number and proximity of neighbouring properties there is limited opportunity to apply pest control activities such as poisoning or night shooting. Protective sleeves or repellents will otherwise be used to deter rabbit browsing of new plantings.

Pre-release & Planting

- Planting spots will be sprayed with a suitable herbicide (e.g. glyphosate) at least three weeks prior to planting.
- Plant spacing will generally be no greater than 1.5 x 1.5 m for most species, while some wetland genera such as *Carex* and *Cyperus* will be at closer spacings.
- All plants will be 1 L potted stock, or similar grade, and will be planted in holes slightly larger than the root ball, with any spiralled roots removed. All plant pots or other packaging will be removed off site.
- A planting list of species is set out in Appendix B. Plant stock will be sought as eco-sourced material from within the Foxton Ecological District- 31.02[1] .
- To facilitate periodic channel maintenance access for a long-reach excavator, plantings on the true left bank will largely comprise herbaceous species with a maximum height of 2 m.
- A small number of taller woody will be spread throughout the planting, and may be concentrated on those sections of stream bank directly opposite the proposed inset sections of fence line on the neighbouring property, which provide alternative access points for excavator reach.

Plant Maintenance

- Each plant will be released (control of competing vegetation within an 800-1000mm radius) in the spring and mid-summer, for up to five years.
- Weed control will use carefully directed or shielded low-pressure spray of a suitable herbicide. Operators will hold current GROWSAFE certification, and will use approved methods and equipment to prevent spray drift when applying herbicide.
- Any resurgent or invasive weeds will also be controlled concurrently.
- The site will be monitored for resurgent or invasive weeds during the five year establishment period, and weed control will be applied annually as required.

6. Programme Management

- All works will be performed by suitably qualified and experienced operators contracted to Opus (on behalf of the NZ Transport Agency) and supervised by experienced Opus staff.

[1] Ecological Regions and Districts of New Zealand (1987) NZ Dept of Conservation

Property work areas, including access routes, will be determined in advance of site activity, in consultation with the Landowner.

- The Contractor will give adequate notice of timing for entry to the property, and will comply with Landowner requirements in regard to factors such as stock management, vehicle access and Health and Safety obligations.
- Opus staff will maintain contact with Contractors on a regular basis, including periodic site inspections as works progress.
- Any Landowner concerns that may arise about progress of works or Contractor activity should be communicated to the designated Opus Project Manager at the earliest opportunity. If necessary, a hold-point on works can be applied until matters of concern are resolved.

7. Timetable

7. Activity	Timing	Responsibility	Supervision
Invasive weed control	Feb - March 2018	Contractor	Opus
Willow removal	March 2018	Contractor	Opus
Existing fence removal	April 2018	Contractor	Opus
Construct new fence	April 2018	Contractor	Opus
Pre-plant spot spray	May 2018	Contractor	Opus
Planting	June 2018	Contractor	Opus
Releasing	Oct 2018 & Feb2019	Contractor	Opus
Releasing	Oct 2019 & Feb2020	Contractor	Opus
Releasing	Oct 2020 & Feb2021	Contractor	Opus
Maintenance	Oct 2021 & Feb2022	Contractor	Opus
Maintenance	Oct 2022 & Feb2023	Contractor	Opus

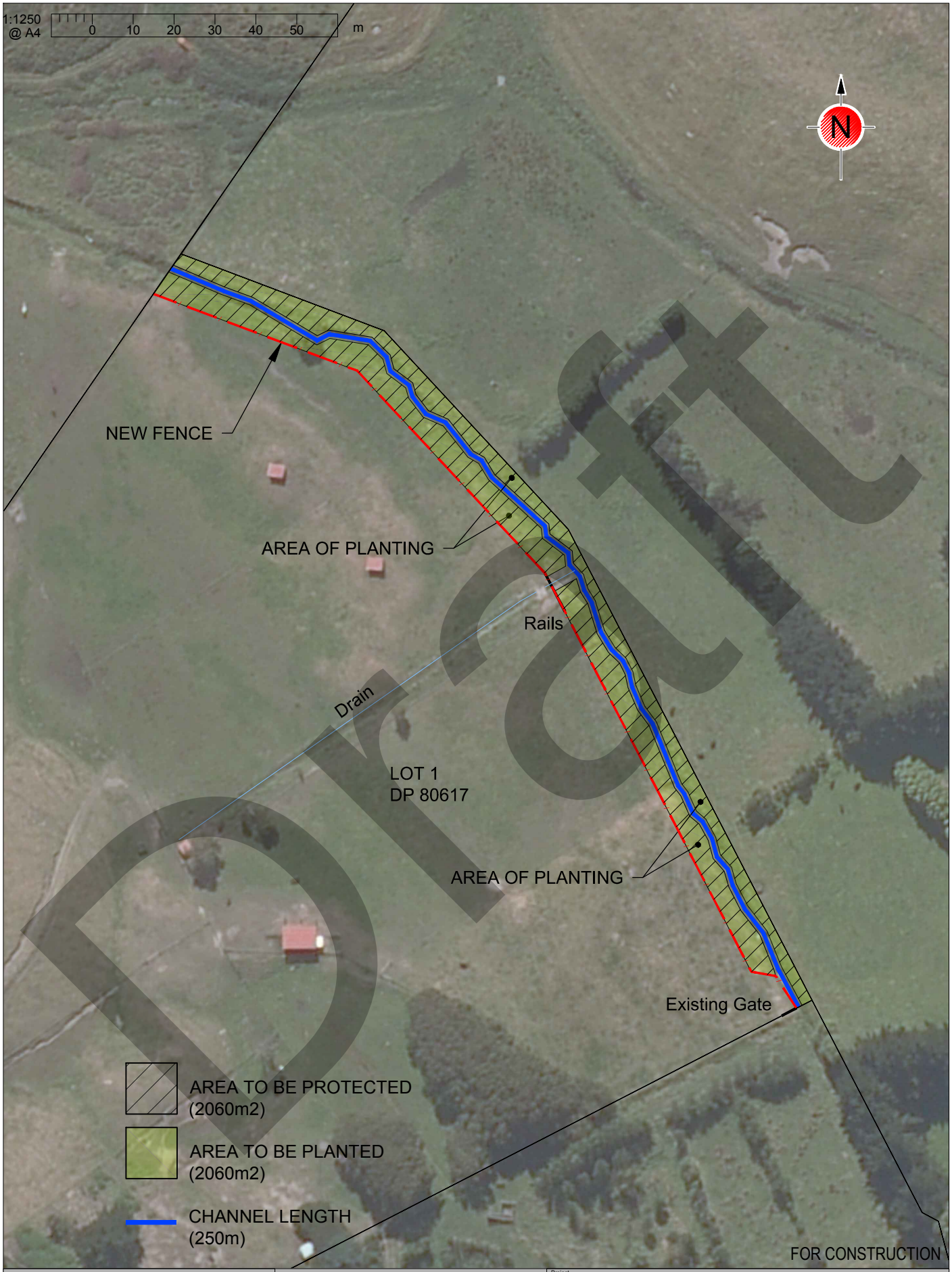
Note: this timing indicative, specific dates will be confirmed prior to commencement of works.

8. Review and Update

- The Riparian Enhancement Plan will be monitored and reviewed annually by Opus, in consultation with the Landowner and NZTA. Any major changes will be documented and an amended plan will be submitted to NZTA for approval.

- Any channel management issues arising, which affect stream bank integrity such that establishment of plantings may be threatened, will be addressed on a situation-by-situation basis within the five year establishment period.

APPENDIX A



NZ TRANSPORT AGENCY WAKA KOTAHI

OPUS
Wellington Office
+64 4 471 7000
PO Box 12-003
Wellington 6144
New Zealand

1	ISSUED FOR CONSTRUCTION	R.M.	3/02/2017
2	CHANNEL LENGTH ADDED	R.M.	11/04/2017

Designed	Approved	Approved Date
R. MACGIBBON	R.McFADYEN	03/02/2017
Drawn	Scales	
B.CRAIG	1:250	

Project
NEW ZEALAND TRANSPORT AGENCY
S.H.1 REGION 9 R.P. 995/2.738 - 15.423
PEKA PEKA TO OTAKI (PP2O) EXPRESSWAY - SPECIMEN DESIGN

Sheet
RIPARIAN PLANTING - PROPERTY 8
HART , 66 MORRISON ROAD, TE HORO

Project No.	Sheet. No.	Revision
5-C2771.00	P208	2

Original Sheet Size A4 [210x297] Plot Date 2017-04-11 at 9:36:34 a.m. Path P:\projects\5-C2771.00 PP2O Specimen Design\500 Technical\501 Drawings\03 CAD\01_DWGS\Property\Riparian Planting\Drawings\5-C2771.00_P201-212.dwg P208

APPENDIX B

Appendix B - Species List

Species	Common Name	True left bank	True right bank	Fenceline	TOTAL
Aristotelia serrata	makomako, wineberry	25	25	15	65
Austroderia toetoe	toetoe	50	75	15	140
Carex secta	pukio	70	50	15	135
Carex virigata	pukio	0	50	0	50
Coprosma robusta	karamu	35	25	25	85
Cordyline australis	ti kouka, cabb tree	15	15	15	45
Cyperus ustulatus	upokotangata	100	50	0	150
Dodonaea viscosa	akeake	0	0	25	25
Hebe stricta	koromiko	25	25	15	65
Kunzea ericoides	kanuka	25	0	0	25
Leptospermum scoparium	manuka	25	25	15	65
Melicytus ramiflorus	whiteywood	25	25	0	50
Phormium tenax	harakeke	100	100	0	200
Pittosporum eugenioides	tarata, lemonwood	25	10	0	35
Pittosporum tenuifolium	kohuhu	25	20	0	45
Plagianthus regius	manatu, ribbonwood	25	0	10	35
Sophora microphylla	kowhai	10	5	10	25
Total		580	500	160	**1240**

Jewell Stream, Te Horo

Riparian Enhancement Plan

Iris and Peter Bean, 188 Pukenamu Road, Te Horo

Prepared By

Colin Stace
Senior Rural Consultant

Reviewed By

Roger MacGibbon
Design Team Leader

Opus International Consultants Ltd

Napier Office
Opus House, 6 Ossian Street
Private Bag 6019, Napier 4142
New Zealand

Telephone: +64 6 349 6600
Facsimile: +64 6 348 4601

Date: April 2017
Reference: 5-c2771.00
Status: Final

Contents

1. Property Details

Owner(s): Iris May Bean & Peter Norman Bean	
Contacts: ph. 06 364 2248, email iris.bean@clear.net.nz	
Legal Description: Lot 22 Deposited Plan 91189	**Area:** 19.895 ha
Title: WN59A/398	**Valuation Number:** 14871-3640

Property location and planting site

2. Purpose of this Plan

The resource consent conditions for the construction of the 13km Peka Peka to Otaki (PP2O) section of the Kapiti Expressway require that at least 2601 lineal metres of stream length undergo riparian fencing and restorative planting as compensation for stream sections that will be altered by the Expressway construction.

Because of significant flooding issues on the Mangaone Stream especially downstream of State Highway 1, which additional riparian planting would likely exacerbate, and because contiguous or near-contiguous riparian restoration along a single stream is likely to be of greater ecological value to aquatic life than small patches over several streams, agreement was reached between the NZ Transport Agency and Greater Wellington Regional Council that riparian restoration effort would be focused on the Jewell Stream as a priority.

The Jewell Stream is likely to provide the best ecological return from riparian restoration because:

i. Riparian planting along both sides of Jewell Stream is not likely to exacerbate flooding to the same extent as would be the case along the lower Mangaone Stream.
ii. Jewell Stream would appear to carry the largest water volume of the ephemeral streams in the area and it flows permanently for a longer duration during summer.
iii. It flows through the area known as Mary Crest where a remnant wetland area is proposed for significant restoration as part of the Expressway mitigation. The collective ecological value of the wetland and riparian restoration effort will be greater if they are physically linked.
iv. At least one barrier to fish passage exists along the Jewell – a concrete culvert sump structure between SH 1 and the railway line – which, if removed, would open up the entire upper catchment to fish usage.
v. The Jewell Stream joins the Mangaone Stream near its river mouth. The Mangaone Stream has a natural, passable river mouth and is known to be inhabited by native fish species. Enhancement of the Jewell Stream will significantly increase the available habitat for native fish species.
vi. A considerable length (greater than 5km) of the Jewell would benefit from riparian fencing and planting.

The objective is to generate 2601 stream length metres of riparian retirement with 5 metres (or more) between the stream channel and fence on each side of the stream, planted with native vegetation suitable to provide shade to the stream channel and create improved habitat for aquatic life.

Landowners along Jewell Stream have been approached to see if they were prepared to offer their stream margins for fencing off and planting. The NZ Transport Agency has offered to pay for the fencing, planting and 5 years of maintenance in return for a covenant which will be placed on each restored area to ensure the plants and fence remain intact into the future. Property owners who have indicated an interest in offering their stream margins for restoration have each had a riparian enhancement plan produced for their consideration.

This Riparian Enhancement Plan provides the fencing details (fence route and design), plant prescription (species, grades), site preparation (removal of weed species and methods to be used), and a five year post-planting maintenance programme for the property of Iris and Peter Bean at 188 Pukenamu Road, Te Horo.

3. Overview (refer Plan P210, Appendix A)

The Jewell Stream flows northwards along the property's western boundary, largely within the neighbouring property (see figure 1). However at the NW corner of the property the boundary line crosses the stream and runs parallel with it on the true left bank. This corner point in the boundary line is marked by an existing strainer (refer Fig. 1 below). Both left and right banks of the stream are within the property along this section of stream, but the true left bank has a very narrow and insufficient margin for planting, and is also used as access for GWRC channel maintenance operations.

Fig. 1 Boundary corner post, looking north.

Fig. 2 Shrub willow planting at drain outlet

The stream is currently fenced along the western boundary of the property, including the section of stream entirely within the property. Within this section there are some poplar and shrub willow plantings on the true right bank, including a localised planting of shrub willow around a drainage pipe outlet (Fig. 2).

Fig. 3 Fence south of boundary corner post.

Fig. 4 North end of site looking upstream, note shrub shrub willow over fence (upper left of photo).

The fence is serviceable but in a semi-aged condition, with rusting wire and staples. Replacement with a new 8-wire post and batten fence is proposed to provide optimum stock exclusion and longevity. New fencing will be placed on an alignment approximately 1 m out from the current fence line north of the existing boundary corner post (as agreed by the owners).

One group of shrub willow will be removed (Fig. 4). The existing fence south of the boundary corner post (Fig. 3) contains stream margin that falls within the neighbouring property.

Summary of enhancement works

Length of channel	138 m	True right bank
New fencing	138 m, 8 wire post & batten with electric outrigger	
Available planting Area	665 square meters	
Estimated number of plants	380 – native trees, shrubs and wetland species	

4. Fencing Works

Line Preparation

- The existing fence will be removed. Any recoverable materials the Landowner may wish to retain, such as posts, will be stockpiled at their direction. Unwanted materials will be disposed of off-site.

Fence Construction

- New fencing will consist of an 8 wire post and batten fence, with the addition of an electric outrigger on the top of the fence to deter cattle from reaching into the planting area.
- Hot-dipped staples will be used to provide extra galvanising for coastal conditions.
- A short (1 m) set of rails will be installed at the boundary corner post.

5. Planting Activities

Site Preparation

- Invasive weed control with suitable herbicide (e.g. triclopyr) will be applied during the spring and summer preceding planting, to control brushweeds and bindweeds in particular.
- Existing poplar plantings and shrub willow at the drain outlet will be retained. Elsewhere, shrub willows growing over the existing fence will be removed by cutting and stumps will be swabbed with glyphosate.
- Rank grass to be spot-sprayed with a suitable herbicide (e.g. glyphosate) in the summer - autumn period preceding planting works.

Pest Animal Control

- Rabbits are present in low to moderate numbers throughout the property. Given the number and proximity of neighbouring properties there is limited opportunity to apply pest control activities such as poisoning or night shooting. Protective sleeves or repellents will otherwise be used to deter rabbit browsing of new plantings.

Pre-release & Planting

- Planting spots will be sprayed with a suitable herbicide (e.g. glyphosate) at least three weeks prior to planting.
- Plant spacing will generally be no greater than 1.5 x 1.5 m for most species, while some wetland genera such as *Carex* and *Cyperus* will be at closer spacings.
- All plants will be 1 L potted stock, or similar grade, and will be planted in holes slightly larger than the root ball, with any spiralled roots removed. All plant pots or other packaging will be removed and disposed of off-site.
- A planting list of species is set out in Appendix B. Plant stock will be sought as eco-sourced material from within the Foxton Ecological District- 31.02.[1]

Plant Maintenance

- Each plant will be released (control of competing vegetation within an 800-1000mm radius) in the spring and mid-summer, for up to five years.
- Weed control will use carefully directed or shielded low-pressure spray of a suitable herbicide. Operators will hold current GROWSAFE certification, and will use approved methods and equipment to prevent spray drift when applying herbicide.
- Any resurgent or invasive weeds will also be controlled concurrently.
- The site will be monitored for resurgent or invasive weeds during the five year establishment period, and weed control will be applied annually as required.

6. Programme Management

- All works will be performed by suitably qualified and experienced operators contracted to Opus (on behalf of the NZ Transport Agency) and supervised by experienced Opus staff. Property work areas, including access routes, will be determined in advance of site activity, in consultation with the Landowner.
- The Contractor will give adequate notice of timing for entry to the property, and will comply with Landowner requirements in regard to factors such as stock management, vehicle access and Health and Safety obligations.
- Opus staff will maintain contact with Contractors on a regular basis, including periodic site inspections as works progress.
- Any Landowner concerns that may arise about progress of works or Contractor activity should be communicated to the designated Opus Project Manager at the earliest opportunity. If necessary, a hold-point on works can be applied until matters of concern are resolved.

[1] Ecological Regions and Districts of New Zealand (1987) NZ Dept. of Conservation

7. Timetable

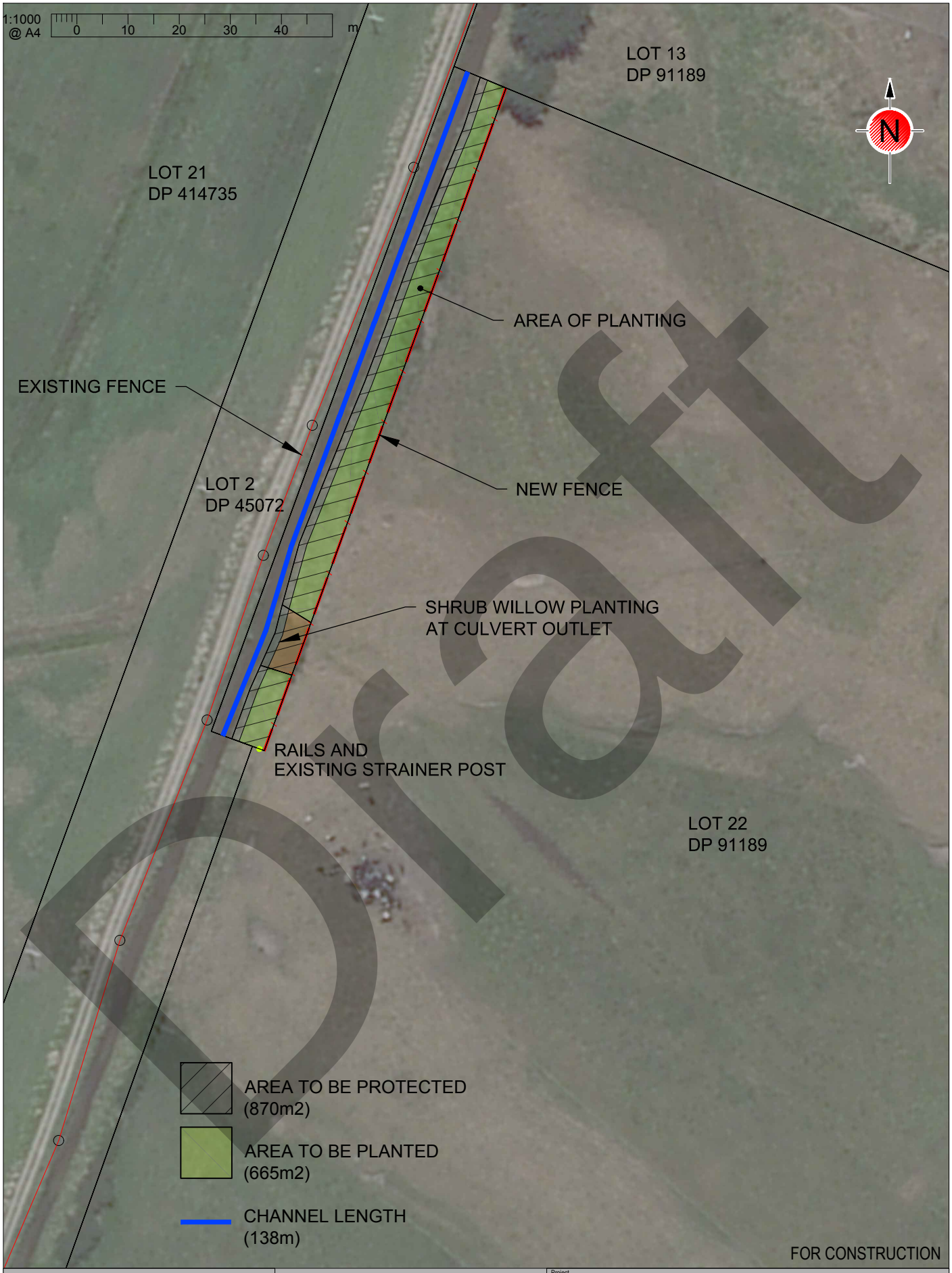
7. Activity	Timing	Responsibility	Supervision
Invasive weed control	Feb - March 2018	Contractor	Opus
Rank growth spot spray	Feb - March 2018	Contractor	Opus
Existing fence removal	April 2018	Contractor	Opus
Construct new fence	April 2018	Contractor	Opus
Pre-plant spot spray	May 2018	Contractor	Opus
Planting	June 2018	Contractor	Opus
Releasing	Oct 2018 & Feb2019	Contractor	Opus
Releasing	Oct 2019 & Feb2020	Contractor	Opus
Releasing	Oct 2020 & Feb2021	Contractor	Opus
Maintenance	Oct 2021 & Feb2022	Contractor	Opus
Maintenance	Oct 2022 & Feb2023	Contractor	Opus

Note: this timing indicative, specific dates will be confirmed prior to commencement of works.

8. Review and Update

- The Riparian Enhancement Plan will be monitored and reviewed annually by Opus, in consultation with the Landowner and NZTA. Any major changes will be documented and an amended plan will be submitted to NZTA for approval.
- Any channel management issues arising, which affect stream bank integrity such that establishment of plantings may be threatened, will be addressed on a situation-by-situation basis within the five year establishment period.

APPENDIX A



1	ISSUED FOR CONSTRUCTION	R.M.	3/02/2017
2	CHANNEL LENGTH ADDED	R.M.	11/04/2017

OPUS
Wellington Office
+64 4 471 7000
PO Box 12-003
Wellington 6144
New Zealand

Designed	Approved	Approved Date
R. MACGIBBON	R.McFADYEN	03/02/2017
Drawn	Scales	
B.CRAIG	1:1000	

Project
NEW ZEALAND TRANSPORT AGENCY
S.H.1 REGION 9 R.P. 995/2.738 - 15.423
PEKA PEKA TO OTAKI (PP2O) EXPRESSWAY - SPECIMEN DESIGN

Sheet
RIPARIAN PLANTING - PROPERTY 10
BEAN , 188 PUKENAMU ROAD, TE HORO

Project No.	Sheet. No.	Revision
5-C2771.00	P210	2

Original Sheet Size A4 [210x297] Plot Date 2017-04-11 at 9:41:08 a.m. Path P:\projects\5-C2771.00 PP2O Specimen Design\500 Technical\501 Drawings\03 CAD\01_DWGS\Property\Riparian Planting\Drawings\5-C2771.00_P201-212.dwg P210

APPENDIX B

Appendix B – Species List

Species	Common Name	Streamside	Central	Fenceline	TOTAL
Austroderia fulvida	kakaho, toetoe	25	25	30	80
Coprosma repens	taupata	10	25	15	50
Cordyline australis	ti kouka, cabb tree	0	25	0	25
Corynocarpus lavigatus	karaka	0	10	0	10
Cyperus ustulatus	upokotangata	15	0	0	15
Dodonaea viscosa	akeake	0	25	10	35
Leptospermum scoparium	manuka	15	25	15	55
Myoporum laetum	ngaio	0	15	0	15
Olearia solandri	coastal shrub daisy	0	10	15	25
Phormium tenax	harakeke	0	50	0	50
Plagianthus regius	manatu, ribbonwood	20	0	0	20
Total		85	210	85	**380**

Jewell Stream, Te Horo

Riparian Enhancement Plan

Suzanne Blumhardt & Peter Hatfield, 86 Derham Road, Te Horo

Prepared By

Colin Stace
Senior Rural Consultant

Reviewed By

Roger MacGibbon
Design Team Leader

Opus International Consultants Ltd

Napier Office
Opus House, 6 Ossian Street
Private Bag 6019, Napier 4142
New Zealand

Telephone: +64 6 349 6600
Facsimile: +64 6 348 4601

Date: April 2017
Reference: 5-c2771.00
Status: Final

Contents

1. Property Details

Owner(s): Valerie Suzanne Blumhardt and Peter John Hatfield	
Contacts: ph. 06 367 9800, 04 384 7046, 027 350 4216 email hatblum@xtra.co.nz	
Legal Description: Lot 1 Deposited Plan 78501	**Area:** 5.299 ha
Title: WN45A/521	**Valuation Number:** 14890-00422

Property location

2. Purpose of this Plan

The resource consent conditions for the construction of the 13km Peka Peka to Otaki (PP2O) section of the Kapiti Expressway require that at least 2601 lineal metres of stream length undergo riparian fencing and restorative planting as compensation for stream sections that will be altered by the Expressway construction.

Because of significant flooding issues on the Mangaone Stream especially downstream of State Highway 1, which additional riparian planting would likely exacerbate, and because contiguous or near-contiguous riparian restoration along a single stream is likely to be of greater ecological value to aquatic life than small patches over several streams, agreement was reached between the NZ Transport Agency and Greater Wellington Regional Council that riparian restoration effort would be focused on the Jewell Stream as a priority.

The Jewell Stream is likely to provide the best ecological return from riparian restoration because:

i. Riparian planting along both sides of Jewell Stream is not likely to exacerbate flooding to the same extent as would be the case along the lower Mangaone Stream.
ii. Jewell Stream would appear to carry the largest water volume of the ephemeral streams in the area and it flows permanently for a longer duration during summer.
iii. It flows through the area known as Mary Crest where a remnant wetland area is proposed for significant restoration as part of the Expressway mitigation. The collective ecological value of the wetland and riparian restoration effort will be greater if they are physically linked.
iv. At least one barrier to fish passage exists along the Jewell – a concrete culvert sump structure between SH 1 and the railway line – which, if removed, would open up the entire upper catchment to fish usage.
v. The Jewell Stream joins the Mangaone Stream near its river mouth. The Mangaone Stream has a natural, passable river mouth and is known to be inhabited by native fish species. Enhancement of the Jewell Stream will significantly increase the available habitat for native fish species.
vi. A considerable length (greater than 5km) of the Jewell would benefit from riparian fencing and planting.

The objective is to generate 2601 stream length metres of riparian retirement with 5 metres (or more) between the stream channel and fence on each side of the stream, planted with native vegetation suitable to provide shade to the stream channel and create improved habitat for aquatic life.

Landowners along Jewell Stream have been approached to see if they were prepared to offer their stream margins for fencing off and planting. The NZ Transport Agency has offered to pay for the fencing, planting and 5 years of maintenance in return for a covenant which will be placed on each restored area to ensure the plants and fence remain intact into the future. Property owners who have indicated an interest in offering their stream margins for restoration have each had a riparian enhancement plan produced for their consideration.

This Riparian Enhancement Plan provides the fencing details (fence route and design), plant prescription (species, grades), site preparation (removal of weed species and methods to be used), and a five year post-planting maintenance programme for the property of Suzanne Blumhardt and Peter Hatfield at 86 Derham Road, Te Horo.

3. Overview (refer Plan P206, Appendix A)

The Jewell Stream flows through the central property in a westerly direction. Both left and right banks of the stream are within the property. The true left bank of the stream throughout the property is managed as a native plant restoration area, while the true left bank is managed as part of an open space area with selected tree plantings and mown grass ground cover. No livestock grazing is carried out on the property and there is no existing stream fencing in place on stream banks.

Fig. 1 Eastern planting area upstream of crossing, single row planting area on opposite (true right) bank.

Fig. 2 Kahikatea glade adjacent S end of western planting area.

An area of around 2,400 m2 adjacent the true left bank of the stream has been planted with a selection of native shrubs and trees. Within the established native plantings there are a number of localised areas with scope for further planting, including a potential row planting on the true right bank (refer Fig 1). Two glade areas are set aside as small clearings to remain unplanted (Fig. 2). The Landowners will give direction to the Contractor as planting works are implemented, to define planting limits around the glades areas.

Fig. 3 Western planting area, north (stream) end.

Fig. 4 Central property looking downstream.

The site is well maintained with a high level of weed control. Some tree removal and pruning work will be required in preparation for additional plantings, including removal of wilding cherry trees (Fig. 3) and form pruning of willow to reduce crown competition (Fig 4).

Summary of enhancement works

Length of channel	116 m	Both banks
New fencing	N/A	
Available planting Area	565 square meters	
Estimated number of plants	360 – native trees, shrubs and wetland species	

4. Fencing Works

No additional fencing works are required.

5. Planting Activities

Site Preparation

- Invasive weed control with suitable herbicide (e.g. triclopyr) will be applied during the summer preceding planting, to control potential spread of blackberry or bindweed from the neighbouring property.
- Existing willows will be retained and have some form pruning (removal of multiple leaders) in some cases.

Pest Animal Control

- Rabbits are present in low to moderate numbers throughout the property. Given the number and proximity of neighbouring properties there is limited opportunity to apply pest control activities such as poisoning or night shooting. Protective sleeves or repellents will otherwise be used to deter rabbit browsing of new plantings.

Pre-release & Planting

- Planting spots will be sprayed with a suitable herbicide (e.g. glyphosate) at least three weeks prior to planting.
- Plant spacing will generally be no greater than 1.5 x 1.5 m for most species, while some wetland genera such as *Carex* and *Cyperus* will be at closer spacings.
- All plants will be 1 L potted stock, or similar grade, and will be planted in holes slightly larger than the root ball, with any spiralled roots removed. All plant pots or other packaging will be removed off site.
- A planting list of species is set out in Appendix B. Plant stock will be sought as eco-sourced material from within the Foxton Ecological District- 31.02.[1]
- Layout will generally follow the siting indicated in the list, with species such as koromiko and akeake used in plantings on the western margin of the site; and species such as cabbage tree, long-leaved lacebark, ribbonwood and kowhai used in row plantings on the true right bank.

Plant Maintenance

- Each plant will be released (control of competing vegetation within an 800-1000mm radius) in the spring and mid-summer, for up to five years.
- Weed control will use carefully directed or shielded low-pressure spray of a suitable herbicide. Operators will hold current GROWSAFE certification, and will use approved methods and equipment to prevent spray drift when applying herbicide.
- Any resurgent or invasive weeds will also be controlled concurrently.

[1] Ecological Regions and Districts of New Zealand (1987) NZ Dept. of Conservation

- The site will be monitored for resurgent or invasive weeds during the five year establishment period, and weed control will be applied annually as required.

6. Programme Management

- All works will be performed by suitably qualified and experienced operators contracted to Opus (on behalf of the NZ Transport Agency) and supervised by experienced Opus staff. Property work areas, including access routes, will be determined in advance of site activity, in consultation with the Landowner.
- The Contractor will give adequate notice of timing for entry to the property, and will comply with Landowner requirements in regard to factors such as stock management, vehicle access and Health and Safety obligations.
- Opus staff will maintain contact with Contractors on a regular basis, including periodic site inspections as works progress.
- Any Landowner concerns that may arise about progress of works or Contractor activity should be communicated to the designated Opus Project Manager at the earliest opportunity. If necessary, a hold-point on works can be applied until matters of concern are resolved.

7. Timetable

7. Activity	Timing	Responsibility	Supervision
Invasive weed control	Feb - March 2018	Contractor	Opus
Pre-plant spot spray	May 2018	Contractor	Opus
Planting	June 2018	Contractor	Opus
Releasing	Oct 2018 & Feb2019	Contractor	Opus
Releasing	Oct 2019 & Feb2020	Contractor	Opus
Releasing	Oct 2020 & Feb2021	Contractor	Opus
Maintenance	Oct 2021 & Feb2022	Contractor	Opus
Maintenance	Oct 2022 & Feb2023	Contractor	Opus

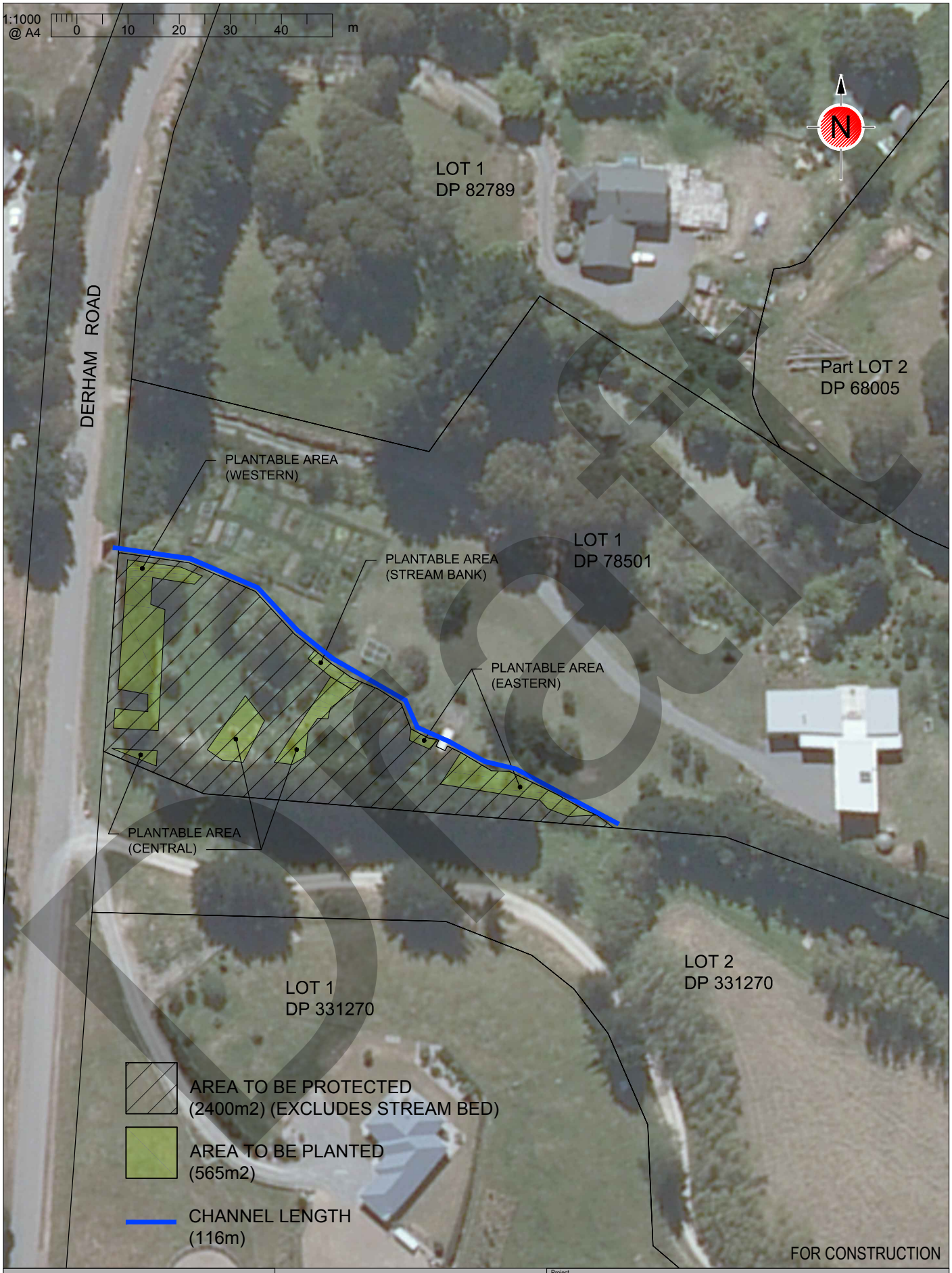
Note: this timing indicative, specific dates will be confirmed prior to commencement of works.

8. Review and Update

- The Riparian Enhancement Plan will be monitored and reviewed annually by Opus, in consultation with the Landowner and NZTA. Any major changes will be documented and an amended plan will be submitted to NZTA for approval.

- Any channel management issues arising, which affect stream bank integrity such that establishment of plantings may be threatened, will be addressed on a situation-by-situation basis within the five year establishment period.

APPENDIX A



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NZ TRANSPORT AGENCY
WAKA KOTAHI

OPUS
Wellington Office
+64 4 471 7000
PO Box 12-003
Wellington 6144
New Zealand

1	ISSUED FOR CONSTRUCTION	R.M.	3/02/2017
2	REMOVE 2 SMALL AREAS, ADJUST TOTALS	R.M.	4/04/2017
3	CHANNEL LENGTH ADDED	R.M.	11/04/2017

Designed	Approved	Approved Date
R. MACGIBBON	R.McFADYEN	03/02/2017
Drawn	Scales	
B.CRAIG	1:1000	

Project
NEW ZEALAND TRANSPORT AGENCY
S.H.1 REGION 9 R.P. 995/2.738 - 15.423
PEKA PEKA TO OTAKI (PP2O) EXPRESSWAY - SPECIMEN DESIGN

Sheet
RIPARIAN PLANTING - PROPERTY 6
BLUMHARDT & HATFIELD , 86 DERHAM ROAD, TE HORO

Project No.	Sheet. No.	Revision
5-C2771.00	P206	3

Original Sheet Size A4 [210x297] Plot Date 2017-04-11 at 9:34:04 a.m. Path P:\projects\5-C2771.00 PP2O Specimen Design\500 Technical\501 Drawings\03 CAD\01_DWGS\Property\Riparian Planting\Drawings\5-C2771.00_P201-212.dwg P206

APPENDIX B

Appendix B – Species List

Species	Common Name	Streamside	Central	TOTAL
Aristotelia serrata	makomako, wineberry	0	15	15
Austroderia fulvida	kakaho, toetoe	0	25	25
Austroderia toetoe	toetoe	25	0	25
Carex secta	pukio	25	0	25
Carex virigata	pukio	0	30	30
Coprosma robusta	karamu	5	20	25
Cordyline australis	ti kouka, cabbage tree	5	20	25
Cyperus ustulatus	upokotangata	25	0	25
Dodonaea viscosa	akeake	0	10	10
Hebe stricta	koromiko	0	10	10
Kunzea ericoides	kanuka	0	15	15
Leptospermum scoparium	manuka	0	15	15
Melicytus ramiflorus	whiteywood	0	10	10
Phormium tenax	harakeke	15	25	40
Pittosporum tenuifolium	kohuhu	5	25	30
Plagianthus regius	manatu, ribbonwood	10	20	30
Sophora microphylla	kowhai	0	5	5
TOTAL		115	245	**360**

Jewell Stream, Te Horo

Riparian Enhancement Plan

Albertus and Sarah de Geest, 193 Pukenamu Road, Te Horo

Prepared By

Colin Stace
Senior Rural Consultant

Reviewed By

Roger MacGibbon
Design Team Leader

Opus International Consultants Ltd

Napier Office
Opus House, 6 Ossian Street
Private Bag 6019, Napier 4142
New Zealand

Telephone: +64 6 349 6600
Facsimile: +64 6 348 4601

Date: April 2017
Reference: 5-c2771.00
Status: Final

Contents

1. Property Details

Owner(s): Albertus de Geest and Sarah Christyne de Geest	
Contacts: ph. 06 364 2499, email sarah.degeest@xtra.co.nz	
Legal Description: Lot 14 Deposited Plan 91189	**Area:** 5.299 ha
Title: WN59A/390	**Valuation Number:** 14890-00212

Property location and planting site

2. Purpose of this Plan

The resource consent conditions for the construction of the 13km Peka Peka to Otaki (PP2O) section of the Kapiti Expressway require that at least 2601 lineal metres of stream length undergo riparian fencing and restorative planting as compensation for stream sections that will be altered by the Expressway construction.

Because of significant flooding issues on the Mangaone Stream especially downstream of State Highway 1, which additional riparian planting would likely exacerbate, and because contiguous or near-contiguous riparian restoration along a single stream is likely to be of greater ecological value to aquatic life than small patches over several streams, agreement was reached between the NZ Transport Agency and Greater Wellington Regional Council that riparian restoration effort would be focused on the Jewell Stream as a priority.

The Jewell Stream is likely to provide the best ecological return from riparian restoration because:

i. Riparian planting along both sides of Jewell Stream is not likely to exacerbate flooding to the same extent as would be the case along the lower Mangaone Stream.
ii. Jewell Stream would appear to carry the largest water volume of the ephemeral streams in the area and it flows permanently for a longer duration during summer.
iii. It flows through the area known as Mary Crest where a remnant wetland area is proposed for significant restoration as part of the Expressway mitigation. The collective ecological value of the wetland and riparian restoration effort will be greater if they are physically linked.
iv. At least one barrier to fish passage exists along the Jewell – a concrete culvert sump structure between SH 1 and the railway line – which, if removed, would open up the entire upper catchment to fish usage.
v. The Jewell Stream joins the Mangaone Stream near its river mouth. The Mangaone Stream has a natural, passable river mouth and is known to be inhabited by native fish species. Enhancement of the Jewell Stream will significantly increase the available habitat for native fish species.
vi. A considerable length (greater than 5km) of the Jewell would benefit from riparian fencing and planting.

The objective is to generate 2601 stream length metres of riparian retirement with 5 metres (or more) between the stream channel and fence on each side of the stream, planted with native vegetation suitable to provide shade to the stream channel and create improved habitat for aquatic life.

Landowners along Jewell Stream have been approached to see if they were prepared to offer their stream margins for fencing off and planting. The NZ Transport Agency has offered to pay for the fencing, planting and 5 years of maintenance in return for a covenant which will be placed on each restored area to ensure the plants and fence remain intact into the future. Property owners who have indicated an interest in offering their stream margins for restoration have each had a riparian enhancement plan produced for their consideration.

This Riparian Enhancement Plan provides the fencing details (fence route and design), plant prescription (species, grades), site preparation (removal of weed species and methods to be used), and a five year post-planting maintenance programme for the property of Albertus and Sarah de Geest at 193 Pukenamu Road, Te Horo.

3. Overview (refer Plan P209, Appendix A)

The Jewell Stream flows through the property in close proximity to the south-western boundary. Both left and right banks of the stream are within the property, and the margin between the stream channel and the south-western boundary fence varies between 3 – 11 m approximately. The existing boundary fence is a post and batten fence and is in good condition. It does not require replacement for the purpose of providing long term protection for riparian enhancement works.

Fig. 1 South end of site, looking downstream.

Fig. 2 Channel upstream of pump shed, rank grass and (sprayed) blackberry.

An existing fence is located adjacent to the true right bank of the stream and comprises a four-wire electric fence with posts at 5 m spacings, with two 3.6 m gates. The fence serviceable but in a semi-aged condition, and susceptible to voltage loss and other maintenance issues in close proximity to a body of vegetation. Replacement with a new 8-wire post and batten fence is proposed to provide optimum stock exclusion and longevity, to be erected along the current fence line.

Fig. 3 Pump shed, southern side of view shaft area.

Fig. 4 North end of site, bindweed on boundary fence.

A total planting area of 2,570 m^2 is available within the site, however a number of exiting tree and shrub plantings, and a small pump shed, reduce the effective planting area to around 2,420 m^2.

Summary of enhancement works

Length of channel	260 m	Both banks
New fencing	254 m, 8 wire post & batten with electric outrigger	
Available planting Area	2,570 square meters	
Estimated number of plants	1460 – native trees, shrubs and wetland species	

4. Fencing Works

Line Preparation

- The existing fence (4 wire electric) and gates will be removed. Any recoverable materials the Landowner may wish to retain will be stockpiled at their direction. Unwanted materials will be disposed of off-site.

Fence Construction

- New fencing will consist of an 8 wire post and batten fence, with the addition of an electric outrigger on the top of the fence to deter horses and cattle from reaching into the planting area.
- Two pedestrian gates will be installed; one at the pump shed and one at the crossing point approximately 45 m downstream of the pump shed.

5. Planting Activities

Site Preparation

- Invasive weed control with suitable herbicide (e.g. triclopyr) will be applied during the spring and summer preceding planting, for spot control of blackberry and convolvulus in particular.
- Existing plants, including poplar and eucalyptus trees, will be retained.
- Rank grass to be spot-sprayed with a suitable herbicide (e.g. glyphosate) in the summer - autumn period preceding pre-release and planting.

Pest Animal Control

- Rabbits are present in low to moderate numbers throughout the property. Given the number and proximity of neighbouring properties there is limited opportunity to apply pest control activities such as poisoning or night shooting. Protective sleeves or repellents will otherwise be used to deter rabbit browsing of new plantings.

Pre-release & Planting

- Planting spots will be sprayed with a suitable herbicide (e.g. glyphosate) at least three weeks prior to planting.

- Plant spacing will generally be no greater than 1.5 x 1.5 m for most species, while some wetland genera such as *Carex* and *Cyperus* will be at closer spacings.
- All plants will be 1 L potted stock, or similar grade, and will be planted in holes slightly larger than the root ball, with any spiralled roots removed. All plant pots or other packaging will be removed off site.
- A planting list of species is set out in Appendix B. Plant stock will be sought as eco-sourced material from within the Foxton Ecological District- 31.02.[1]
- Layout will generally follow the siting indicated in the list, and a view shaft area of low canopy species will the set out opposite the neighbouring residence. This area will extend from a point adjacent the neighbour's water tanks, downstream to the crossing point pedestrian gate (refer Plan 209, Appendix A).

Plant Maintenance

- Each plant will be released (control of competing vegetation within an 800-1000mm radius) in the spring and mid-summer, for up to five years.
- Weed control will use carefully directed or shielded low-pressure spray of a suitable herbicide. Operators will hold current GROWSAFE certification, and will use approved methods and equipment to prevent spray drift when applying herbicide.
- Any resurgent or invasive weeds will also be controlled concurrently.
- The site will be monitored for resurgent or invasive weeds during the five year establishment period, and weed control will be applied annually as required.

6. Programme Management

- All works will be performed by suitably qualified and experienced operators contracted to Opus (on behalf of the NZ Transport Agency) and supervised by experienced Opus staff. Property work areas, including access routes, will be determined in advance of site activity, in consultation with the Landowner.
- The Contractor will give adequate notice of timing for entry to the property, and will comply with Landowner requirements in regard to factors such as stock management, vehicle access and Health and Safety obligations.
- Opus staff will maintain contact with Contractors on a regular basis, including periodic site inspections as works progress.
- Any Landowner concerns that may arise about progress of works or Contractor activity should be communicated to the designated Opus Project Manager at the earliest opportunity. If necessary, a hold-point on works can be applied until matters of concern are resolved.

[1] Ecological Regions and Districts of New Zealand (1987) NZ Dept. of Conservation

7. Timetable

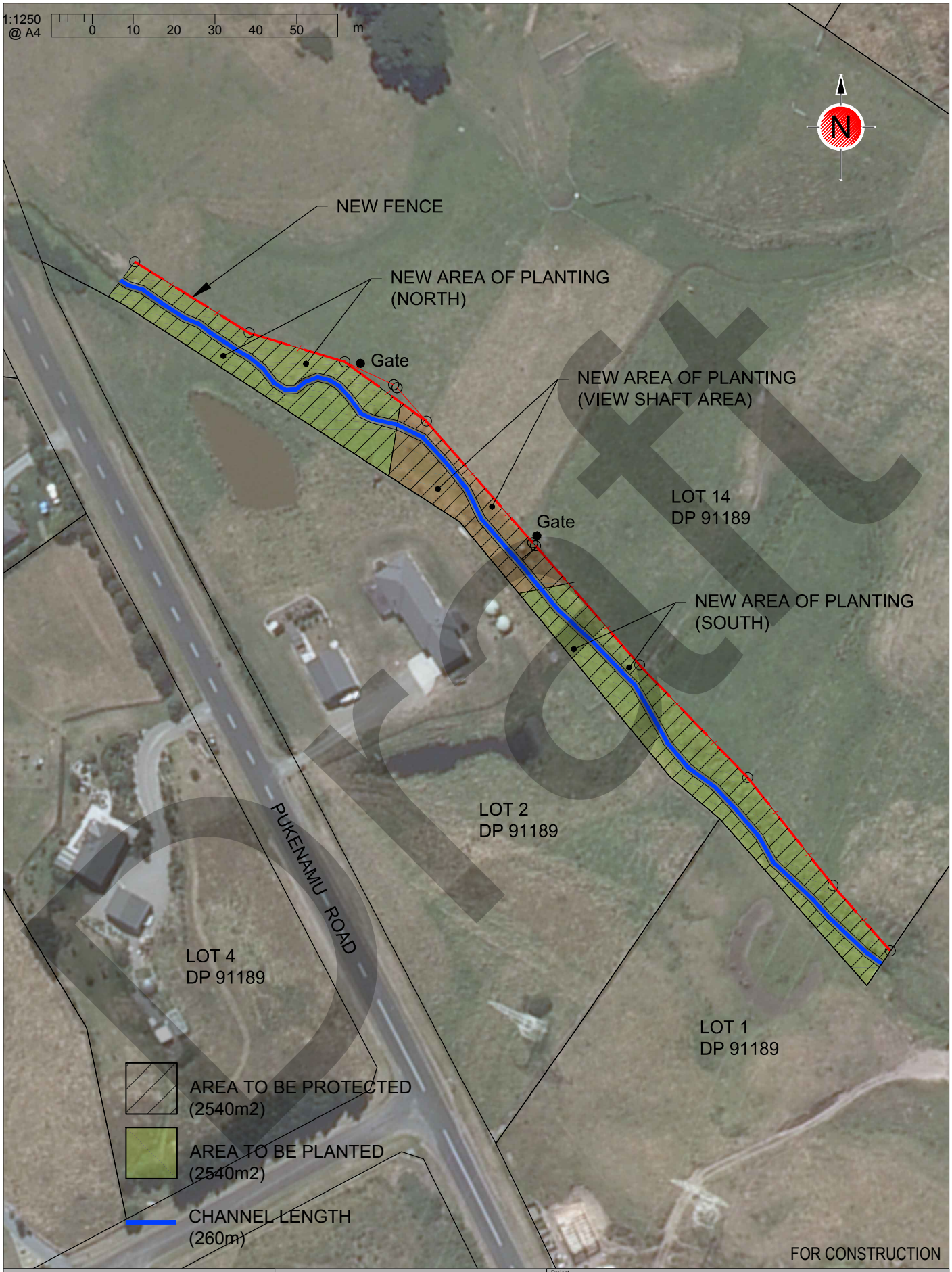
7. Activity	Timing	Responsibility	Supervision
Invasive weed control	Feb - March 2018	Contractor	Opus
Rank growth spot spray	Feb - March 2018	Contractor	Opus
Existing fence removal	April 2018	Contractor	Opus
Construct new fence	April 2018	Contractor	Opus
Pre-plant spot spray	May 2018	Contractor	Opus
Planting	June 2018	Contractor	Opus
Releasing	Oct 2018 & Feb2019	Contractor	Opus
Releasing	Oct 2019 & Feb2020	Contractor	Opus
Releasing	Oct 2020 & Feb2021	Contractor	Opus
Maintenance	Oct 2021 & Feb2022	Contractor	Opus
Maintenance	Oct 2022 & Feb2023	Contractor	Opus

Note: this timing indicative, specific dates will be confirmed prior to commencement of works.

8. Review and Update

- The Riparian Enhancement Plan will be monitored and reviewed annually by Opus, in consultation with the Landowner and NZTA. Any major changes will be documented and an amended plan will be submitted to NZTA for approval.
- Any channel management issues arising, which affect stream bank integrity such that establishment of plantings may be threatened, will be addressed on a situation-by-situation basis within the five year establishment period.

APPENDIX A



NZ TRANSPORT AGENCY
WAKA KOTAHI

OPUS
Wellington Office
+64 4 471 7000
PO Box 12-003
Wellington 6144
New Zealand

1	ISSUED FOR CONSTRUCTION	R.M.	3/02/2017
2	CHANNEL LENGTH ADDED	R.M.	11/04/2017

Designed	Approved	Approved Date
R. MACGIBBON	R.McFADYEN	03/02/2017
Drawn	Scales	
B.CRAIG	1:250	

Project
NEW ZEALAND TRANSPORT AGENCY
S.H.1 REGION 9 R.P. 995/2.738 - 15.423
PEKA PEKA TO OTAKI (PP2O) EXPRESSWAY - SPECIMEN DESIGN

Sheet
RIPARIAN PLANTING - PROPERTY 9
DE GEEST , 193 PUKENAMU ROAD, TE HORO

Project No.	Sheet. No.	Revision
5-C2771.00	P209	2

Original Sheet Size A4 [210x297] Plot Date 2017-04-12 at 1:20:24 p.m. Path P:\projects\5-C2771.00 PP2O Specimen Design\500 Technical\501 Drawings\03 CAD\01_DWGS\Property\Riparian Planting\Drawings\5-C2771.00_P201-212.dwg P209

APPENDIX B

Appendix B - Species List

Species	Common Name	Streamside	Central	Fenceline	TOTAL
Aristotelia serrata	makomako, wineberry	20	50	0	70
*Austroderia toetoe**	toetoe	0	0	0	0
Carex germinata	rautahi, cutty grass	0	50	0	50
*Carex secta**	pukio	130	50	50	230
*Carex virigata**	pukio	75	50	25	150
Coprosma robusta	karamu	0	75	20	95
Cordyline australis	ti kouka, cabbage tree	0	25	0	25
*Corokia cotoeaster**	korokio	25	0	0	25
*Cyperus ustulatus**	upokotangata	75	75	25	175
Dodonaea viscosa	akeake	0	50	25	75
Hebe stricta	koromiko	0	25	25	50
Hoheria sexstylosa	houhere, long-leaved lacebark	0	15	0	15
Kunzea ericoides	kanuka	0	75	0	75
Leptospermum scoparium	manuka	0	100	0	100
*Phormium tenax**	harakeke	80	100	10	190
Pittosporum eugenioides	tarata, lemonwood	0	25	0	25
Pittosporum tenuifolium	kohuhu	0	50	0	50
Plagianthus regius	manatu, ribbonwood	0	50	0	50
Sophora microphylla	kowhai	0	10	0	10
TOTAL		405	875	180	**1460**

* low canopy species

Jewell Stream, Te Horo

Riparian Enhancement Plan

John Kiernan, 29 Puruaha Road, Te Horo

Prepared By

Colin Stace
Senior Rural Consultant

Reviewed By

Roger MacGibbon
Design Team Leader

Opus International Consultants Ltd

Napier Office
Opus House, 6 Ossian Street
Private Bag 6019, Napier 4142
New Zealand

Telephone: +64 6 349 6600
Facsimile: +64 6 348 4601

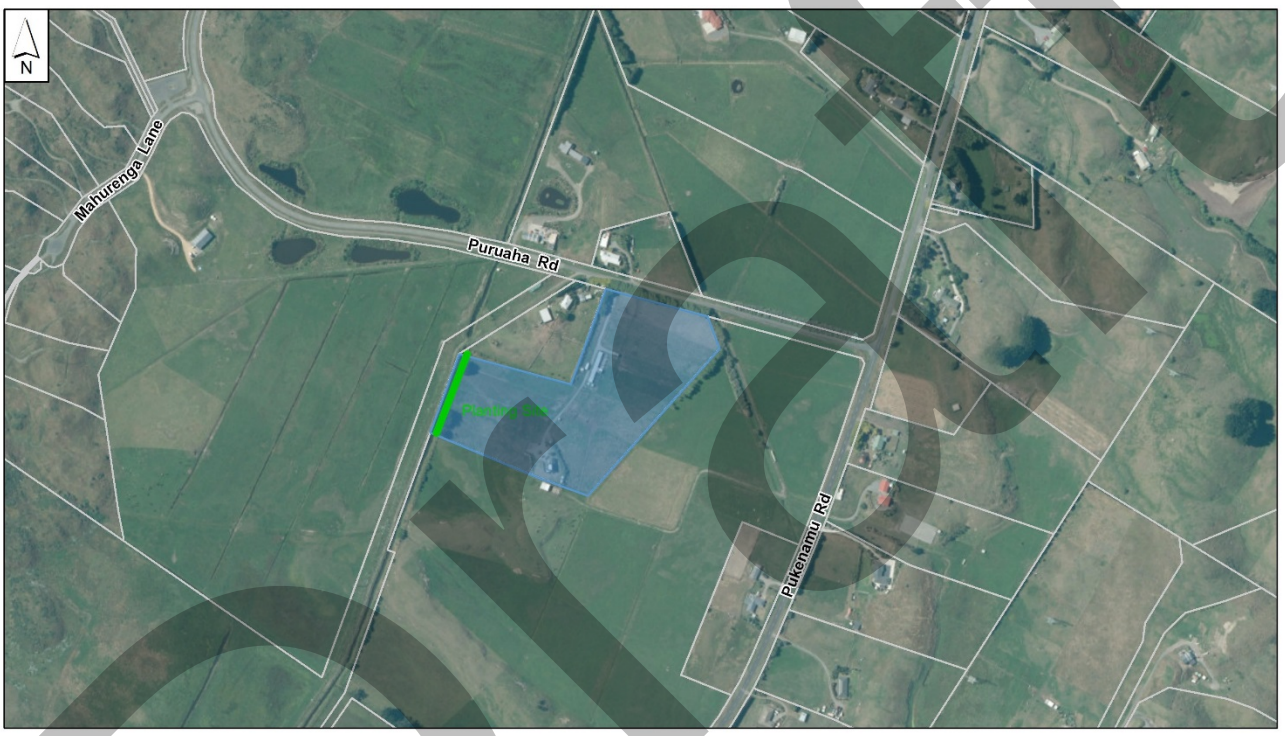
Date: April 2017
Reference: 5-c2771.oo
Status: Final

Contents

1. Property Details

Owner(s): Phillip John Kiernan	
Contacts: ph. 027 272 3262	
Legal Description: Lot 13 Deposited Plan 91189	**Area:** 3.666 ha
Title: WN59A/389	**Valuation Number:** 14871-36509

Property location and planting site



2. Purpose of this Plan

The resource consent conditions for the construction of the 13km Peka Peka to Otaki (PP2O) section of the Kapiti Expressway require that at least 2601 lineal metres of stream length undergo riparian fencing and restorative planting as compensation for stream sections that will be altered by the Expressway construction.

Because of significant flooding issues on the Mangaone Stream especially downstream of State Highway 1, which additional riparian planting would likely exacerbate, and because contiguous or near-contiguous riparian restoration along a single stream is likely to be of greater ecological value to aquatic life than small patches over several streams, agreement was reached between the NZ Transport Agency and Greater Wellington Regional Council (GWRC) that riparian restoration effort would be focused on the Jewell Stream as a priority.

The Jewell Stream is likely to provide the best ecological return from riparian restoration because:

i. Riparian planting along both sides of Jewell Stream is not likely to exacerbate flooding to the same extent as would be the case along the lower Mangaone Stream.
ii. Jewell Stream would appear to carry the largest water volume of the ephemeral streams in the area and it flows permanently for a longer duration during summer.
iii. It flows through the area known as Mary Crest where a remnant wetland area is proposed for significant restoration as part of the Expressway mitigation. The collective ecological value of the wetland and riparian restoration effort will be greater if they are physically linked.
iv. At least one barrier to fish passage exists along the Jewell – a concrete culvert sump structure between SH 1 and the railway line – which, if removed, would open up the entire upper catchment to fish usage.
v. The Jewell Stream joins the Mangaone Stream near its river mouth. The Mangaone Stream has a natural, passable river mouth and is known to be inhabited by native fish species. Enhancement of the Jewell Stream will significantly increase the available habitat for native fish species.
vi. A considerable length (greater than 5km) of the Jewell Stream would benefit from riparian fencing and planting.

The objective is to generate 2601 stream length metres of riparian retirement with 5 metres (or more) between the stream channel and fence on each side of the stream, planted with native vegetation suitable to provide shade to the stream channel and create improved habitat for aquatic life.

Landowners along Jewell Stream have been approached to see if they were prepared to offer their stream margins for fencing off and planting. The NZ Transport Agency has offered to pay for the fencing, planting and 5 years of maintenance in return for a covenant which will be placed on each restored area to ensure the plants and fence remain intact into the future. Property owners who have indicated an interest in offering their stream margins for restoration have each had a riparian enhancement plan produced for their consideration.

This Riparian Enhancement Plan provides the fencing details (fence route and design), plant prescription (species, grades), site preparation (removal of weed species and methods to be used), and a five year post-planting maintenance programme for the property of John Kiernan at 29 Puruaha Road, Te Horo.

3. Overview (refer Plan P211, Appendix A)

The Jewell Stream flows northwards along the property's western boundary and both left and right banks of the stream are within the property. The true left bank has a narrow and insufficient margin for planting, and is also used as access for GWRC channel maintenance operations.

Fig. 1 South end of site, looking downstream. Note blackberry on opposite bank.

Fig. 2 Central site, looking downstream.

The stream is currently fenced adjacent the true right bank, enclosing a channel margin varying between 4.5 – 5 m wide. At the northern end of the site adjacent an existing culvert crossing, some 8 m of channel sits within a 'give and take' fence configuration. Immediately upstream of the culvert intake the margin within existing fencing tapers down to 3.5 m. Three established Monterey cypress (*Cupressus macrocarpa*) are situated on the immediate paddock side of the existing fence line (refer Figs 1 & 4).

Fig. 3 Corroded wire and staple.

Fig 4. Rails connecting side fence.

The fence serviceable but in a semi-aged condition, with rusting wire and staples (Fig. 3). Replacement with a new 7-wire post and batten fence is proposed to provide optimum stock exclusion and longevity. New fencing will be placed on the alignment of the current fence line, such that the Monterey Cypress trees will be excluded from the proposed planting area. A 3-4 m side lift

pruning of the cypress trees will be included in site preparation to limit shading of proposed native plantings. The fenced area will connect with the 'give & take' fence line on the northern boundary.

Summary of enhancement works

Length of channel	104 m	True right bank
New fencing	100 m, 7 wire post & batten with electric outrigger	
Available planting Area	380 square meters	
Estimated number of plants	230 – native trees, shrubs and wetland species	

4. Fencing Works

Line Preparation

- The existing fence will be removed. Any recoverable materials the Landowner may wish to retain, such as posts, will be stockpiled at their direction. Unwanted materials will be disposed of off-site.

Fence Construction

- New fencing will consist of a 7 wire post and batten fence, with the addition of an electric outrigger on the top of the fence to deter horses and cattle from reaching into the planting area.
- Hot-dipped staples will be used to provide extra galvanising for coastal conditions.
- Where appropriate, existing structures, such as a set of rails, will be repaired or upgraded as required.

5. Planting Activities

Site Preparation

- Invasive weed control with suitable herbicide (e.g. triclopyr) will be applied during the spring and summer preceding planting, to control brushweeds and bindweeds in particular.
- Adjacent cypress trees will be side pruned.
- Rank grass to be spot-sprayed with a suitable herbicide (e.g. glyphosate) in the summer - autumn period preceding pre-release and planting works.

Pest Animal Control

- Rabbits are present in low to moderate numbers throughout the property. Given the number and proximity of neighbouring properties there is limited opportunity to apply pest control activities such as poisoning or night shooting. Protective sleeves or repellents will otherwise be used to deter rabbit browsing of new plantings.

Pre-release & Planting

- Planting spots will be sprayed with a suitable herbicide (e.g. glyphosate) at least three weeks prior to planting.
- Plant spacing will generally be no greater than 1.5 x 1.5 m for most species, while some wetland genera such as *Carex* and *Cyperus* will be at closer spacings.
- All plants will be 1 L potted stock, or similar grade, and will be planted in holes slightly larger than the root ball, with any spiralled roots removed. All plant pots or other packaging will be removed off site.
- A planting list of species is set out in Appendix B. Plant stock will be sought as eco-sourced material from within the Foxton Ecological District- 31.02.[1]

Plant Maintenance

- Each plant will be released (control of competing vegetation within an 800-1000mm radius) in the spring and mid-summer, for up to five years.
- Weed control will use carefully directed or shielded low-pressure spray of a suitable herbicide. Operators will hold current GROWSAFE certification, and will use approved methods and equipment to prevent spray drift when applying herbicide.
- Any resurgent or invasive weeds will also be controlled concurrently.
- The site will be monitored for resurgent or invasive weeds during the five year establishment period, and weed control will be applied annually as required.

6. Programme Management

- All works will be performed by suitably qualified and experienced operators contracted to Opus (on behalf of the NZ Transport Agency) and supervised by experienced Opus staff. Property work areas, including access routes, will be determined in advance of site activity, in consultation with the Landowner.
- The Contractor will give adequate notice of timing for entry to the property, and will comply with Landowner requirements in regard to factors such as stock management, vehicle access and Health and Safety obligations.
- Opus staff will maintain contact with Contractors on a regular basis, including periodic site inspections as works progress.
- Any Landowner concerns that may arise about progress of works or Contractor activity should be communicated to the designated Opus Project Manager at the earliest opportunity. If necessary, a hold-point on works can be applied until matters of concern are resolved.

7. Timetable

7. Activity	Timing	Responsibility	Supervision
Invasive weed control	Feb - March 2018	Contractor	Opus
Rank growth spot spray	Feb - March 2018	Contractor	Opus

[1] Ecological Regions and Districts of New Zealand (1987) NZ Dept. of Conservation

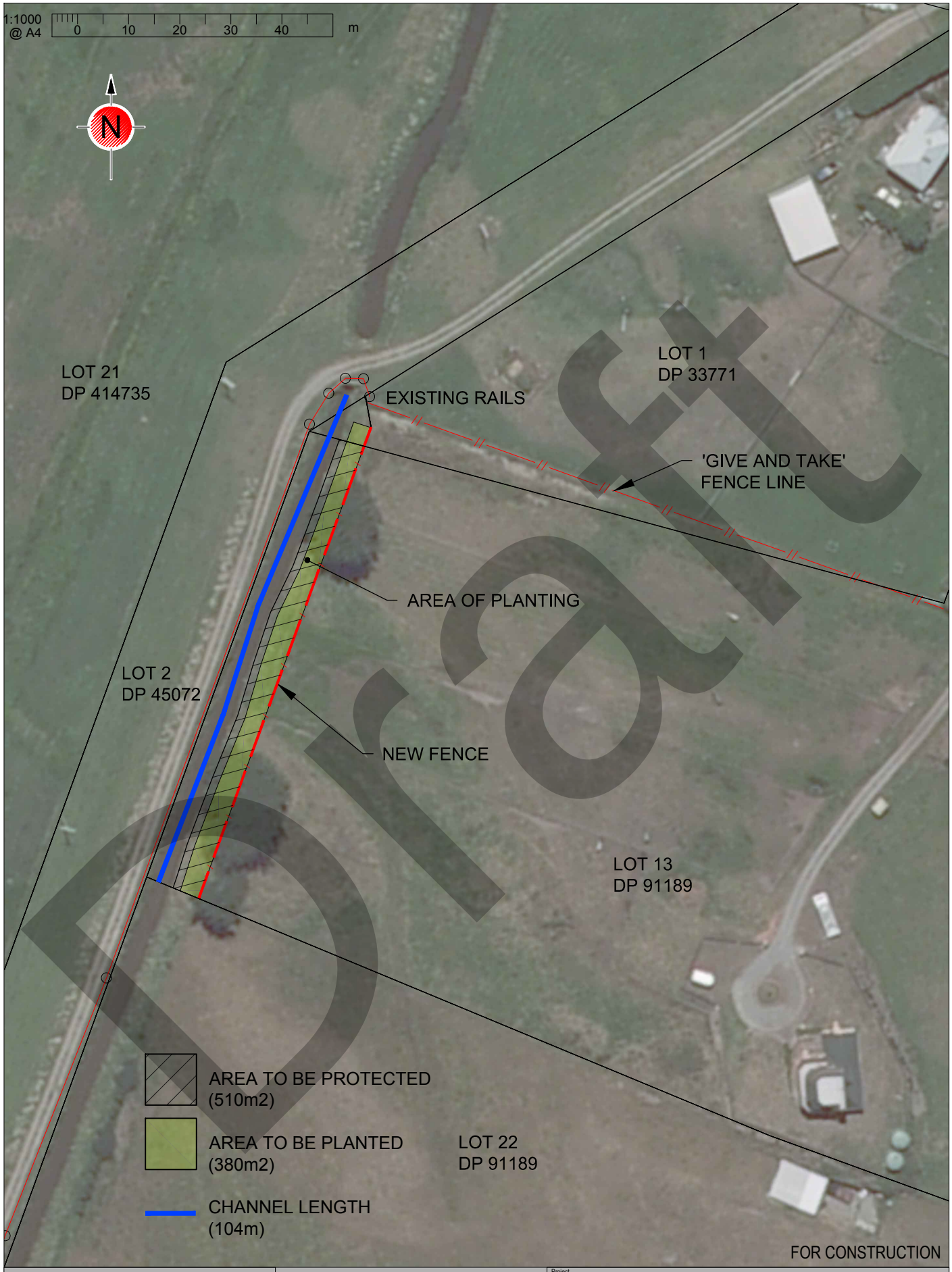
Existing fence removal	April 2018	Contractor	Opus
Side prune C. macrocarpa	April 2018	Contractor	Opus
Construct new fence	April 2018	Contractor	Opus
Pre-plant spot spray	May 2018	Contractor	Opus
Planting	June 2018	Contractor	Opus
Releasing	Oct 2018 & Feb2019	Contractor	Opus
Releasing	Oct 2019 & Feb2020	Contractor	Opus
Releasing	Oct 2020 & Feb2021	Contractor	Opus
Maintenance	Oct 2021 & Feb2022	Contractor	Opus
Maintenance	Oct 2022 & Feb2023	Contractor	Opus

Note: this timing indicative, specific dates will be confirmed prior to commencement of works.

8. Review and Update

- The Riparian Enhancement Plan will be monitored and reviewed annually by Opus, in consultation with the Landowner and NZTA. Any major changes will be documented and an amended plan will be submitted to NZTA for approval.
- Any channel management issues arising, which affect stream bank integrity such that establishment of plantings may be threatened, will be addressed on a situation-by-situation basis within the five year establishment period.

APPENDIX A



1	ISSUED FOR CONSTRUCTION	R.M.	3/02/2017
2	CHANNEL LENGTH ADDED	R.M.	11/04/2017

NZ TRANSPORT AGENCY
WAKA KOTAHI

OPUS
Wellington Office
+64 4 471 7000
PO Box 12-003
Wellington 6144
New Zealand

Designed	Approved	Approved Date
R. MACGIBBON	R.McFADYEN	03/02/2017
Drawn	Scales	
B.CRAIG	1:1000	

Project
NEW ZEALAND TRANSPORT AGENCY
S.H.1 REGION 9 R.P. 995/2.738 - 15.423
PEKA PEKA TO OTAKI (PP2O) EXPRESSWAY - SPECIMEN DESIGN

Sheet
RIPARIAN PLANTING - PROPERTY 11
KIERNAN , 29 PURUAHA ROAD, TE HORO

Project No.	Sheet. No.	Revision
5-C2771.00	P211	2

Original Sheet Size A4 [210x297] Plot Date 2017-04-11 at 9:43:21 a.m. Path P:\projects\5-C2771.00 PP2O Specimen Design\500 Technical\501 Drawings\03 CAD\01_DWGS\Property\Riparian Planting\Drawings\5-C2771.00_P201-212.dwg P211

APPENDIX B

Appendix B – Species List

Species	Common Name	Streamside	Central	Fenceline	TOTAL
Austroderia fulvida	toetoe	15	10	15	40
Coprosma repens	taupata	15	15	5	35
Corynocarpus lavigatus	karaka	0	10	0	10
Cyperus ustulatus	upokotangata	20	0	0	20
Dodonaea viscosa	akeake	0	10	10	20
Hebe stricta	koromiko	0	10	10	20
Leptospermum scoparium	manuka	15	10	10	35
Myoporum laetum	ngaio	0	10	0	10
Oleria paniculata	akiraho	0	10	0	10
Olearia solandri	coastal shrub daisy	0	0	15	15
Phormium tenax	harakeke	0	15	0	15
Total		65	100	65	**230**

Jewell Stream, Te Horo

Riparian Enhancement Plan

John Lansbury & Sacha Kenny, 103 Derham Road, Te Horo

Prepared By

Colin Stace
Senior Rural Consultant

Reviewed By

Roger MacGibbon
Design Team Leader

Opus International Consultants Ltd

Napier Office
Opus House, 6 Ossian Street
Private Bag 6019, Napier 4142
New Zealand

Telephone: +64 6 349 6600
Facsimile: +64 6 348 4601

Date: April 2017
Reference: 5-c2771.00
Status: Final

Contents

1. Property Details

Owner(s): John Robert Lansbury & Sacha Elizabeth Lansbury	
Contacts: ph. 06 364 3248, 021 0247 892; email sachakenny@hotmail.com	
Legal Description: Lot 3 Deposited Plan 71409	**Area:** 7.2115 ha
Title: WN39A/891	**Valuation Number:** 14890-00415

Property location and planting sites

2. Purpose of this Plan

The resource consent conditions for the construction of the 13km Peka Peka to Otaki (PP2O) section of the Kapiti Expressway require that at least 2601 lineal metres of stream length undergo riparian fencing and restorative planting as compensation for stream sections that will be altered by the Expressway construction.

Because of significant flooding issues on the Mangaone Stream especially downstream of State Highway 1, which additional riparian planting would likely exacerbate, and because contiguous or near-contiguous riparian restoration along a single stream is likely to be of greater ecological value to aquatic life than small patches over several streams, agreement was reached between the NZ Transport Agency and Greater Wellington Regional Council that riparian restoration effort would be focused on the Jewell Stream as a priority.

The Jewell Stream is likely to provide the best ecological return from riparian restoration because:

i. Riparian planting along both sides of Jewell Stream is not likely to exacerbate flooding to the same extent as would be the case along the lower Mangaone Stream.
ii. Jewell Stream would appear to carry the largest water volume of the ephemeral streams in the area and it flows permanently for a longer duration during summer.
iii. It flows through the area known as Mary Crest where a remnant wetland area is proposed for significant restoration as part of the Expressway mitigation. The collective ecological value of the wetland and riparian restoration effort will be greater if they are physically linked.
iv. At least one barrier to fish passage exists along the Jewell – a concrete culvert sump structure between SH 1 and the railway line – which, if removed, would open up the entire upper catchment to fish usage.
v. The Jewell Stream joins the Mangaone Stream near its river mouth. The Mangaone Stream has a natural, passable river mouth and is known to be inhabited by native fish species. Enhancement of the Jewell Stream will significantly increase the available habitat for native fish species.
vi. A considerable length (greater than 5km) of the Jewell would benefit from riparian fencing and planting.

The objective is to generate 2601 stream length metres of riparian retirement with 5 metres (or more) between the stream channel and fence on each side of the stream, planted with native vegetation suitable to provide shade to the stream channel and create improved habitat for aquatic life.

Landowners along Jewell Stream have been approached to see if they were prepared to offer their stream margins for fencing off and planting. The NZ Transport Agency has offered to pay for the fencing, planting and 5 years of maintenance in return for a covenant which will be placed on each restored area to ensure the plants and fence remain intact into the future. Property owners who have indicated an interest in offering their stream margins for restoration have each had a riparian enhancement plan produced for their consideration.

This Riparian Enhancement Plan provides the fencing details (fence route and design), plant prescription (species, grades), site preparation (removal of weed species and methods to be used), and a five year post-planting maintenance programme for the property of John Lansbury & Sacha Kenny, 103 Derham Road, Te Horo.

3. Overview (refer Plan P207, Appendix A)

The Jewell Stream flows westwards adjacent to the property's south-western boundary, and lies within the neighbouring (Hart) property. The existing boundary fence is in an aged and dilapidated condition (refer Fig. 1), and is generally located around 3 m off the stream channel on the true right bank (Fig 2).

Fig. 1 Existing boundary fence at western corner of the property.

Fig. 2 Riparian margin (true right bank) between boundary fence and channel, 3 m approx.

Three fenced shelterbelts intersect with the boundary fence, on its northern, central and southern sections. The northern and central gates are in a state of disrepair (Fig. 3), and the southern gateway site in is close proximity to the stream channel. This section of the channel has experienced past stream bank erosion and has some semi-mature willow plantings present (Fig. 4). Surface drains discharge to the stream adjacent the northern and central gateways.

Fig. 3 Northern gateway – to have gate supplied and installed.

Fig. 4 South end of fence line; willow to be removed.

Replacement with a new 8-wire post and batten fence is proposed to provide optimum stock exclusion and longevity for proposed stream enhancement plantings on the neighbouring property. New fencing will be placed on an alignment approximate 2 m out from the current boundary fence line to provide a minimum planting margin of 5 m on the true right bank of the stream. To accommodate existing gate positions the proposed fence will be inset to the boundary line 8 m either side of gateways. This will avoid additional works that would otherwise be required for shelter tree removal and formation of vehicle access.

Summary of enhancement works

Length of channel	N/A	True right bank
New fencing	277 m, 8 wire post & batten	
Available planting Area	445 square meters	
Estimated number of plants	210 – native trees, shrubs and wetland species	

4. Fencing Works

Line Preparation

- The existing fence will be removed. Any recoverable materials the Landowner may wish to retain, such as posts, will be stockpiled at their direction. Unwanted materials will be disposed of off-site.
- On approximately 90 m of fence line at the western end of the property, spoil from past dredging operations will be bladed to provide a suitable bench for fencing construction,
- Existing troughs will be relocated to the paddock side of the new fence line. Two unused concrete troughs within the proposed fencing area will be removed, to a site of the Landowners choice.

Fence Construction

- New fencing will consist of an 8 wire post and batten fence, with posts spaced at 4m and three battens between posts.
- The fence line will be inset to align with the boundary, 8 m either side of the northern and central gateway, and 8 m to side of the southern gateway (refer Plan P207, Appendix A).
- One new gate will be supplied and mounted at the northern gateway, and one existing gate will be mounted at the central gateway.
- One pedestrian access gate will located in the new fence line.

5. Planting Activities

Site Preparation

- Invasive weed control with suitable herbicide (e.g. triclopyr) will be applied during the spring and summer preceding planting, for spot control blackberry and bindweeds in particular.

- Willow plantings and flood debris adjacent the southern gateway will be removed. Removal method will be motor-manual and stumps will be treated with a suitable herbicide (e.g. glyphosate).
- Rank grass to be spot-sprayed with a suitable herbicide (e.g. glyphosate) in the summer - autumn period preceding pre-release and planting works.

Pest Animal Control

- Rabbits are present in low to moderate numbers throughout the property. Given the number and proximity of neighbouring properties there is limited opportunity to apply pest control activities such as poisoning or night shooting. Protective sleeves or repellents will otherwise be used to deter rabbit browsing of new plantings.

Pre-release & Planting

- Planting spots will be sprayed with a suitable herbicide (e.g. glyphosate) at least three weeks prior to planting.
- Plant spacing will generally be no greater than 1.5 x 1.5 m for most species, while some wetland genera such as *Carex* and *Cyperus* will be at closer spacings.
- All plants will be 1 L potted stock, or similar grade, and will be planted in holes slightly larger than the root ball, with any spiralled roots removed. All plant pots or other packaging will be removed off site.
- A planting list of species is set out in Appendix B. Plant stock will be sought as eco-sourced material from within the Foxton Ecological District- 31.02.[1]

Plant Maintenance

- Each plant will be released (control of competing vegetation within an 800-1000mm radius) in the spring and mid-summer, for up to five years.
- Weed control will use carefully directed or shielded low-pressure spray of a suitable herbicide. Operators will hold current GROWSAFE certification, and will use approved methods and equipment to prevent spray drift when applying herbicide.
- Any resurgent or invasive weeds will also be controlled concurrently.
- The site will be monitored for resurgent or invasive weeds during the five year establishment period, and weed control will be applied annually as required.

6. Programme Management

- All works will be performed by suitably qualified and experienced operators contracted to Opus (on behalf of the NZ Transport Agency) and supervised by experienced Opus staff. Property work areas, including access routes, will be determined in advance of site activity, in consultation with the Landowner.
- The Contractor will give adequate notice of timing for entry to the property, and will comply with Landowner requirements in regard to factors such as stock management, vehicle access and Health and Safety obligations.

[1] Ecological Regions and Districts of New Zealand (1987) NZ Dept. of Conservation

- Opus staff will maintain contact with Contractors on a regular basis, including periodic site inspections as works progress.
- Any Landowner concerns that may arise about progress of works or Contractor activity should be communicated to the designated Opus Project Manager at the earliest opportunity. If necessary, a hold-point on works can be applied until matters of concern are resolved.

7. Timetable

7. Activity	Timing	Responsibility	Supervision
Invasive weed control	Feb - March 2018	Contractor	Opus
Rank growth spot spray	Feb - March 2018	Contractor	Opus
Willow removal and trough relocations	March 2018	Contractor	Opus
Existing fence removal	April 2018	Contractor	Opus
Construct new fence	April 2018	Contractor	Opus
Pre-plant spot spray	May 2018	Contractor	Opus
Planting	June 2018	Contractor	Opus
Releasing	Oct 2018 & Feb2019	Contractor	Opus
Releasing	Oct 2019 & Feb2020	Contractor	Opus
Releasing	Oct 2020& Feb2021	Contractor	Opus
Maintenance	Oct 2021 & Feb2022	Contractor	Opus
Maintenance	Oct 2022 & Feb2023	Contractor	Opus

Note: this timing indicative, specific dates will be confirmed prior to commencement of works.

8. Review and Update

- The Riparian Enhancement Plan will be monitored and reviewed annually by Opus, in consultation with the Landowner and NZTA. Any major changes will be documented and an amended plan will be submitted to NZTA for approval.

- Any channel management issues arising, which affect stream bank integrity such that establishment of plantings may be threatened, will be addressed on a situation-by-situation basis within the five year establishment period.

APPENDIX A

NZ TRANSPORT AGENCY
WAKA KOTAHI

OPUS
Wellington Office
+64 4 471 7000
PO Box 12-003
Wellington 6144
New Zealand

A	INITIAL DRAFT	L.B.	9/08/2016
B	AMEND TEXT	C.S.	19/12/2016
C	ADD AND AMEND AREAS	C.S.	26/01/2017

Designed	Approved	Approved Date
R. MACGIBBON		
Drawn	Scales	
B.CRAIG	1:1250	

Project
NEW ZEALAND TRANSPORT AGENCY
S.H.1 REGION 9 R.P. 995/2.738 - 15.423
PEKA PEKA TO OTAKI (PP2O) EXPRESSWAY - SPECIMEN DESIGN

Sheet
RIPARIAN PLANTING - PROPERTY 7
LANSBURY , 103 DERHAM ROAD, TE HORO

Project No.	Sheet. No.	Revision
5-C2771.00	P207	C

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APPENDIX B

Appendix B – Species List

Species	Common Name	Drains	Fenceline	TOTAL
Austroderia toetoe	kakaho, toetoe	0	20	20
Carex secta	pukio	5	0	5
Coprosma robusta	karamu	0	25	25
Cordyline australis	ti kouka, cabbage tree	0	15	15
Cyperus ustulatus	upokotangata	5	10	15
Hebe stricta	akeake	0	25	25
Kunzea ericoides	kanuka	0	15	15
Leptospermum scoparium	manuka	0	25	25
Phormium tenax	flax	0	25	25
Pittosporum tenuifolium	kohuhu	0	20	20
Plagianthus regius	manatu, ribbonwood	0	10	10
Sophora microphylla	kowhai	0	10	10
Total		10	200	**210**

Jewell Stream, Te Horo

Riparian Enhancement Plan

Tony Whyman, 35 Puraha Road, Te Horo

Prepared By

Colin Stace
Senior Rural Consultant

Reviewed By

Roger MacGibbon
Design Team Leader

Opus International Consultants Ltd

Napier Office
Opus House, 6 Ossian Street
Private Bag 6019, Napier 4142
New Zealand

Telephone: +64 6 349 6600
Facsimile: +64 6 348 4601

Date: April 2017
Reference: 5-c2771.00
Status: Final

Contents

1. Property Details

Owner(s): Tony Whyman	
Contacts: ph. 021 445 690, email Tonywhyman2@gmail.com	
Legal Description: Lot 2 Deposited Plan 45072	**Area:** 58.5330 ha
Title: WN16C/296	**Valuation Number:** 14890-00100

Property location and planting site

Purpose of this Plan

The resource consent conditions for the construction of the 13km Peka Peka to Otaki (PP2O) section of the Kapiti Expressway require that at least 2601 lineal metres of stream length undergo riparian fencing and restorative planting as compensation for stream sections that will be altered by the Expressway construction.

Because of significant flooding issues on the Mangaone Stream especially downstream of State Highway 1, which additional riparian planting would likely exacerbate, and because contiguous or near-contiguous riparian restoration along a single stream is likely to be of greater ecological value to aquatic life than small patches over several streams, agreement was reached between the NZ Transport Agency and Greater Wellington Regional Council (GWRC) that riparian restoration effort would be focused on the Jewell Stream as a priority.

The Jewell Stream is likely to provide the best ecological return from riparian restoration because:

- Riparian planting along both sides of Jewell Stream is not likely to exacerbate flooding to the same extent as would be the case along the lower Mangaone Stream.

- Jewell Stream would appear to carry the largest water volume of the ephemeral streams in the area and it flows permanently for a longer duration during summer.
- It flows through the area known as Mary Crest where a remnant wetland area is proposed for significant restoration as part of the Expressway mitigation. The collective ecological value of the wetland and riparian restoration effort will be greater if they are physically linked.
- At least one barrier to fish passage exists along the Jewell – a concrete culvert sump structure between SH 1 and the railway line – which, if removed, would open up the entire upper catchment to fish usage.
- The Jewell Stream joins the Mangaone Stream near its river mouth. The Mangaone Stream has a natural, passable river mouth and is known to be inhabited by native fish species. Enhancement of the Jewell Stream will significantly increase the available habitat for native fish species.
- A considerable length (greater than 5km) of the Jewell would benefit from riparian fencing and planting.

The objective is to generate 2601 stream length metres of riparian retirement with 5 metres (or more) between the stream channel and fence on each side of the stream, planted with native vegetation suitable to provide shade to the stream channel and create improved habitat for aquatic life.

Landowners along Jewell Stream have been approached to see if they were prepared to offer their stream margins for fencing off and planting. The NZ Transport Agency has offered to pay for the fencing, planting and 5 years of maintenance in return for a covenant which will be placed on each restored area to ensure the plants and fence remain intact into the future. Property owners who have indicated an interest in offering their stream margins for restoration have each had a riparian enhancement plan produced for their consideration.

This Riparian Enhancement Plan provides the fencing details (fence route and design), plant prescription (species, grades), site preparation (removal of weed species and methods to be used), and a five year post-planting maintenance programme for the property of Tony Whyman at 35 Puruaha Road, Te Horo.

2. Overview (refer Plan 212 North and 212 South, Appendix A)

2.1 Main Channel (North)

The Jewell Stream main channel flows northwards along the property's eastern boundary, partly within the neighbouring properties adjacent the main access lane (see Fig. 5 below). On the NW margin of the property the boundary line crosses the stream and runs parallel with it on the true right bank. This corner point in the boundary line is marked by an existing strainer (refer Fig. 4). Both left and right banks of the stream are within the property along the southern section of the stream, but the true left bank has a very narrow margin for planting, and is also used as access for GWRC channel maintenance operations. This access extends along the true left bank of the steam, north of the planting site, adjacent to the property access lane (refer Fig. 5 & 6).

Fig. 1 Southern end of planting site adjacent boundary fence line, extensive blackberry.

Fig. 2 Northern section of planting area adjacent boundary fence, bindweed present.

The true right bank forms the available planting area, varying from 5 m to 12 m wide and includes a small section of true left bank beside the crossing at the southern end of the site. This area is displayed on Map P212N in Appendix A.

Existing fencing along the true left bank of the site generally comprises a four wire electric fence, with 70 m of single hot wire fencing between crossings at the southern end of the site (refer Fig. 3). A number of semi-mature poplar trees are present along the boundary fence line in the central planting area, and a bindweed infestation is also present in this area (refer Fig. 2). A major blackberry infestation is present at the southern end of the site (refer Fig. 1).

Fig. 3 Southern planting area upstream of existing gate; temporary single hot wire fence

Fig. 4 Boundary corner post at north end of planting, true right bank.

The current boundary fence on the eastern margin of the site is serviceable but in a semi-aged condition, with rusting wire and staples. Replacement with a new 8-wire post and batten fence is proposed to provide optimum stock exclusion and longevity. New fencing will be placed on the current alignment south of the existing boundary corner post (refer Figure 4).

Fig. 5 Stream channel north of planting area adjacent access lane, opposite Bean pty. Note blackberry. True left bank (foreground) reserved for GWRC maintenance purposes.

Fig. 6 North end of stream adjacent access lane, lane opposite Kiernan pty. Note blackberry.

Summary of enhancement works - Jewell Stream Main Channel (North)

Length of channel	329 m	True right bank
New fencing	345 m, 8 wire post & batten with electric outrigger; 589 m 3 wire electric (true left bank)	
Available planting Area	3,275 square meters	
Estimated number of plants	1,460 – native trees, shrubs and wetland species	

2.2 Tributary Channel (South)

To the south of the Jewell Stream main channel where it enters the property, a tributary channel extends to the south-east, turning south to connect form the outlet for a wetland area on a neighbouring property (refer Fig. 8). This feature is displayed on Map P212S in Appendix A.

Fig. 7 Southern end of tributary channel

Fig. 8 Wetland on neighbouring property at south end of tributary channel

The tributary channel is not deeply incised (refer Fig. 7) and has low-lying margins where the water table is close to, or at the surface, in places. The channel connects to an extensive area of wetland, mainly located on a neighbouring property, which is a Schedule A waterbody under the GWRC Proposed Natural Resources Plan 2015 and is identified as the *Te Hapua Swamp Complex A*.

Summary of enhancement works - Tributary Channel (South)

Length of channel	309 m	Both banks
New fencing	645 m, 8 wire post & batten with electric outrigger;	
Available planting Area	3,125 square meters	
Estimated number of plants	2090 – native trees, shrubs and wetland species	

3. Fencing Works

Line Preparation

- The existing fences will be removed, along with a 150 m section of defunct of single hot wire fencing on the true right bank of the main channel. Any recoverable materials the landowners may wish to retain, such as posts, will be stockpiled at their direction. Unwanted materials will be disposed of off-site.

Fence Construction

- New fencing will consist of an 8 wire post and batten fence, with the addition of an electric outrigger on the top of the fence to deter cattle from reaching into the planting areas.
- Hot-dipped staples will be used to provide extra galvanising for coastal conditions.
- A short (1 m) set of rails will be installed at the boundary corner post adjacent the main channel, and rails will be installed at the northern and southern ends of the tributary channel fencing.

4. Planting Activities

Site Preparation

- Invasive weed control with suitable herbicide (e.g. triclopyr) will be applied during the spring and summer preceding planting, to control brushweeds and bindweeds in particular.
- Existing poplar plantings and shrub willow at the drain outlet will be retained. Elsewhere, shrub willows growing over the existing fence will be removed by cutting and stumps will be swabbed with glyphosate.
- Rank grass to be spot-sprayed with a suitable herbicide (e.g. glyphosate) in the summer - autumn period preceding planting works.

Pest Animal Control

- Rabbits are present in low to moderate numbers throughout the property. Given the number and proximity of neighbouring properties there is limited opportunity to apply pest

control activities such as poisoning or night shooting. Protective sleeves or repellents will otherwise be used to deter rabbit browsing of new plantings.

Pre-release & Planting

- Planting spots will be sprayed with a suitable herbicide (e.g. glyphosate) at least three weeks prior to planting.
- Plant spacing will generally be no greater than 1.5 x 1.5 m for most species, while some wetland genera such as *Carex* and *Cyperus* will be at closer spacings.
- All plants will be 1 L potted stock, or similar grade, and will be planted in holes slightly larger than the root ball, with any spiralled roots removed. All plant pots or other packaging will be removed and disposed of off-site.
- A planting list of species is set out in Appendix B. Plant stock will be sought as eco-sourced material from within the Foxton Ecological District- 31.02.[1]

Plant Maintenance

- Each plant will be released (control of competing vegetation within an 800-1000mm radius) in the spring and mid-summer, for up to five years.
- Weed control will use carefully directed or shielded low-pressure spray of a suitable herbicide. Operators will hold current GROWSAFE certification, and will use approved methods and equipment to prevent spray drift when applying herbicide.
- Any resurgent or invasive weeds will also be controlled concurrently.
- The site will be monitored for resurgent or invasive weeds during the five year establishment period, and weed control will be applied annually as required.

5. Programme Management

- All works will be performed by suitably qualified and experienced operators contracted to Opus (on behalf of the NZ Transport Agency) and supervised by experienced Opus staff. Property work areas, including access routes, will be determined in advance of site activity, in consultation with the Landowner.
- The Contractor will give adequate notice of timing for entry to the property, and will comply with Landowner requirements in regard to factors such as stock management, vehicle access and Health and Safety obligations.
- Opus staff will maintain contact with Contractors on a regular basis, including periodic site inspections as works progress.
- Any Landowner concerns that may arise about progress of works or Contractor activity should be communicated to the designated Opus Project Manager at the earliest

[1] Ecological Regions and Districts of New Zealand (1987) NZ Dept. of Conservation

opportunity. If necessary, a hold-point on works can be applied until matters of concern are resolved.

6. Timetable

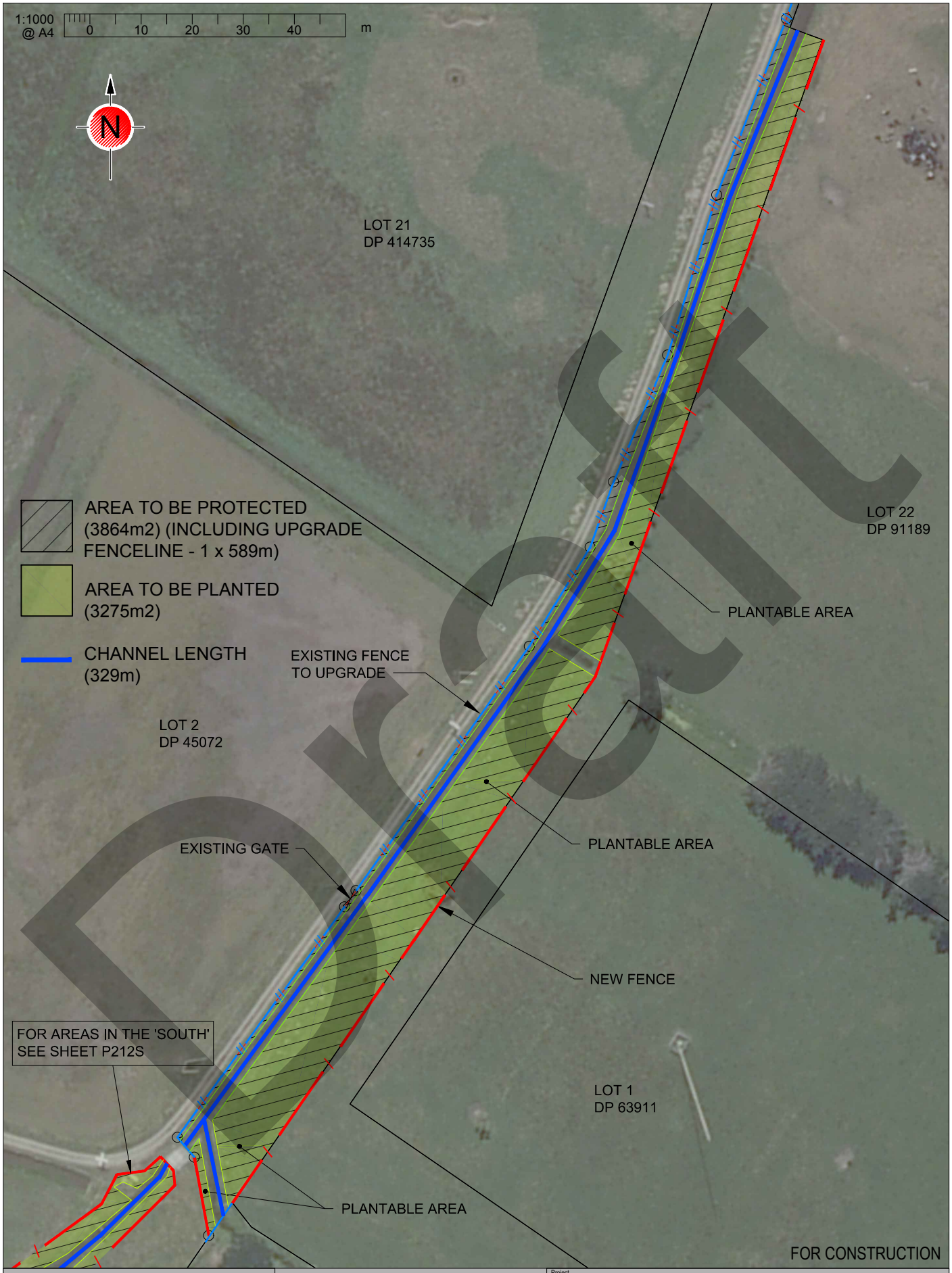
7. Activity	Timing	Responsibility	Supervision
Invasive weed control	Feb - March 2018	Contractor	Opus
Rank growth spot spray	Feb - March 2018	Contractor	Opus
Existing fence removal	April 2018	Contractor	Opus
Construct new fence	April 2018	Contractor	Opus
Pre-plant spot spray	May 2018	Contractor	Opus
Planting	June 2017	Contractor	Opus
Releasing	Oct 2018 & Feb2019	Contractor	Opus
Releasing	Oct 2019 & Feb2020	Contractor	Opus
Releasing	Oct 2020 & Feb2021	Contractor	Opus
Maintenance	Oct 2021 & Feb2022	Contractor	Opus
Maintenance	Oct 2022 & Feb2023	Contractor	Opus

Note: this timing indicative, specific dates will be confirmed prior to commencement of works.

7. Review and Update

- The Riparian Enhancement Plan will be monitored and reviewed annually by Opus, in consultation with the Landowner and NZTA. Any major changes will be documented and an amended plan will be submitted to NZTA for approval.
- Any channel management issues arising, which affect stream bank integrity such that establishment of plantings may be threatened, will be addressed on a situation-by-situation basis within the five year establishment period.

APPENDIX A



1	ISSUED FOR CONSTRUCTION	R.M.	3/02/2017
2	CHANNEL LENGTH ADDED	R.M.	11/04/2017

NZ TRANSPORT AGENCY
WAKA KOTAHI

OPUS
Wellington Office
+64 4 471 7000
PO Box 12-003
Wellington 6144
New Zealand

Designed	Approved	Approved Date
R. MACGIBBON	R.McFADYEN	03/02/2017
Drawn	Scales	
B.CRAIG	1:1250	

Project
NEW ZEALAND TRANSPORT AGENCY
S.H.1 REGION 9 R.P. 995/2.738 - 15.423
PEKA PEKA TO OTAKI (PP2O) EXPRESSWAY - SPECIMEN DESIGN

Sheet
RIPARIAN PLANTING - PROPERTY 12 (NORTH)
WHYMAN , 35 PURUAHA ROAD, TE HORO

Project No.	Sheet. No.	Revision
5-C2771.00	P212N	2

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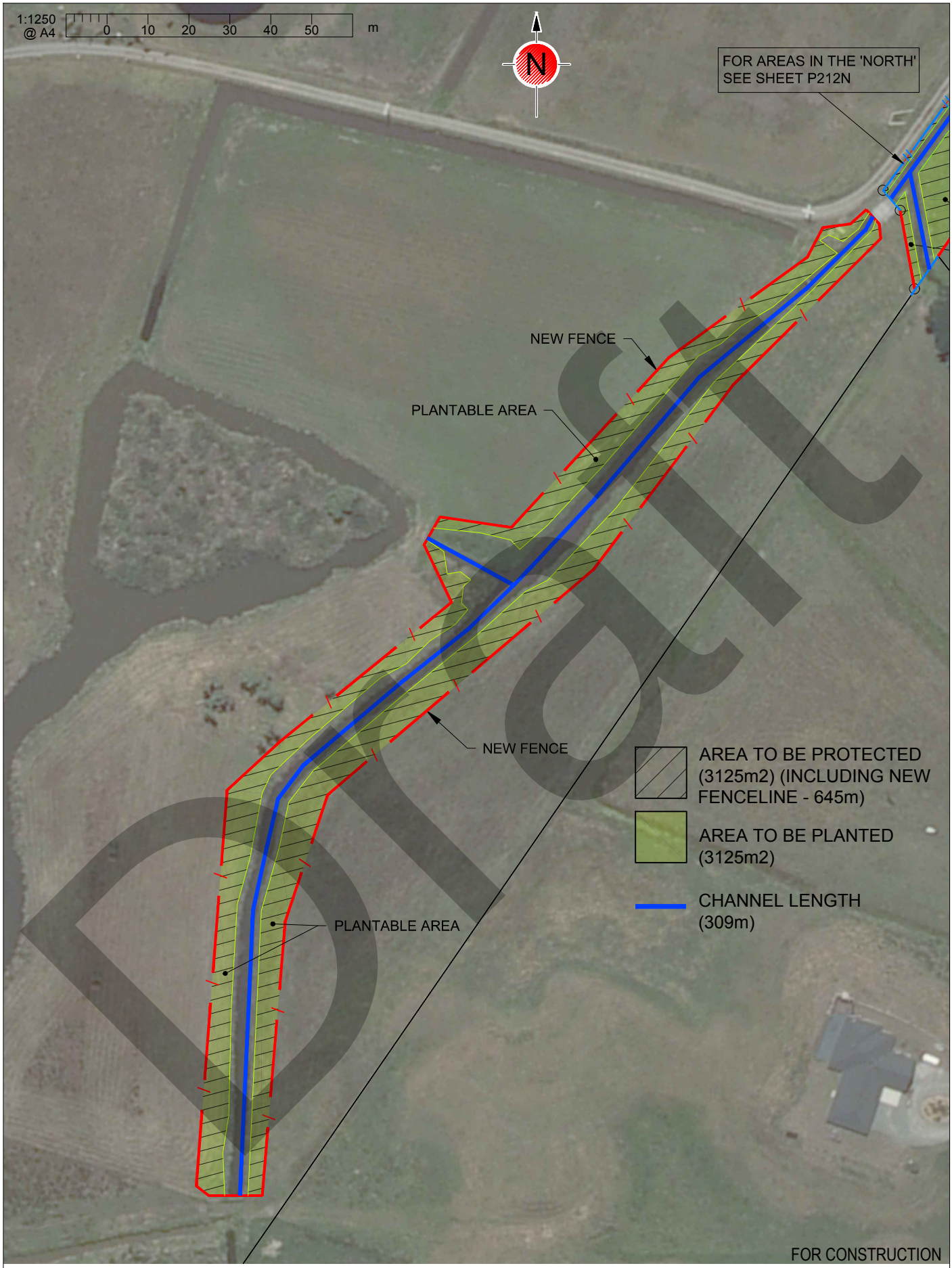

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NZ TRANSPORT AGENCY
WAKA KOTAHI

OPUS
Wellington Office
+64 4 471 7000

PO Box 12-003
Wellington 6144
New Zealand

1	ISSUED FOR CONSTRUCTION	R.M.	4/04/2017
2	CHANNEL LENGTH ADDED	R.M.	11/04/2017

Designed	Approved	Approved Date
R. MACGIBBON	R.McFADYEN	03/02/2017
Drawn	Scales	
B.CRAIG	1:1250	

Project
NEW ZEALAND TRANSPORT AGENCY
S.H.1 REGION 9 R.P. 995/2.738 - 15.423
PEKA PEKA TO OTAKI (PP2O) EXPRESSWAY - SPECIMEN DESIGN

Sheet
RIPARIAN PLANTING - PROPERTY 12 (SOUTH)
WHYMAN , 35 PURUAHA ROAD, TE HORO

Project No.	Sheet. No.	Revision
5-C2771.00	P212S	2

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APPENDIX B

Appendix B.1 – Species List, Main Channel (North)

Species	Common Name	Streamside	Central	Fenceline	Total
Austroderia toetoe	kakaho, toetoe	50	175	50	275
Coprosma repens	taupata	25	125	25	175
Coprosma robusta	karamu	0	50	0	50
Cordyline australis	ti kouka, cabb tree	0	50	0	50
Corynocarpus lavigatus	karaka	0	15	0	15
Cyperus ustulatus	upokotangata	50	0	0	50
Dodonaea viscosa	akeake	0	75	50	125
Hebe stricta	koromiko	25	50	15	90
Leptospermum scoparium	manuka	50	125	25	200
Myoporum laetum	ngaio	0	50	0	50
Oleria paniculata	akiraho	0	55	0	55
Olearia solandri	coastal shrub daisy	0	50	25	75
Phormium tenax	harakeke	0	155	20	175
Plagianthus regius	manatu, ribbonwood	25	50	0	75
Total					**1460**

Appendix B – Species List, Tributary Channel (South)

Species	Common Name	Streamside	Central	Fenceline	TOTAL
Apadasmea similis	oioi, jointed wire rush	50	75	50	175
Austroderia fulvida	kakaho, toetoe	50	100	50	200
Austroderia toetoe	toetoe	50	0	0	50
Carex germinata	rautahi, cutty grass	20	45	20	85
Carex secta	pukio	20	45	20	85
Carex virigata	pukio	50	75	50	175
Coprosma propinqua	mikimiki	25	25	25	75
Coprosma repens	taupata	20	75	30	125
Cordyline australis	ti kouka, cabbage tree	25	25	25	75
Cyperus ustulatus	upokotangata	75	75	75	225
Hebe stricta	koromiko	0	20	20	40
Juncus pallidus	giant rush	75	150	75	300
Leptospermum scoparium	manuka	25	130	25	180
Phormium tenax	harakeke	0	175	75	250
Plagianthus regius	manatu, ribbonwood	50	0	0	50
Total		535	1015	540	**2090**

Opus International Consultants Ltd
L10, Majestic Centre, 100 Willis St
PO Box 12 003, Thorndon, Wellington 6144
New Zealand

t: +64 4 471 7000
f: +64 4 499 3699
w: www.opus.co.nz

APPENDIX B: BASELINE TURBIDITY ASSESSMENT REVIEW REPORT

PP20 Environmental Baseline Monitoring

Turbidity

PP20 Environmental Baseline Monitoring

Turbidity

Prepared by
Samwell Warren, Lizzie Fox
Water Resource Scientists

Reviewed by
Jack McConchie
Technical Principal, Hydrology and Geomorphology

Approved for Release by
Jack McConchie
Technical Principal, Hydrology and Geomorphology

Opus International Consultants Ltd
Wellington Environmental Office
L10, Majestic Centre, 100 Willis St
PO Box 12 003, Thorndon, Wellington 6144
New Zealand

Telephone: +64 4 471 7000
Facsimile: +64 4 499 3699

Date: August 2017
Reference: 5-C2771.W7
Status: FINAL

Executive Summary

One of the outcomes of the Environmental Protection Authority-governed Board of Inquiry into the Peka Peka – Otaki Expressway was a requirement to conduct environmental baseline monitoring of turbidity in four rivers and streams which may be affected by construction activities. Specifically, Resource Consent Condition G39 requires turbidity monitoring of the Otaki River and the Waitohu, Mangapouri, and Mangaone Streams for 6 months prior to the start of construction. Condition G39 does not require the monitoring of flow; however, without such data there is no context for considering the controls and variability of turbidity.

Despite some initial problems relating to the installation of the four turbidity sensors, they functioned well; providing approximately 8-months of data at 10-minute intervals. The turbidity data support the following conclusions:

- Measuring turbidity on a continuous basis is problematic, and issues around obtaining a reliable turbidity record are well known. Despite the use of 'industry standard' sensors, which included an automatic wiper and anti-fouling mechanism, a range of environmental factors such as debris and variable water levels, and instrumental issues including calibration, drift, the growth of algae on the lens, and electronic 'glitches' still affected the turbidity records.;

- The aim of the turbidity monitoring required by Condition G39, which did not require the monitoring of flow, was to assist in the setting of thresholds to control the discharge of sediment laden water as a result of construction of the PP2O Expressway;

- Continuous measurement of turbidity, to be effective for compliance monitoring, would require real-time review and potentially alarms. While this is possible, these data will still be subject to the issues discussed above. This will lead to significant uncertainty regarding the data, and specifically compliance;

- There is no unique turbidity value at any particular time and place as the actual measurement depends to a degree on the instrumentation used. Turbidity measurements are a measure of the scattering of light relative to a formazin standard. Consequently, different turbidity sensors may output different turbidity values for the same sample. The use of the same type of sensor (i.e. same model from the same manufacturer) may help to overcome this issue. However, it is best practice to use the same turbidity sensor unit in either before and after, or upstream-downstream applications;

- Relative measures of the difference in turbidity between two sites, using the same meter, are more reliable for identifying 'change' than the actual measurements themselves;

- Considerable post-processing of the data is necessary to produce a representative turbidity record;

- Turbidity data are highly variable in time and place. This variability can be moderated by using a longer term average, but the presence of discrete 'turbidity events' i.e. 'spikes', real or instrumental, remains an issue with regard to establishing turbidity thresholds or triggers;

- As a result of the above issues, there is likely to be considerable uncertainty over whether a particular trigger or threshold has actually been exceeded;
- The maximum turbidity recorded was about 1200 NTU in the Otaki River. This was during a relatively small fresh. It is likely that turbidity would increase further during larger flood events;
- The relationship between flow and turbidity was different for each river; and
- In each river there was also a high degree of variability in the relationship between flow and turbidity during each flood event.

Given the range of problems and issues discussed above, it is recommended that the monitoring of the effectiveness of erosion and sediment control measures, and compliance with any water quality standards, be confirmed by:

Monitoring the turbidity (using the same instrument) upstream and downstream (after reasonable mixing) of any activity in any watercourse receiving runoff from construction activities be undertaken:

- *When there is a conspicuous change in colour of the water downstream of the activity; or*
- *When hourly rainfall exceeds 20mm/hr (i.e. approximately 2.3-year ARI event); or*
- *When daily rainfall exceeds 70mm (i.e. approximately 2.3-year ARI event).*

Should the downstream turbidity be 20% higher than that measured upstream then:

- *An investigation of the cause or source of the increased turbidity be undertaken;*
- *Immediate actions be taken to mitigate any sediment loss from the construction site so that turbidity drops back to the 20% threshold;*
- *Management and the sediment control structures be modified to prevent a similar occurrence in the future; and*
- *A report be prepared for the consent authority outlining the nature of the breach, any immediate actions taken to limit the loss of sediment from the site, and changes to future practices to ensure that such an occurrence does not happen in the future.*

Contents

1 Background

One of the outcomes of the Environmental Protection Authority-governed Board of Inquiry into the Peka Peka – Otaki (PP2O) Expressway was a requirement to conduct environmental baseline monitoring of turbidity in four rivers and streams which may be affected by construction activities. Specifically, condition G39 requires turbidity monitoring of the Otaki River and the Waitohu, Mangapouri, and Mangaone Streams for 6 months prior to the start of construction (Figure 1.1). Condition G39 does not require the monitoring of flow; however, without such data there is no context for considering the variability of turbidity.

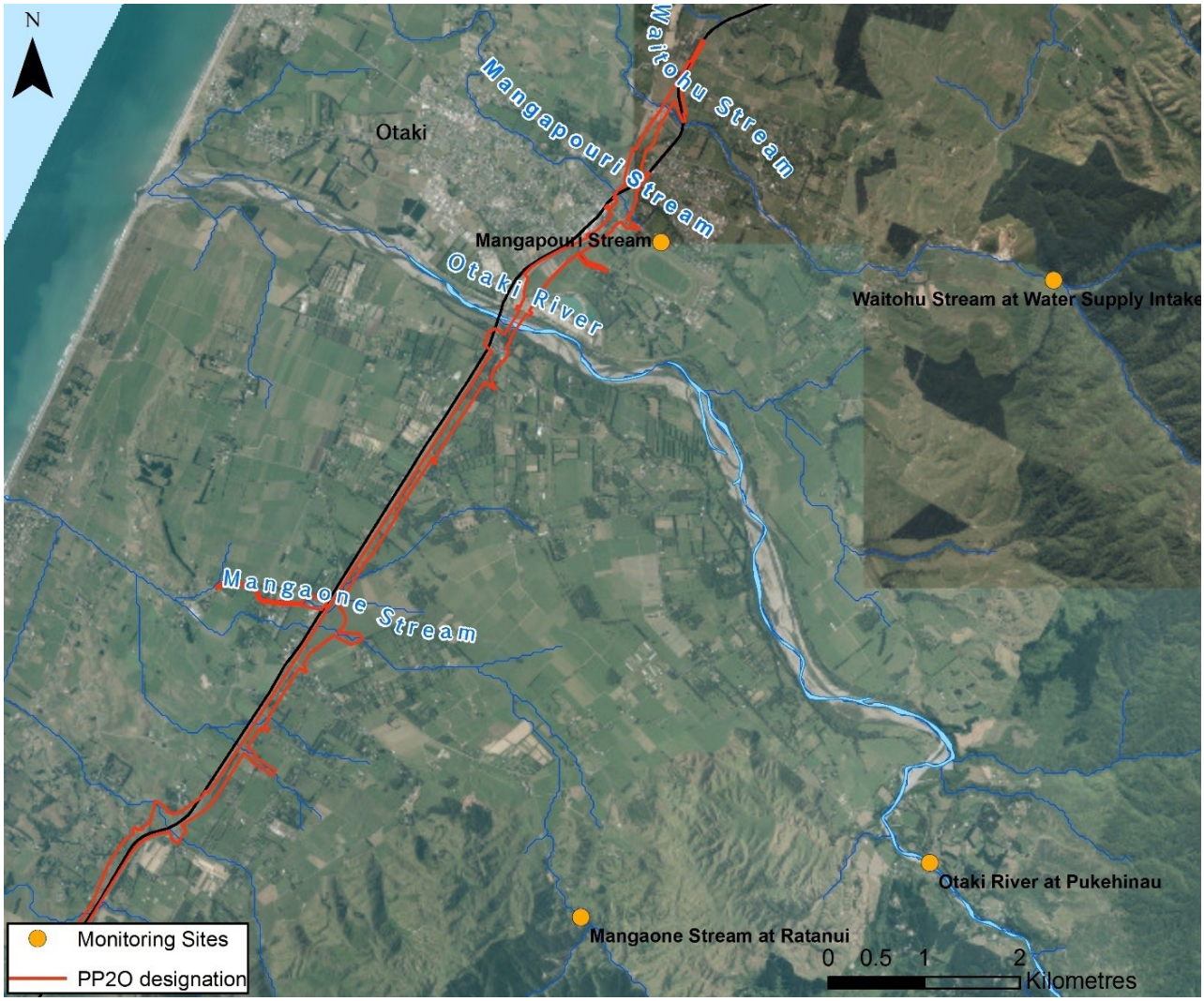

Figure 1.1: Rivers potentially impacted by the PP2O Expressway and the locations of turbidity sensors and flow recorders.

This report details the selection of representative sites, the installation of monitoring equipment, and the resulting flow and turbidity data from each of the four watercourses.

1.1 Turbidity

Turbidity, usually measured in Nephelometric Turbidity Units (NTU), defines an optical characteristic of the water; essentially a relative measure of the scattering of light against a formazin standard. As such, turbidity is a measure of the scattering of light by suspended particles in the water. Consequently, turbidity is often used as a surrogate for suspended sediment concentration. This is likely to be the case regarding the pre-construction monitoring for the PP2O Expressway.

Elevated levels of suspended sediment in rivers and streams may have adverse effects on the aquatic environment. Since turbidity is easier to measure than suspended sediment concentrations, both continuously and automatically, and since the two environmental indicators are usually related, a rise in turbidity is often used as an indication of a rise in suspended sediment.

However, the two indices measure distinctly different, although related, properties of the flow in a river or stream. This is because turbidity is not just affected by the concentration of particles within the water column. It is also affected by the characteristics of those particles e.g. their size, shape, colour and texture. These properties vary as a function of lithology, mineralogy and availability, and so there is no unique relationship between turbidity and sediment concentration. Predicting and interpreting continuous sediment records is therefore difficult, as the multitude of variables controlling the sediment load can produce unique values. That is, there can be different turbidity for the same sediment concentration, and *vice versa*.

Changes in land use, particularly that related to land clearance and the alteration of the vegetation cover, can be a major driver in modifying the sediment load in a river or stream. Vegetation clearance can result in a greater amount of sediment becoming mobilised during storm events, and potentially entering the fluvial system via overland flow, including rilling and gullying. Consequently, any potential increase in sediment load as a result of large scale roading projects is an important environmental concern. This is likely to be the rationale behind condition G39 which requires turbidity monitoring of the Otaki River and the Waitohu, Mangapouri, and Mangaone Streams for 6 months prior to the start of construction of the PP2O Expressway.

While multiple methods are available to measure turbidity, *in-situ* measurements using optical sensors are preferred. They can achieve the same, potentially more accurate, results as a sediment-discharge relationship, while also being easier to deploy over longer sampling periods (Anderson, 2005). The main disadvantages of using an *in situ* continuous turbidity data record is the need to calibrate the sensor, verify the recorded data, and correct for the impact of on-site factors that negatively affect the record. *In-situ* sensors can also drift, requiring re-calibration and continual verification (Davies-Colley & Smith, 2001; Hicks, 2009). Careful consideration of a sensor's deployment, and the ambient environment, are therefore critical to the acquisition of high quality data.

2 Methodology

2.1 Monitoring locations

Quasi-continuous turbidity data were collected in the Otaki River and the Waitohu, Mangapouri, and Mangaone Streams between January and September 2016. The equipment deployed and the dates of installation and removal of the equipment within each watercourse are detailed in Table 2.1.

Table 2.1: Equipment used and the date of installation and removal.

Sensor	Parameter	Location	Installed	Removed	Duration (months)
Greenspan Pentair TS1000	Turbidity 0-1000NTU	Waitohu Stream at Water Supply Intake	18-Jan-2016	23-Sep-2016	~8
Greenspan Pentair TS1000	Turbidity 0-1000NTU	Mangapouri Stream	14-Jan-2016	23-Sep-2016	~8
INW AquiStar PT2X Smart Sensor	Water level 0-5m	Mangapouri Stream	14-Jan-2016	23-Sep-2016	~8
Greenspan Pentair TS300	Turbidity 0-1000NTU	Mangaone Stream at Ratanui	14-Jan-2016	11-Aug-2016	~7
Greenspan Pentair TS1000	Turbidity 0-1000NTU	Otaki River at Pukehinau	03-Feb-2016	23-Sep-2016	~7

For efficiency and security, and to allow the turbidity data to be related to flow, on three of the rivers the sensors were co-sited at hydrometric monitoring sites maintained by either the Greater Wellington Regional Council (i.e. Mangaone and Waitohu) or NIWA (i.e. Otaki). As mentioned, condition G39 does not require the monitoring of flow. Approval for installing the turbidity monitoring equipment at these sites was obtained from the appropriate organisation.

No flow monitoring station exists on Mangapouri Stream. It was therefore necessary to find a suitably representative monitoring site, and to install a water level recorder on this stream (Figure 1.1). Site selection was based on accessibility, security, and representativeness.

It is noted that all the sites, except for that on Mangapouri Stream, are located a significant distance upstream of the PP2O Expressway (Table 2.2). However, these sites are considered representative of baseline conditions in each river because:

- Turbidity is unlikely to change significantly downstream of the various flow monitoring sites. This is because the suspended sediment concentration, the primary control on turbidity, is unlikely to reduce downstream given the gradient of the channels and the velocity of flow;
- The variation in turbidity, and the implications of this for establishing appropriate triggers, will be characteristic for each river;

- The continuity and security of the turbidity record outweighs any small potential difference in turbidity downstream, which is likely to be within the measurement error of the sensors;
- The ability to relate turbidity to the flow in a river is also a considerable advantage over any small potential difference in turbidity downstream;
- Any turbidity record will be affected to some degree by site factors; and
- There is value in any turbidity record being able to be related to, and compared against, that recorded during other periods by other interested parties.

The choice of the monitoring location therefore has no effect on the validity of the monitoring data, or its value in assisting to define realistic and representative triggers as required by condition G39.

Table 2.2: Distance of monitoring site upstream of PP2O designation (Figure 1.1).

Location	Distance (km)
Waitohu Stream at Water Supply Intake	5.12
Mangapouri Stream	0.50
Mangaone Stream at Ratanui	4.97
Otaki River at Pukehinau	9.30

2.2 Data collection

Condition G39 requires monitoring of turbidity over a period of 6 months prior to the start of construction of the PP2O Expressway. However, it is critical that the full range of natural variability in turbidity be measured so that realistic 'environmental triggers' can be established. Since turbidity is generally related to flow, and the monitoring period commenced during summer, i.e. when flows are generally low; it was recommended that the sensors be deployed for a longer period, increasing the likelihood that conditions during a wide range of flows, particularly less frequent higher flow events, were monitored.

During monitoring, the largest event recorded in the Otaki River and Mangaone Stream were 39% and 11% respectively of the previous maximum recorded flow at each site (Table 2.3). Despite monitoring only covering a relatively small range of total flow variability, turbidity during these events exceeded 850 NTU.

Table 2.3: Largest recorded flows, and largest flows recorded over the monitoring period in the Otaki and Mangaone Rivers.

Location/Stream	Maximum recorded flow (m^3/s)	Maximum recorded flow during monitoring period (m^3/s)	% of maximum recorded flow
Otaki River	1540	593	39
Mangaone Stream at Ratanui	33	3.5	11

No flow data exists for Mangapouri Stream, or for Waitohu Stream as Greater Wellington Regional Council (GWRC) were experiencing problems with their water level recorder over the monitoring period.

2.3 Sensor setup

Three Greenspan Pentair TS1000 turbidity sensors, and one Greenspan Pentair TS300 turbidity sensor with an external battery, were supplied by NIWA Instruments Ltd on the 15th December 2015. These sensors meet strict specifications for accuracy, reliability and minimal drift; and enable on-board datalogging.

Each sensor was calibrated, and programmed to initially scan and record turbidity at 15-min intervals. Since turbidity can be highly variable, it can be desirable to scan at a faster rate and then 'smooth' the turbidity record during subsequent data processing. However, the relatively remote locations of the sensors in this study means that battery life was a constraint. A 15-min logging interval therefore reflected a practical compromise between data frequency and battery efficiency. Following the first maintenance visit, it was decided that batteries would be sufficient to support data collection at a 10-min resolution and the programming of the sensors was adjusted accordingly.

To relate turbidity measurements to flow in Mangapouri Stream, a PT2X pressure logger, calibrated on the 17th December 2015, was also installed to record variation in water level.

2.4 Installation

The sensors were installed in accordance with recommendations found in the Greenspan Pentair TS1000 User Manual. Installation and tethering were designed to prevent any persistent pulling, snagging, or compression on the sensor or the sensor cable; while making sure that the sensor was stable during normal operation. Sensors were tethered with chain to avoid tampering and theft, and to mitigate the risk of vandalism. The risk of vandalism is considered low because of the location of the monitoring sites, and the restricted public access.

Sensors were positioned such that:

- The sensor window would remain completely submerged, even during low flow conditions;
- Where possible, the sensor was in the thalweg of the channel i.e. the area of deepest and fastest flow. This ensures even mixing of suspended sediment, and therefore representative turbidity data;
- Sensors were tethered to the upstream side of the various anchoring points to avoid the entrapment of air bubbles below the sensor. However, the sensors were moved to the downstream side of the various mounts if the initial data indicated that debris was being caught on the sensor and was affecting the validity of the turbidity data; and
- Where possible, the sensors were installed in an area of shade to avoid direct sunlight, subsequent warming, and therefore algae growth on the lens.

On Waitohu Stream the turbidity sensor was mounted on a railway iron driven into the bed of the river; immediately downstream of the water level recorder at the old Water Supply Intake (Figure 2.1).

On the Otaki River, the sensor was installed on the downstream side of the stage plate. Site access is secure but difficult, and requires traversing a ladder to access the stage plate at water level. The sensor

and chain was mounted inside PVC pipe to avoid tampering, and to add further security and protection during high flow events (Figure 2.2).

On Mangaone Stream, a Greenspan Pentair TS300, externally-powered sensor, was installed. The external battery was housed with Greater Wellington Regional Council's telemetry equipment. From the sensor in the river, the power cable was secured via the stilling tower to the battery housing. Generally, it is advised that the cable is housed inside a slightly larger diameter conduit to protect it from heat, water movement, sunlight, and flood debris etc. However, at this site the majority of the cable was located in the shade, and tethered to the platform out of the water. There was only 3m of cable exposed and this is unlikely to have affected the reliability of the turbidity record (Figure 2.3).

Figure 2.1: Sensor installation on the Waitohu Stream at the water supply intake.

Figure 2.2: Sensor installation on the Otaki River at Pukehinau.

Figure 2.3: Sensor installation on the Mangaone Stream at Ratanui.

Figure 2.4: Water level and turbidity sensor installation on the Mangapouri Stream.

There is no flow monitoring site on Mangapouri Stream. Therefore, a suitable location for both the turbidity sensor, and a water level recorder, was located at the 98 Rahui Road.

Both the turbidity sensor and vented pressure sensor (i.e. water level recorder) were installed on a waratah™ standard, driven into the stream bed of the thalweg and anchored to a tree. As discussed in the INW AquiStar PT2X Smart Sensor User Manual, the water level sensor was installed at a fixed point below the minimum water level. The sensor remained fixed relative to this datum until monitoring was completed. The vented cable was tethered to a tree (Figure 2.4).

3 Results

3.1 Preliminary data

The first period of data collection highlighted problems associated with sensor deployment; caused primarily by the ambient environment, and the low flows over this period.

Monitoring equipment on the Mangapouri Stream was therefore moved upstream to a deeper and more exposed reach. Monitoring equipment in the Otaki River, and Mangaone and Waitohu Streams was adjusted to increase the distance between the sensor lens and the stream bed.

3.2 Data issues

Despite being 'industry standard' turbidity sensors, the resulting data are still prone to interference from debris and biofouling, and drift over time. It was therefore necessary to undertake some post-processing of the data to account for a range of environmental factors. Obvious, erroneous data 'spikes', caused by floating debris or signal 'glitches', also had to be removed prior to any analysis.

Data collected in the Otaki River was of sufficiently high quality that no editing of turbidity (beyond removal of an anomalous 'turbidity event') was required.

Turbidity data from Mangaone Stream becomes uncertain when the water level drops during low flow conditions. Since the sensor needs to be offset from the river bed, in a small stream at low flows the water level can drop below the sensor window. This leads to errors in the apparent turbidity data. The shallow nature of Mangaone Stream means that this is unavoidable during certain periods. Despite this, the turbidity data collected required little editing after the redeployment of the sensor on 23 February 2016.

Greater Wellington Regional Council (GWRC) are currently having significant issues with their flow recorder on the Waitohu Stream. Over the period of turbidity monitoring, GWRC adjusted the water level monitoring equipment on three occasions. However, as of this time no changes have been made to the rating curve used to convert water level to flow. Consequently, the available flow data are currently erroneous.

As an interim measure, the recorded stage data were 'ramped' to provide a more realistic representation of likely water levels in the stream (Figure 3.1). It is considered that the relative water levels are likely to be correct, even if the absolute data is in error. Once the stage data were adjusted in this manner, the peaks in flow corresponded with the peaks in measured turbidity (Figure 3.9).

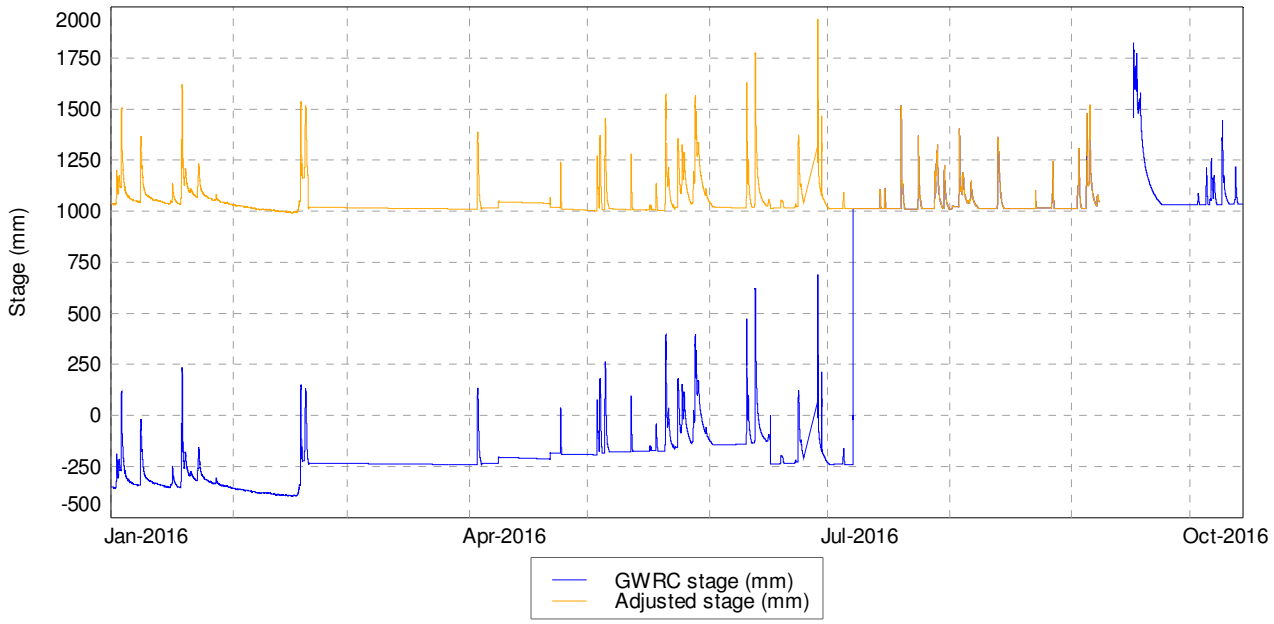

Figure 3.1: Stage provided by GW, and the adjusted series used in analysis at the Waitohu Stream at Water Supply Intake

Turbidity data collected in Waitohu Stream shows fouling on multiple occasions when debris became snagged around the base of the sensor (Figure 3.2 & Figure 3.3). Occasionally the debris flushed off naturally during the next high flow event; however, at other times it had to be removed manually during routine site visits. Turbidity data recorded during these periods was removed from the dataset.

Sometime in late August, between site visits, a ford and stock access track was constructed approximately 50m upstream of the monitoring site (Figure 3.3). This generated a plume of sediment that should have been recorded at the monitoring site. Unfortunately, debris caught on the sensor at the time has prevented the identification of this environmental signature.

Acquisition of reliable turbidity data in the Mangapouri Stream proved to be more challenging than at any other site. The ambient environment of the stream, particularly the shallow water and silty substrate, was not really suitable for optical turbidity sensors. Considerable biofouling of the sensor lens occurred between each visit, as did the trapping of debris around the sensor (Figure 3.4). As was the case in Waitohu Stream, erroneous data were removed, and significant post-processing was required (Figure 3.5).

The water level data from Mangapouri Stream showed an unnatural increase in baseflow after June 2016. While part of this can be attributed to a seasonal increase in baseflow during autumn, a tree which had fallen across the river downstream created a backwater effect raising the water level. An adjustment of the water level data to the changed baseline condition was therefore required (Figure 3.6).

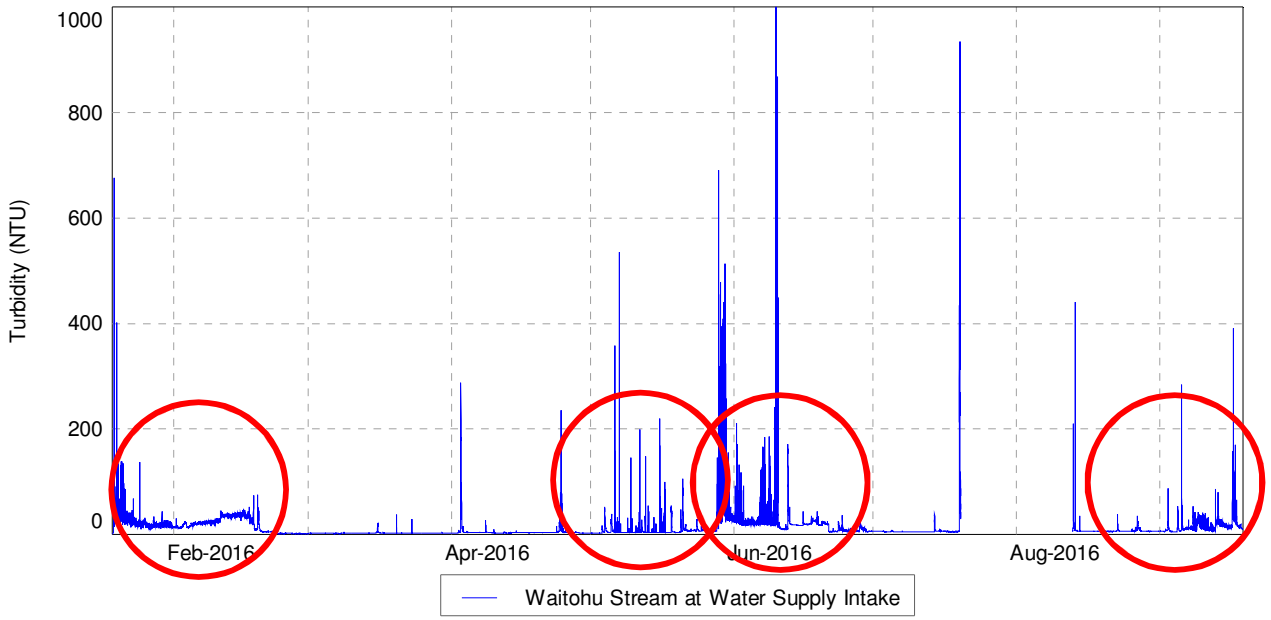

Figure 3.2: **Fouling of sensor windows caused by the trapping of debris around the base of the railway iron in the Waitohu Stream.**

Figure 3.3: **Debris trapped around the base of the turbidity sensor in Waitohu Stream (left) and a ford constructed approximately 50m upstream of the monitoring site (right).**

Figure 3.4: **Trapping of debris around the turbidity and water level recorder in the Mangapouri Stream (left). Increased water level as a result of the backwater effect of a fallen tree in the stream (right).**

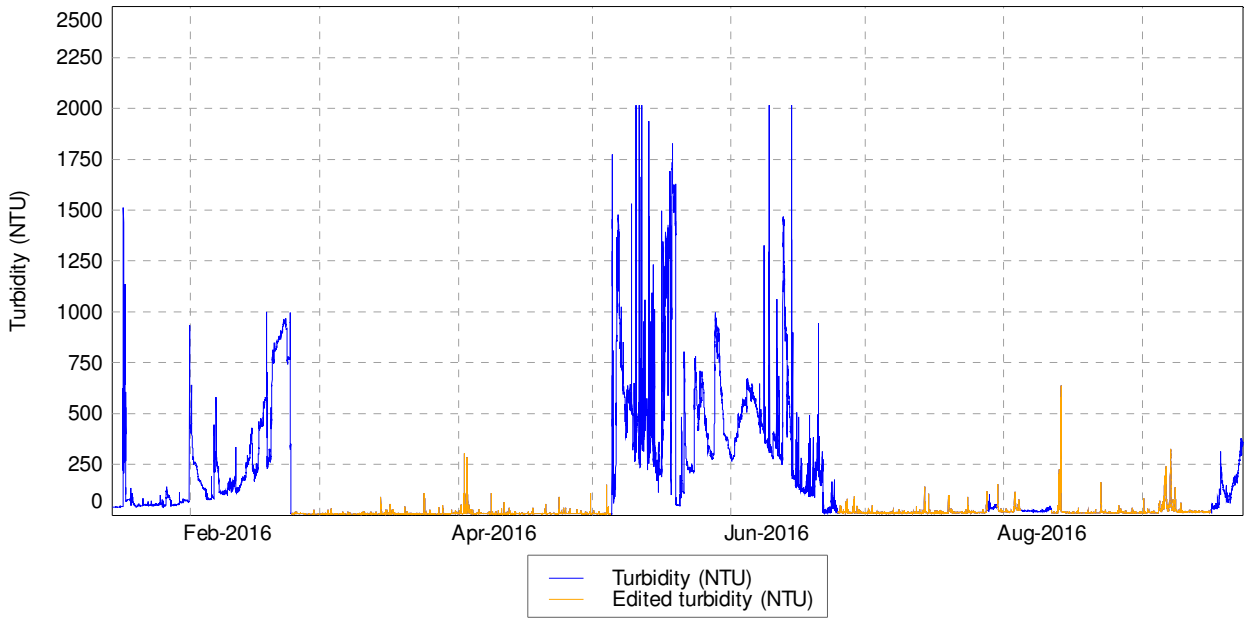

Figure 3.5: **Edited turbidity data for Mangapouri Stream.**

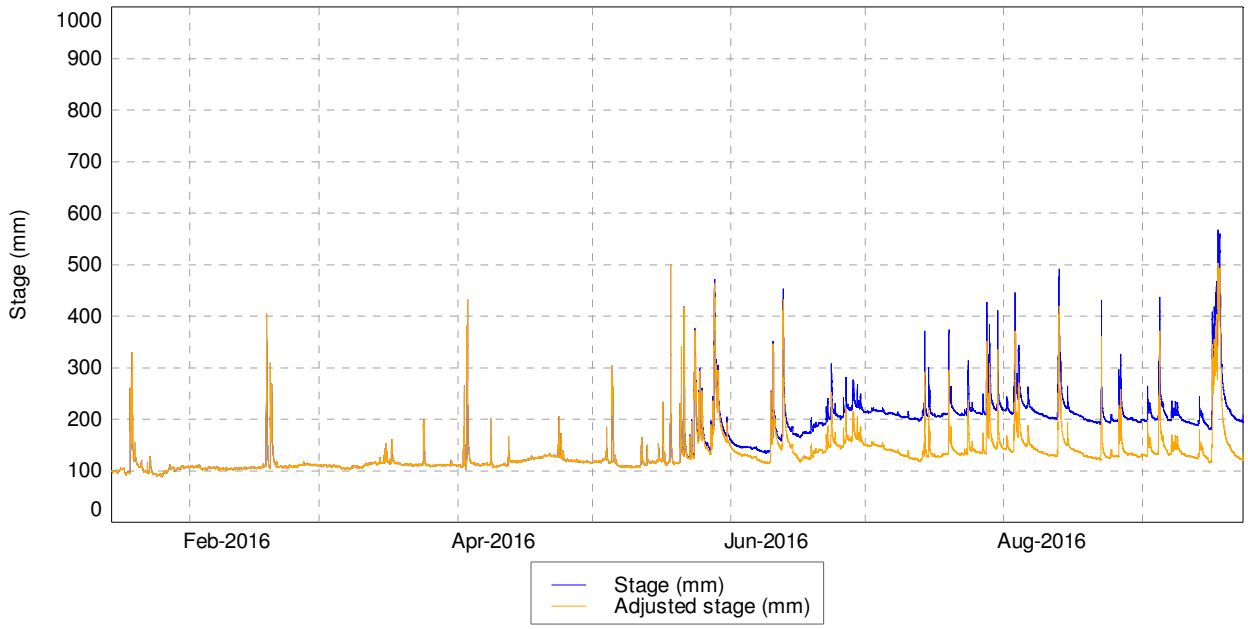

Figure 3.6: Adjusted stage (i.e. water level) record at Mangapouri Stream.

3.3 Turbidity records

Edited turbidity data and flows are compared for the Otaki River and Mangaone Stream in Figure 3.7 and Figure 3.8.

As a result of the problems experienced with the water level and flow data available from Waitohu Stream, the turbidity data has been over-plotted with an adjusted water level record as discussed previously (Figure 3.9).

Since no hydrometric data exist for the Mangapouri Stream, and the few gaugings attempted were insufficient to produce a reliable rating curve, turbidity has been plotted against relative water level (Figure 3.10).

As expected, data collected in each of the four rivers demonstrate a general relationship between flow and turbidity, with elevated flows/ levels coinciding with an increase in turbidity. All four sites experience turbidity maxima of between 600-1200 NTU, that correlate with each river's mean flow i.e. the higher the mean flow the higher the turbidity maxima (Table 3.1).

Table 3.1: Maximum and mean flows and turbidity recorded in each river over the monitoring period.

Watercourse	Max. flow over monitoring period (m^3/s)	Mean flow over monitoring period (m^3/s)	Max. recorded turbidity (NTU)
Otaki River	593	29.2	1197
Waitohu Stream		0.46*	935
Mangaone Stream	3.5	0.27	856
Mangapouri Stream	**503mm	**133mm	637

* **Taken from Jan-Sep 2015** ** **Stage not flow**

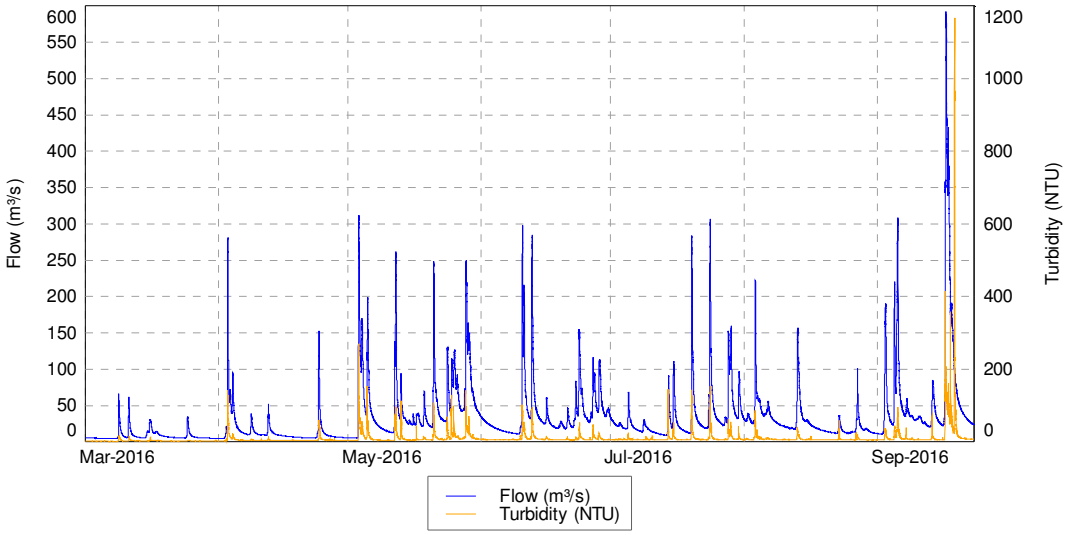

Figure 3.7: Flow and turbidity for Otaki River at Pukehinau.

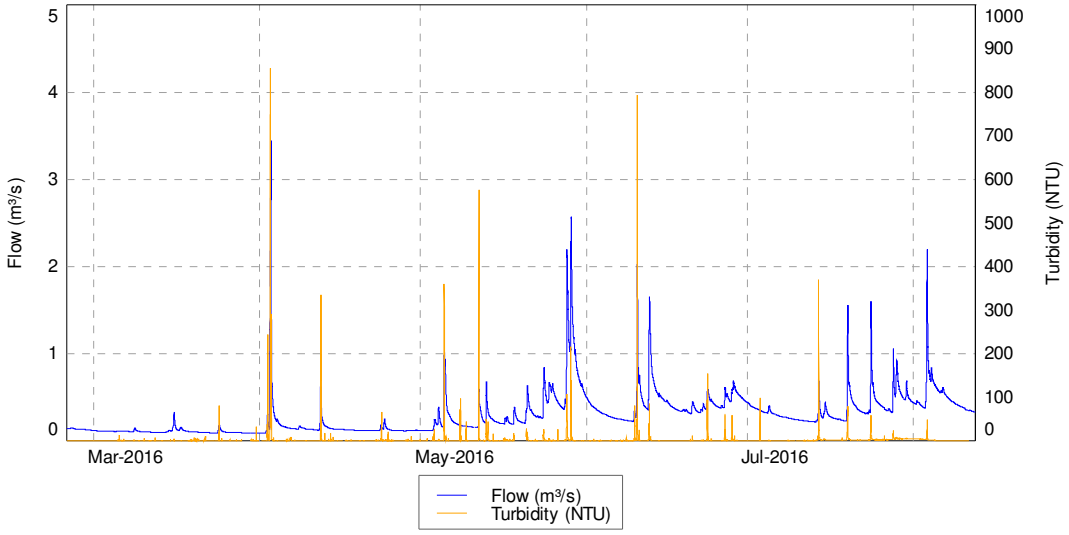

Figure 3.8: Flow and turbidity at Mangaone Stream at Ratanui.

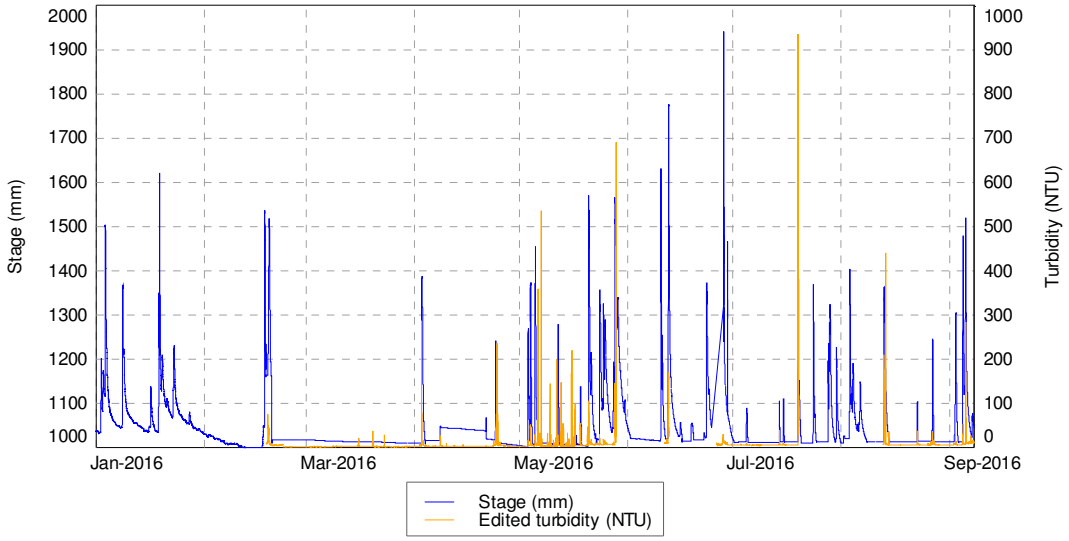

Figure 3.9: Adjusted stage and turbidity for Waitohu Stream at Water Supply Intake.

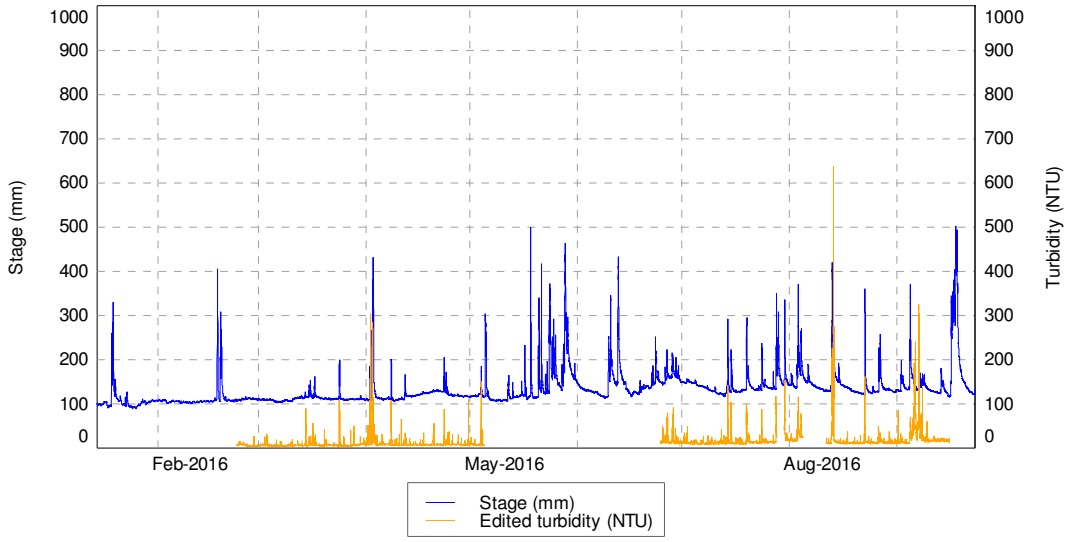

Figure 3.10: Water level and turbidity for Mangapouri Stream.

4 Analysis

The turbidity and flow data presented above reflect the actual variability measured in each of the four watercourses. While any obviously anomalous data have been removed, the remaining data are those actually measured using 'best practice' and 'industry standard' sensors. Consequently, these data are likely to reflect 'natural' conditions during the construction of the PP2O Expressway.

It should be noted that the aim of the monitoring undertaken was to provide information on environmental baseline turbidity in the four rivers and streams. From these data it was hoped that thresholds could be developed to ensure that the construction activities have no significant adverse effect on the turbidity of any receiving water body. As such, the monitoring was aimed at informing decision-making regarding turbidity and how it can best be monitored from a compliance perspective.

It has been suggested that some of the data could be 'cleaned' (e.g. the removal of the 19 Sept 2016 turbidity event from the Otaki record) to provide a stronger relationship between turbidity and flow, and to remove some of the 'noise' and scatter which is inherent in the data. However, such an approach would mask the natural variability in turbidity, particularly that variability which cannot be 'explained' by the flow regime.

There are a range of statistical measures to describe the variability of turbidity around flow e.g. conditional statistics, and locally weighted scatterplot smoothing (LOWESS). While these provide a good measure of the conditional mean, they do not help to define robust, realistic, and most importantly defensible, thresholds for turbidity. In fact, these techniques tend to highlight the high degree of variability of turbidity at any particular flow, and therefore the difficulty in defining a single, or even multiple robust thresholds.

The following analysis therefore considers all the data collected from the four monitoring sites; excluding those which are obviously spurious.

Correlation coefficients were derived using the 10-min data to quantify any relationship between flow and turbidity in each catchment. However, the highly variable nature of turbidity meant that no statistically significant relationships were found. In an attempt to minimise the effect of the natural scatter inherent in the turbidity data, correlations were therefore obtained over a range of different temporal resolutions. These correlations can be found in Appendix A.

4.1 Otaki River at Pukehinau

Turbidity and flow data recorded at a 10-minute resolution in the Otaki River at Pukehinau were correlated. This highlighted an event on 19 September 2016 when a major turbidity event occurred, the largest recorded over the 8-months of monitoring, even though flows were receding (Figure 4.1). A detailed review of this 'peak in turbidity' suggests that the data are correct, and that turbidity did actually increase significantly over this period. This event was therefore likely entirely 'natural' and reflects the variability in turbidity within a largely natural catchment. This turbidity event, however, reduces the strength of any correlation. Removal of this event in turbidity increases the strength of the correlation from 0.3 to 0.65; however, its removal is difficult to justify except for a statistical purpose (Figure 4.2).

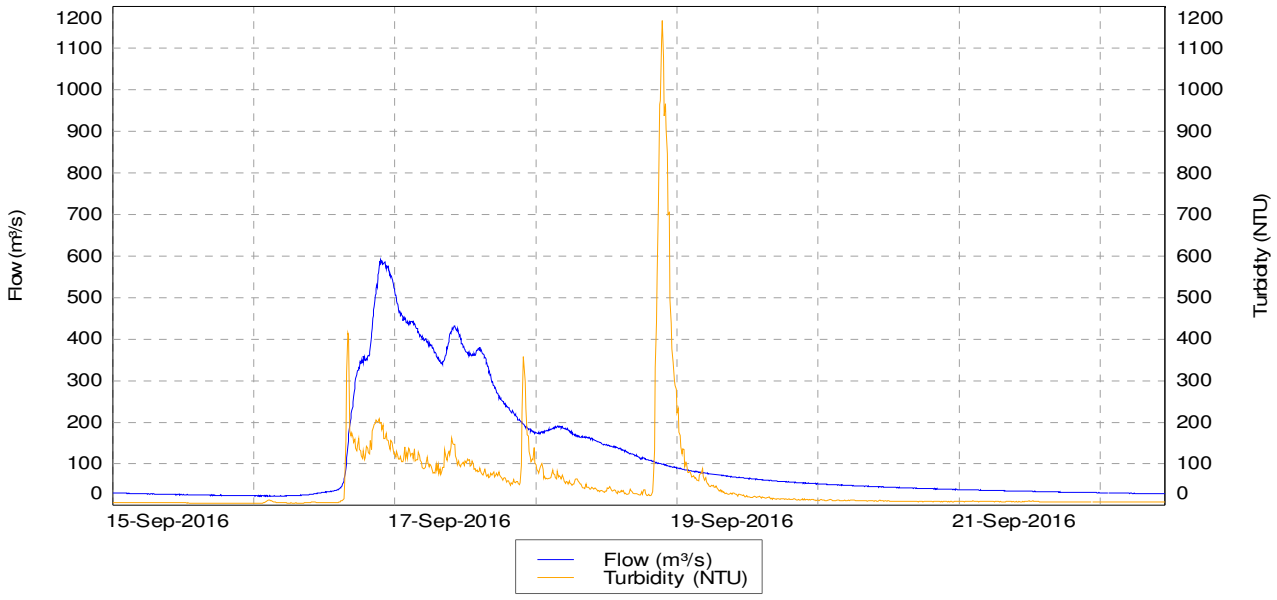

Figure 4.1: A peak in turbidity during recession of flow in the Otaki River at Pukehinau.

Additional correlations were undertaken using data averaged over 3, 6 and 24-hours. As the duration of the averaging increases so too does the strength of the relationship between average flow and average turbidity (Table 4.1). Averaging both data sets over 24 hours produces the strongest apparent relationship (i.e. r^2 of 0.91).

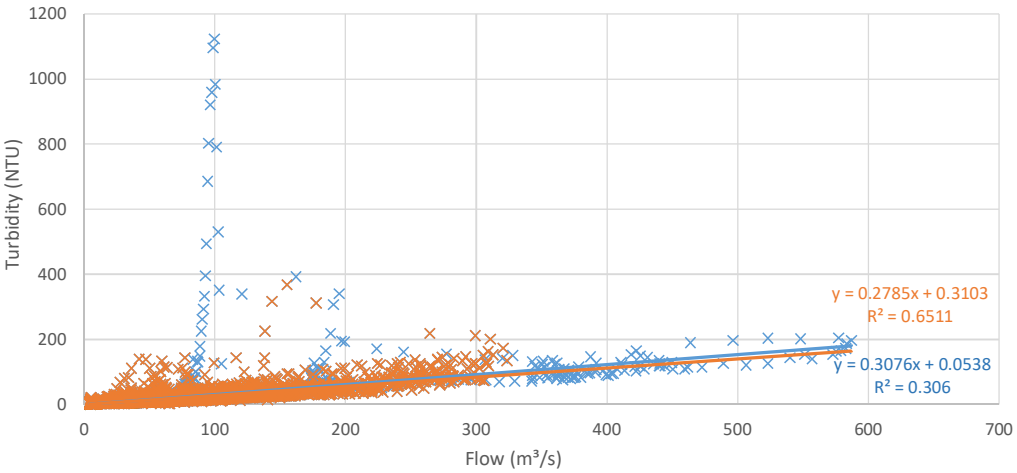

Figure 4.2: Correlation between flow and turbidity in the Otaki River recorded at Pukehinau; including and excluding the event of 16-20 September 2016.

Table 4.1: Correlations at different temporal resolutions for Otaki River at Pukehinau

Temporal resolution	Correlation (r^2)	
	Raw Data	Removed outlier
10-min	0.305	0.650
3-hours	0.396	0.732
6-hours	0.440	0.763
24-hours	0.645	0.910

4.2 Mangaone Stream at Ratanui

Any relationship between flow and turbidity in Mangaone Stream was also examined at a range of different temporal resolutions (Table 4.2). The strongest correlation, although still weak, is observed when averaging the data over 3-hour intervals. It would appear therefore that the variability in turbidity data reflects a range of natural (and potentially instrumental) factors other than just the discharge of the river (Figure 4.3).

Table 4.2: Correlations at different temporal resolutions for Mangaone at Ratanui.

Temporal resolution	Correlation (r^2)
10-min	0.109
1 hours	0.144
2 hours	0.203
3-hours	0.396
6-hours	0.234
24-hours	0.188

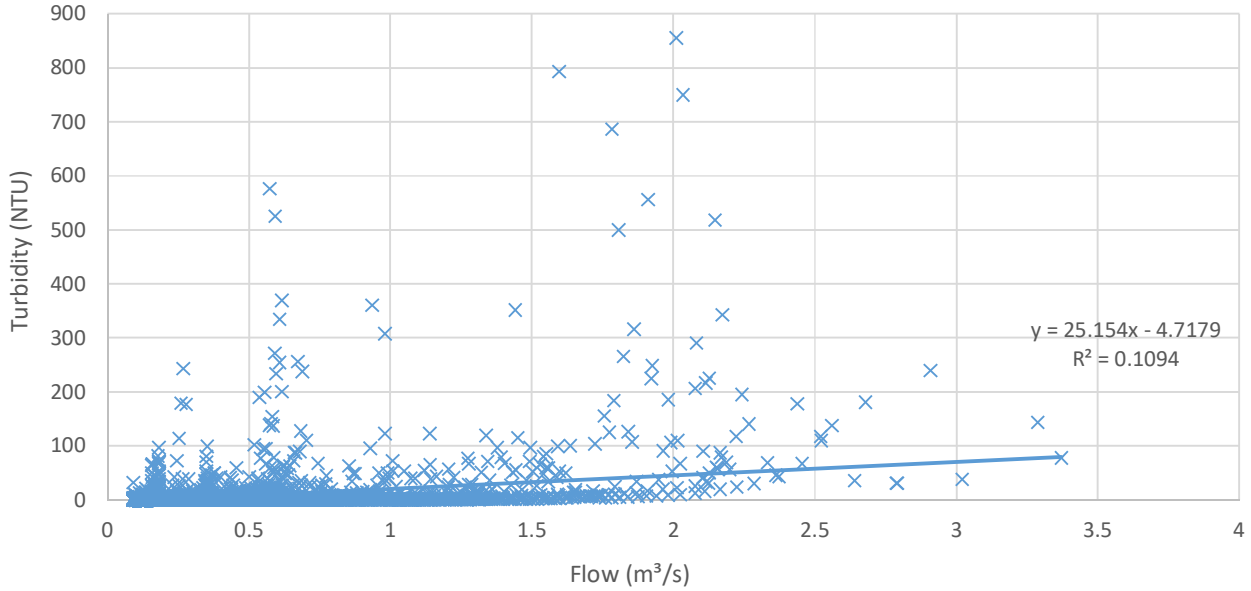

Figure 4.3: Correlation between flow and turbidity in the Mangaone at Ratanui (10-min average).

4.3 Waitohu Stream at Water Supply Intake

Any relationship between flow and turbidity in Waitohu Stream was also examined at a range of different temporal resolutions; however, no relationship was able to be determined. There were a number of events where there was considerable scatter in the turbidity data, after a more defined peak in turbidity (Figure 4.4). The editing of this 'noise' improved the correlations but they remained weak (Table 4.3).

The lack of any defined relationship between flow and turbidity in the Waitohu Stream would appear to be a function of the uncertain flow series, and the highly variable nature of turbidity in this stream; possibly a function of land use and stock being able to enter the stream just upstream of the sensor.

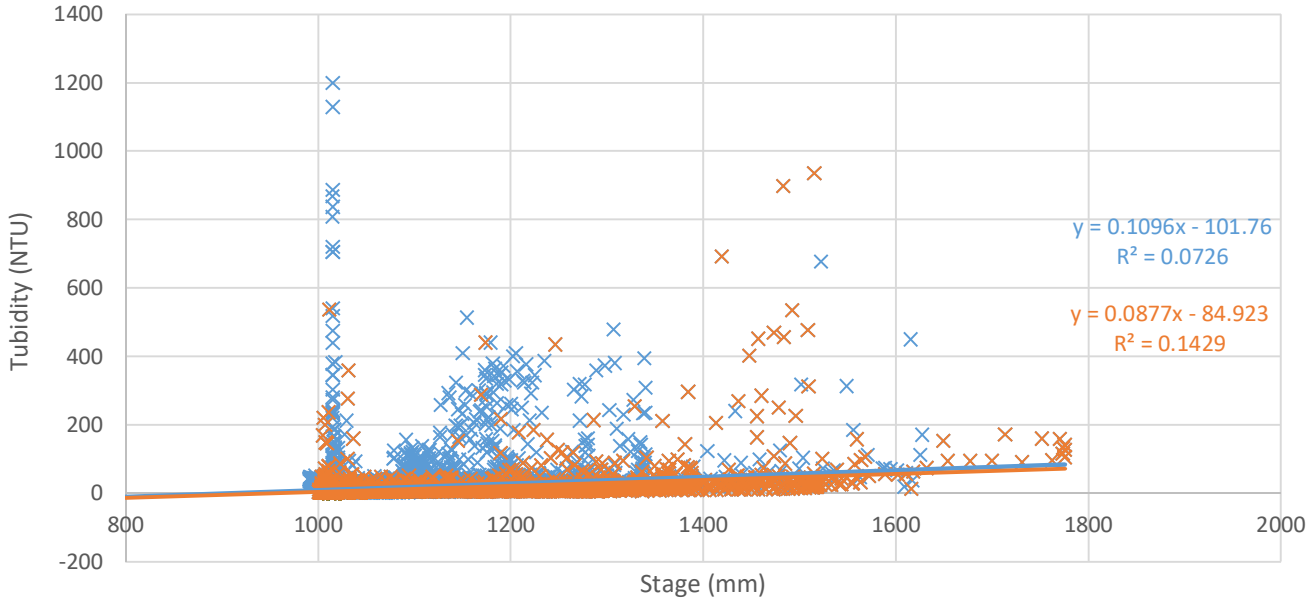

Figure 4.4: Raw and refined turbidity and stage relationships recorded in the Waitohu Stream (10-min data).

Table 4.3: Correlations at different temporal resolutions for Waitohu Stream at Water Supply Intake.

Resolution	Correlation (r^2)	
	Raw Data	Edited Data
10-min	0.073	0.143
1 hours		0.211
2 hours		0.228
3-hours		0.237
6-hours		0.268
12-hours		0.266
24-hours		0.278

4.4 Mangapouri Stream

Any relationship between flow and turbidity in Mangapouri Stream was also examined (Figure 4.5). Despite significant 'cleaning' and editing of the data, the apparent turbidity remained extremely variable. No statistically significant relationship could be found between turbidity and flow, defined by the water level, for Mangapouri Stream.

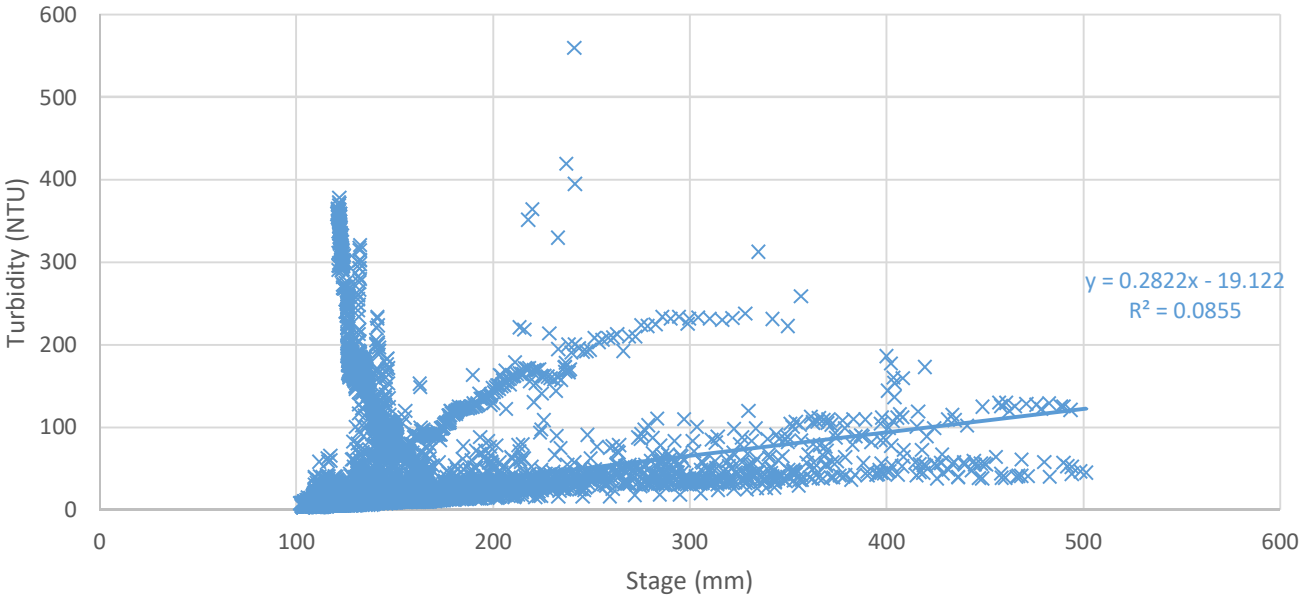

Figure 4.5: Turbidity and stage relationships recorded in the Mangapouri Stream (10-min data).

4.5 Log-log plots

As illustrated above, there is a general relationship between flow and turbidity in the four rivers and streams monitored. However, there is also a high degree of variability between the different rivers, between different flood events in a particular river, and therefore the range of turbidity experienced at a particular flow. This makes it difficult to provide robust, defensible and potentially enforceable turbidity thresholds to manage the discharge of sediment from construction activities associated with the PP2O Expressway.

One approach to minimise the apparent effect of the high degree of variability, is to plot the log of the data, rather than the raw data, and to then 'fit' a power function to provide the 'explanation'. Invariably this results in an improvement of the coefficient of determination (i.e. r^2) data (Figure 4.6 through Figure 4.9). However, such an approach does not affect the inherent scatter, and therefore 'uncertainty' within the raw data. In the case of the Otaki River, which contains the least scatter, the variation in turbidity for a flow of 100m³/s is over two orders of magnitude i.e. from <10NTU to >1000NTU (Figure 4.6). Furthermore, in the case of Waitohu Stream the scatter is so large that it is impossible to 'fit' any reasonable power function (Figure 4.8).

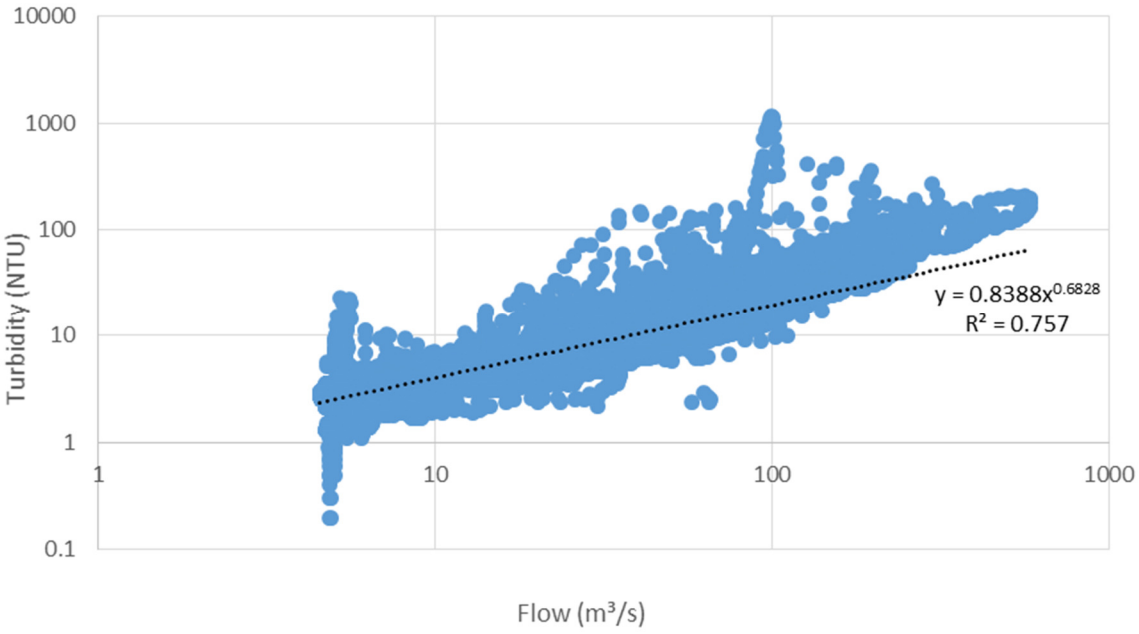

Figure 4.6: Log-log plot and correlation between flow and turbidity in the Otaki River.

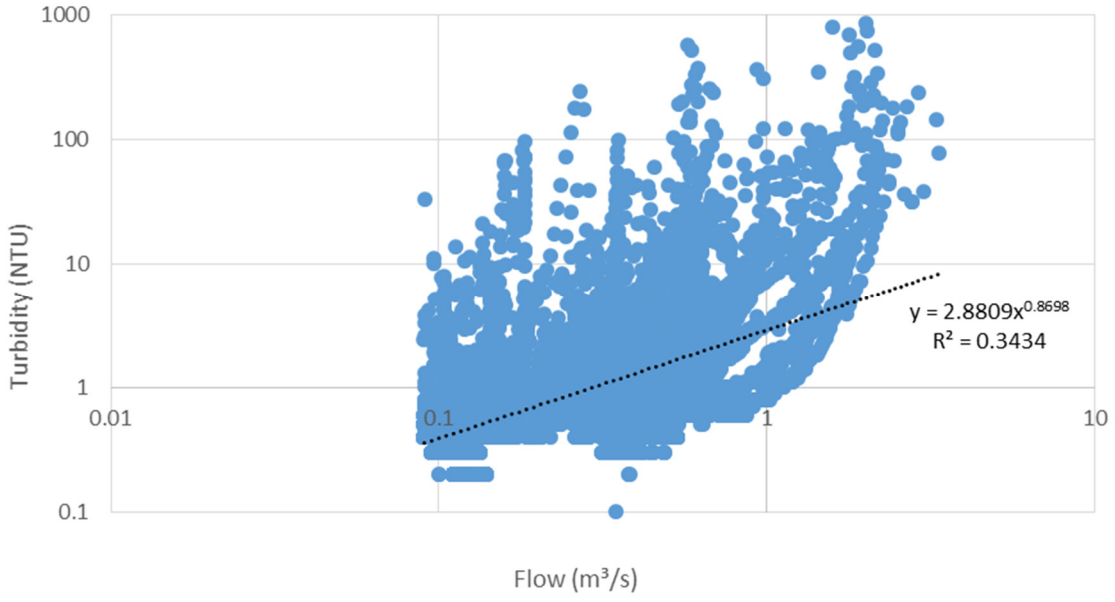

Figure 4.7: Log-log plot and correlation between flow and turbidity in Mangaone Stream.

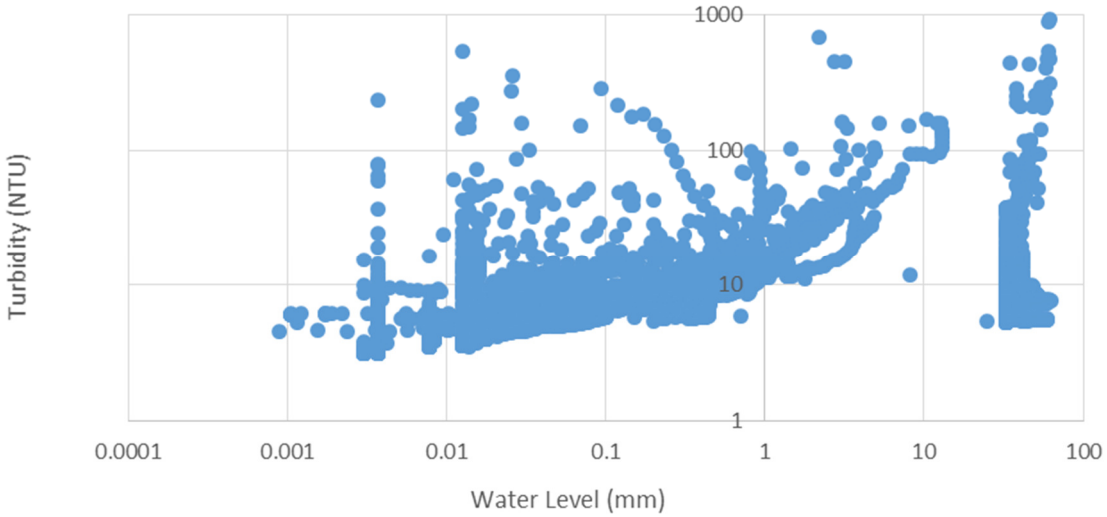

Figure 4.8: Log-log plot and correlation between flow and turbidity in Waitohu Stream.

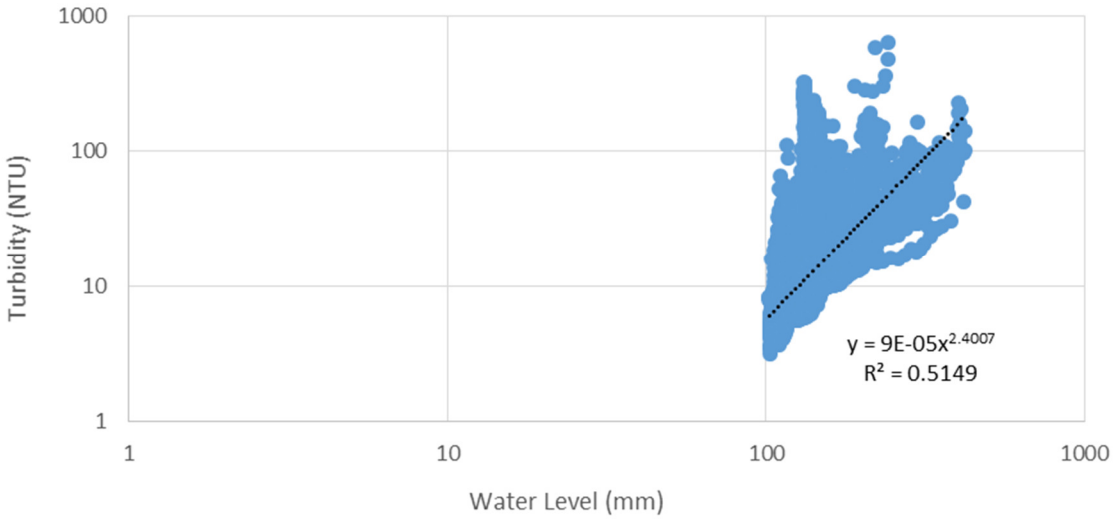

Figure 4.9: Log-log plot and correlation between flow and turbidity in Mangapouri Stream.

5 Conclusion

Despite some initial problems relating to the installation of the four turbidity sensors they functioned well; providing approximately 8-months of data at 10-minute intervals. The turbidity data support the following conclusions:

- Measuring turbidity on a continuous basis is problematic, and issues around obtaining a reliable turbidity record are well known. Despite the use of 'industry standard' sensors, which included an automatic wiper and anti-fouling mechanism, a range of environmental factors such as debris and variable water levels, and instrumental issues including calibration, drift, the growth of algae on the lens, and electronic 'glitches' still affected the turbidity records.;

- The aim of the turbidity monitoring required by Condition G39, which did not require the monitoring of flow, was to assist in the setting of thresholds to control the discharge of sediment laden water as a result of construction of the PP2O Expressway;
- Continuous measurement of turbidity, to be effective for compliance monitoring, would require real-time review and potentially alarms. While this is possible, these data will still be subject to the issues discussed above. This will lead to significant uncertainty regarding the data, and specifically compliance;
- There is no unique turbidity value at any particular time and place as the actual measurement depends to a degree on the instrumentation used. Turbidity measurements are a measure of the scattering of light relative to a formazin standard. Consequently, different turbidity sensors may output different turbidity values for the same sample. The use of the same type of sensor (i.e. same model from the same manufacturer) may help to overcome this issue. However, it is best practice to use the same turbidity sensor unit in either before and after, or upstream-downstream applications;
- Relative measures of the difference in turbidity between two sites, using the same meter, are more reliable for identifying 'change' than the actual measurements themselves;
- Considerable post-processing of the data is necessary to produce a representative turbidity record;
- Turbidity data are highly variable in time and place. This variability can be moderated by using a longer term average, but the presence of discrete 'turbidity events' i.e. 'spikes', real or instrumental, remains an issue with regard to establishing turbidity thresholds or triggers;
- As a result of the above issues, there is likely to be considerable uncertainty over whether a particular trigger or threshold has actually been exceeded;
- The maximum turbidity recorded was about 1200 NTU in the Otaki River. This was during a relatively small fresh. It is likely that turbidity would increase further during larger flood events;
- The relationship between flow and turbidity was different for each river; and
- In each river there was also a high degree of variability in the relationship between flow and turbidity during each flood event.

6 Recommendation

Given the range of problems and issues discussed above, it is recommended that the monitoring of the effectiveness of erosion and sediment control measures, and compliance with any water quality standards be confirmed by:

Monitoring the turbidity (using the same instrument) upstream and downstream (after reasonable mixing) of any activity in any watercourse receiving runoff from construction activities be undertaken;

- When there is a conspicuous change in colour of the water downstream of the activity; or
- When hourly rainfall exceeds 20mm/hr (i.e. approximately 2.3-year ARI event); or
- When daily rainfall exceeds 70mm (i.e. approximately 2.3-year ARI event).

Should the downstream turbidity be 20% higher than that measured upstream then:

- An investigation of the cause or source of the increased turbidity be undertaken;
- Immediate actions be taken to mitigate any sediment loss from the construction site so that turbidity drops back to the 20% threshold;
- Management and the sediment control structures be modified to prevent a similar occurrence in the future; and
- A report be prepared for the consent authority outlining the nature of the breach, any immediate actions taken to limit the loss of sediment from the site, and changes to future practices to ensure that such an occurrence does not happen in the future.

7 References

Anderson, C. W. (2005). Turbidity 6.7. In USGS National Field Manual for the Collection of Water-Quality Data. *U S Geological Survey*.

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Appendix A – Correlations

Otaki River

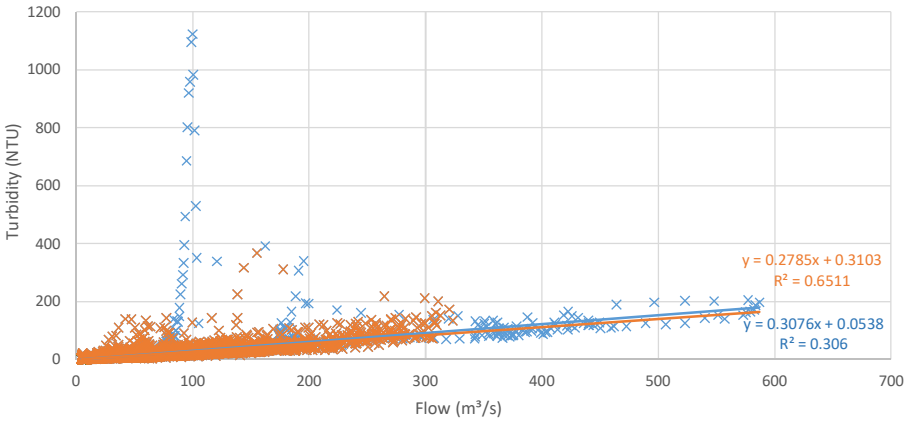


Figure 1: **Correlation between flow and turbidity in the Otaki River recorded at Pukehinau, including, and excluding turbidity recorded from the 16-20 September 2016 (10-min average flow and turbidity data).**

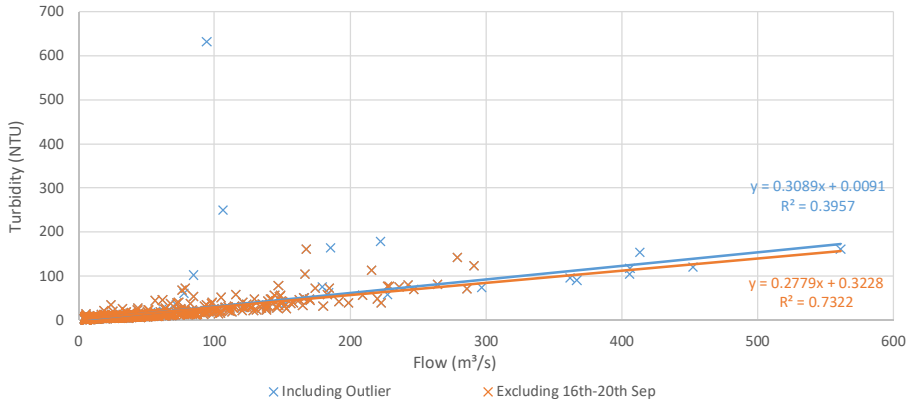


Figure 2: **Correlation between flow and turbidity in the Otaki River recorded at Pukehinau, including, and excluding turbidity recorded from the 16-20 September 2016 (3-hour average).**

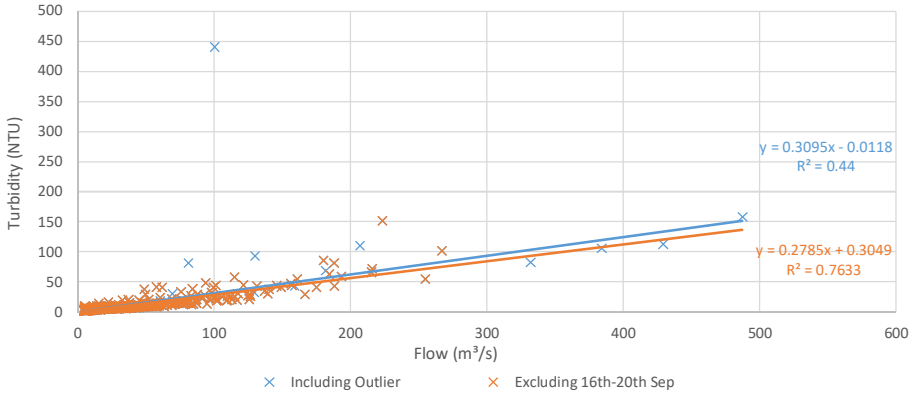


Figure 3: **Correlation between flow and turbidity in the Otaki River recorded at Pukehinau, including, and excluding turbidity recorded from the 16-20 September 2016 (6-hour average).**

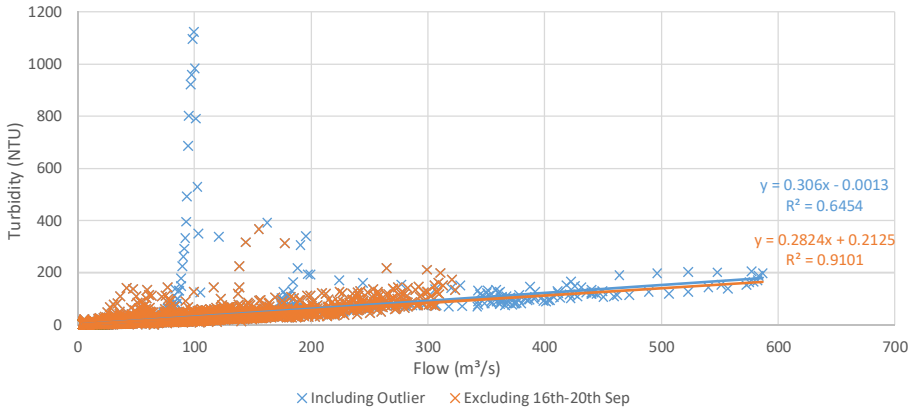


Figure 4: **Correlation between flow and turbidity in the Otaki River recorded at Pukehinau, including, and excluding turbidity recorded from the 16-20 September 2016 (24-hour average).**

Mangaone Stream at Ratanui

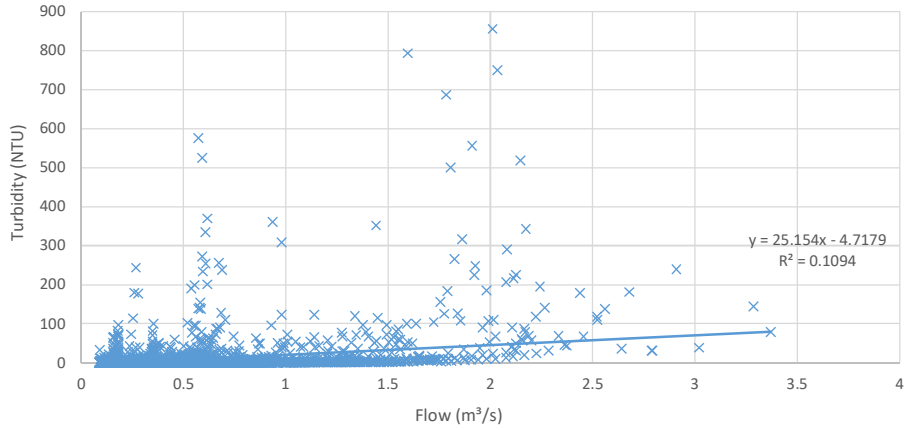


Figure 5: **Correlation between flow and turbidity in the Mangaone Stream at Ratanui (10-min average).**

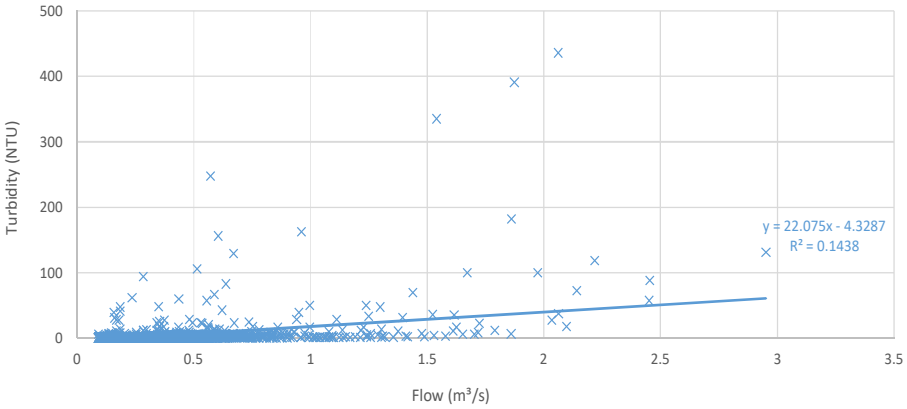


Figure 6: **Correlation between flow and turbidity in the Mangaone Stream at Ratanui (1 hour average).**

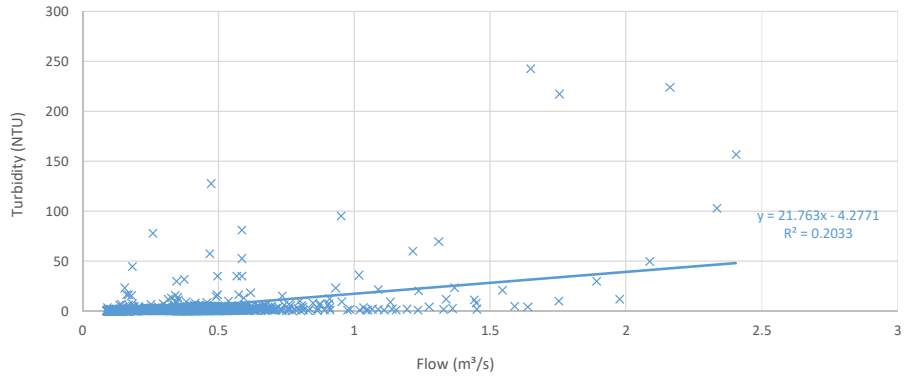


Figure 7: **Correlation between flow and turbidity in the Mangaone Stream at Ratanui (2 hour average).**

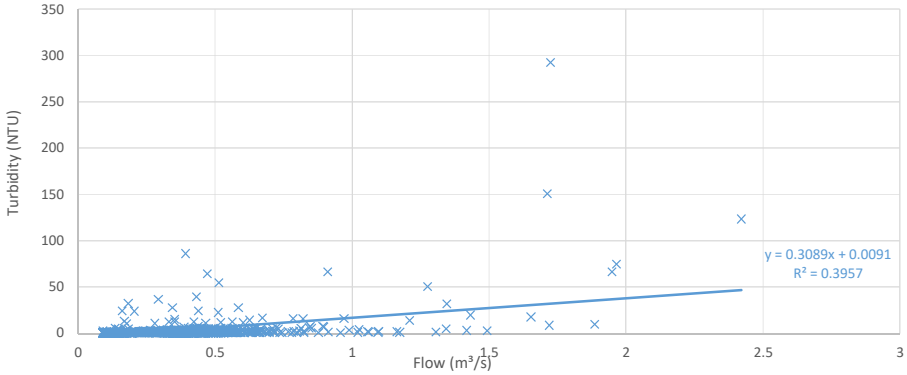


Figure 8: Correlation between flow and turbidity in the Mangaone Stream at Ratanui (3-hour average).

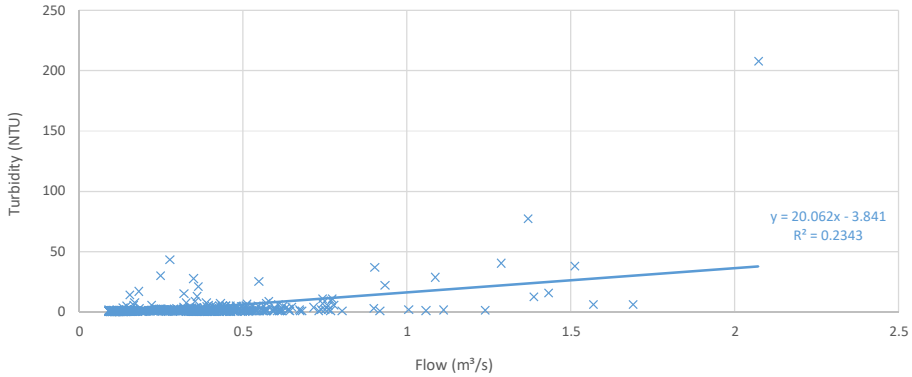


Figure 9: Correlation between flow and turbidity in the Mangaone Stream at Ratanui (6-hour average).

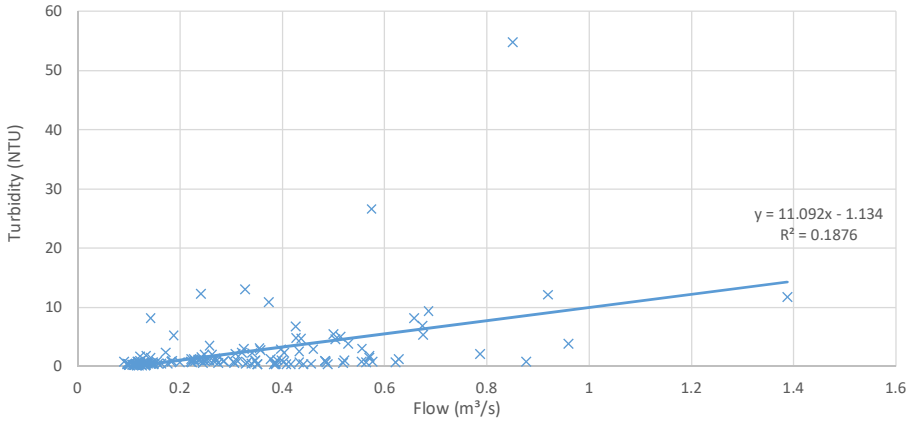


Figure 10: Correlation between flow and turbidity in the Mangaone Stream at Ratanui (24-hour average flow).

Waitohu Stream at Water Supply Intake

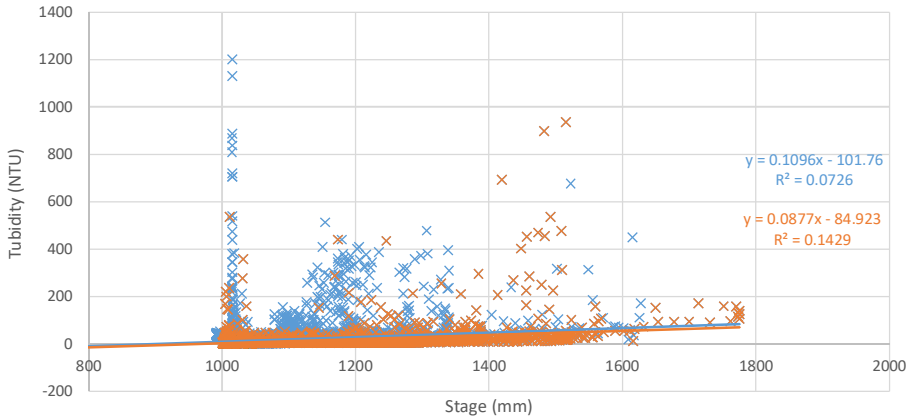


Figure 11: **Raw and refined turbidity and stage relationships recorded in the Waitohu Stream (10-min data).**

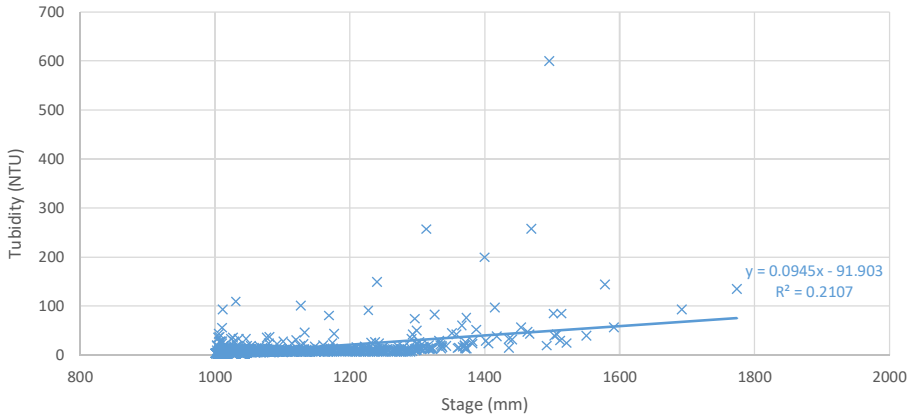


Figure 12: **Correlation between stage and turbidity in the Waitohu Stream (1-hour average).**

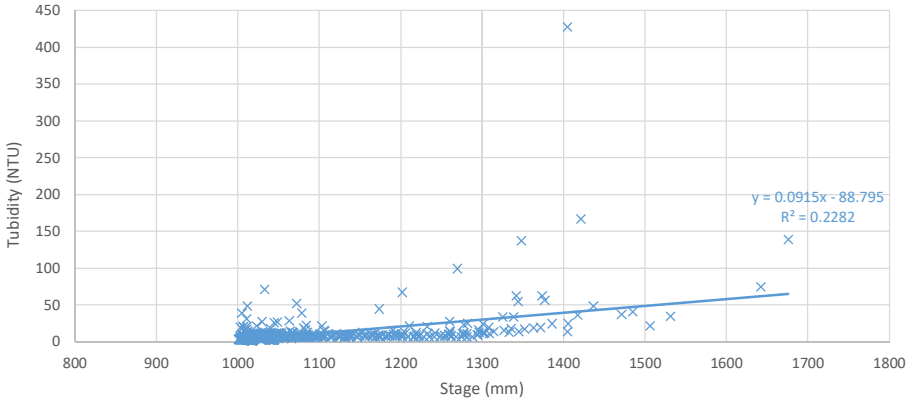


Figure 13: **Correlation between stage and turbidity in the Waitohu Stream (2-hour average).**

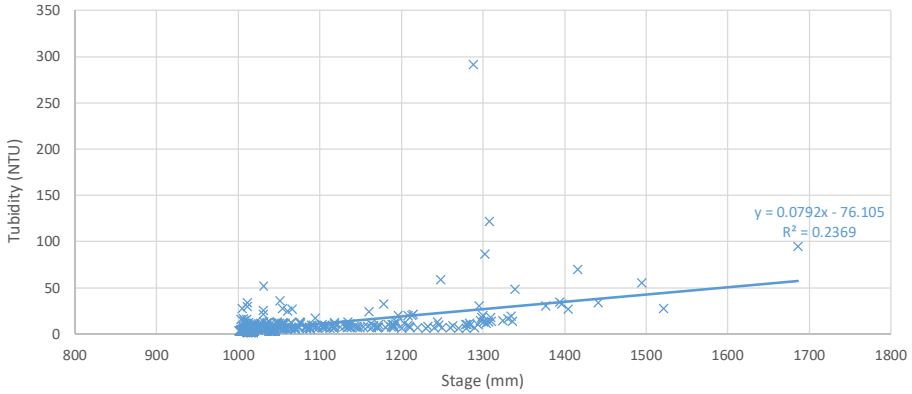


Figure 14: Correlation between stage and turbidity in the Waitohu Stream (3-hour average).

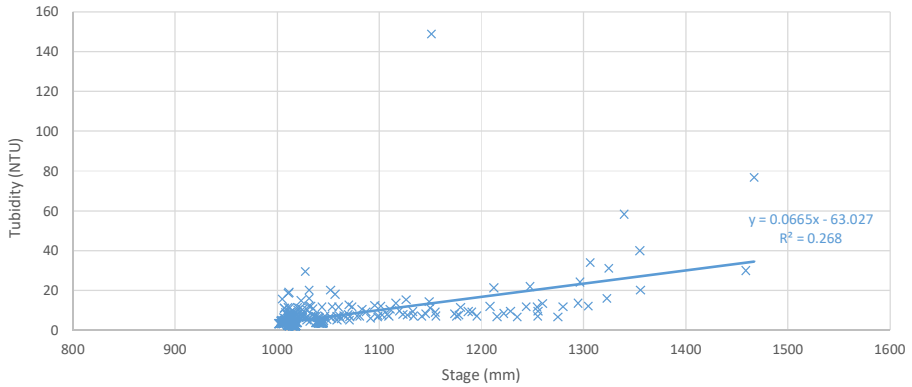


Figure 15: Correlation between stage and turbidity in the Waitohu Stream (6-hour average).

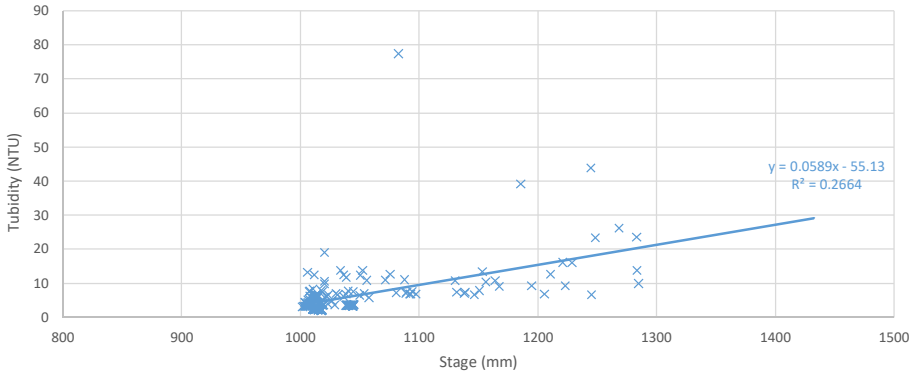


Figure 16: Correlation between stage and turbidity in the Waitohu Stream (12-hour average).

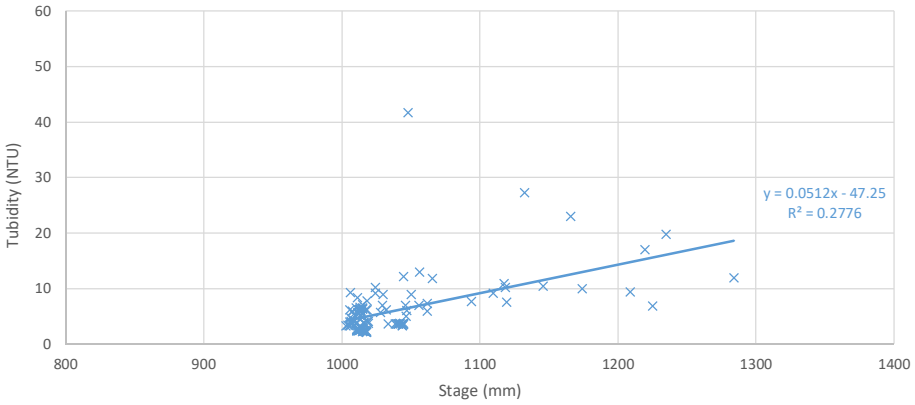


Figure 17: Correlation between stage and turbidity in the Waitohu Stream (24-hour average).

Opus International Consultants Ltd
L10, Majestic Centre, 100 Willis St
PO Box 12 003, Thorndon, Wellington 6144
New Zealand

t: +64 4 471 7000
f: +64 4 499 3699
w: www.opus.co.nz

APPENDIX C: ECOLOGY LAYOUT PLANS (17 SHEETS)

Save Date: 18 May 2017 10:30 AM

ECOLOGY LEGEND:

STREAM ECOLOGY REQUIREMENTS:


FISH SALVAGE/ RELOCATION


MUDFISH SURVEY (AND RELOCATION IF FOUND)


WATER QUALITY AND STREAM ECOLOGY MONITORING


FISH PASSAGE

TERRESTRIAL ECOLOGY REQUIREMENTS:


LIZARD SURVEYS, SALVAGING AND MONITORING


NATIVE TREE LOG SALVAGE


PERIPATUS MANAGEMENT


POWELLIPHANTA TRAVERSI OTAKI SURVEY

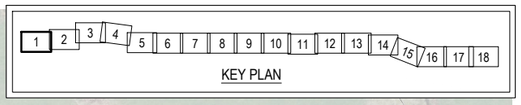
BIRD SURVEY


PIPIT SURVEY


BANDED DOTTEREL SURVEY

WETLAND ECOLOGY REQUIREMENTS:


MACROINVERTEBRATE MONITORING



GREENWOOD STREAM

PROPOSED GREENWOOD BASIN (TREATMENT & ATTENUATION)

GREENWOOD STREAM DIVERSION

1,680 - START OF ALIGNMENT

TIE IN WITH EXISTING ROAD DRAINAGE SYSTEM

100 200 300 400 500 600 700

HD-1A SDMH 1 B HD-2A HD-2B HD-69A HD-69B

EXISTING STATE HIGHWAY 1

MATCHLINE - REFER SHEET 2

TAYLORS ROAD

TAYLORS ROAD

CULVERT No.1
SIZE: 3.5m x 2m (WxD)
IL US = 22.7
IL DS = 22.4

EXISTING CULVERT No.108
SIZE: 1.5m DIA

LEGEND:

- DESIGNATION
- RAILWAY DESIGNATION
- EXISTING STREAMS
- PROPOSED STREAMS DIVERSIONS
- EXISTING CULVERTS
- PROPOSED CULVERTS
- STORMWATER WETLAND/POND

ECOLOGICAL PLANTING:

- RIPARIAN MITIGATION PLANTING
- TERRESTRIAL BUFFER PLANTING
- WETLAND MITIGATION PLANTING
- SWAMP FOREST MITIGATION BUFFER PLANTING
- LOW STATURE WETLAND MITIGATION PLANTING

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Drawn	S.Halliday	10.05.17	·
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Peka Peka to Ōtaki Expressway

Fletcher HIGGINS Beca Tonkin+Taylor

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Title: LAYOUT PLAN SHEET 1 OF18

Discipline: CIVIL

Drawing No.: PP2O-DR-CE-0801

Rev.: 0

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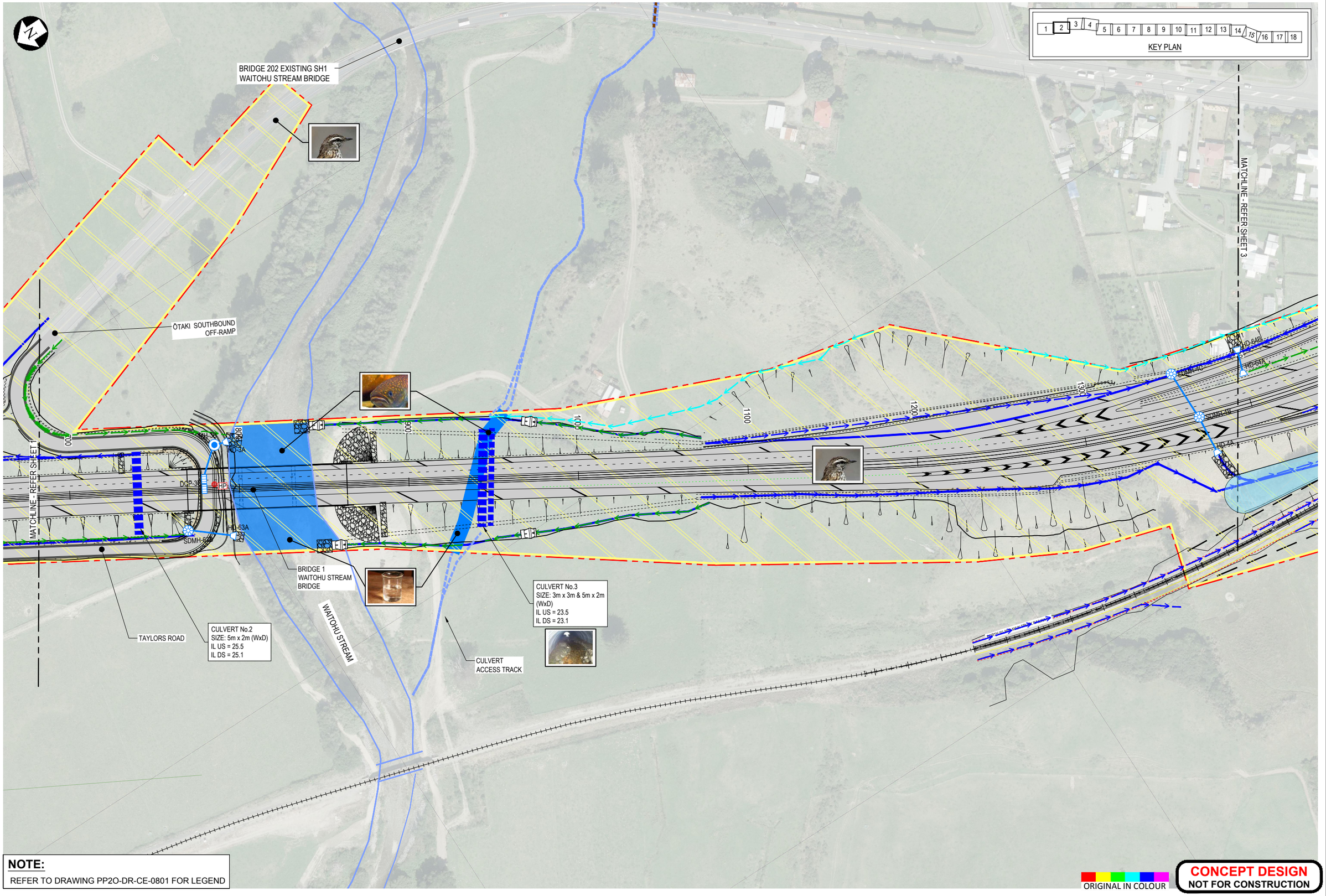

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Discipline	CIVIL
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KEY PLAN

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

CULVERT No.7
SIZE: 10m x 1m (WxD)
IL US = 14.06m
IL DS = 13.90m

CULVERT No.13
SIZE: 0.9m DIA
IL US = 12.3m
IL DS = 11.9m

EXISTING CULVERT No.5
SIZE: 1.2m DIA

EXISTING CULVERT No.6
SIZE: 0.95m x 1.2m DIA

CULVERT No.9
SIZE: 3m x 3m
IL US = 10.6m
IL DS = 10.35m

EXISTING
CULVERT No.104
SIZE: 0.55m DIA

PROPOSED KENNEDY WETLAND

EXISTING RAIL EMBANKMENT TO
BE RETAINED AS FLOOD BUND

CULVERT No.12
SIZE: 1m DIA
IL US = 17.06
IL DS = 15.76

NORTH ŌTAKI MAIN
ROAD UNDERPASS

REMNANT OTAKI RAILROAD
WETLAND (K134)

CULVERT No.70
SIZE: 1m DIA
IL US = 17.3m
IL DS = 16.96m

PUMP STATION

MANGAPOURI
RAILWAY NIMT
CULVERT

PROPOSED TAYLOR BASIN
(TREATMENT & ATTENUATION)

CULVERT No.10
SIZE: 3m x 3m (WxD)
IL US = 10.35m
IL DS = 10.2m

LOW BUND

NORTH ŌTAKI RAIL
OVERPASS

ACCESS TRACK

EXISTING CULVERT No.11
SIZE: TWIN 1.91m DIA

PROPOSED
REMNANT
WETLAND

PROPOSED RAILWAY WETLAND B
(TREATMENT & ATTENUATION)

PROPOSED RAILWAY WETLAND A
(TREATMENT & ATTENUATION)

MANGAPOURI STREAM

MATCHLINE - REFER SHEET 2

MATCHLINE - REFER SHEET 4

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Discipline: CIVIL
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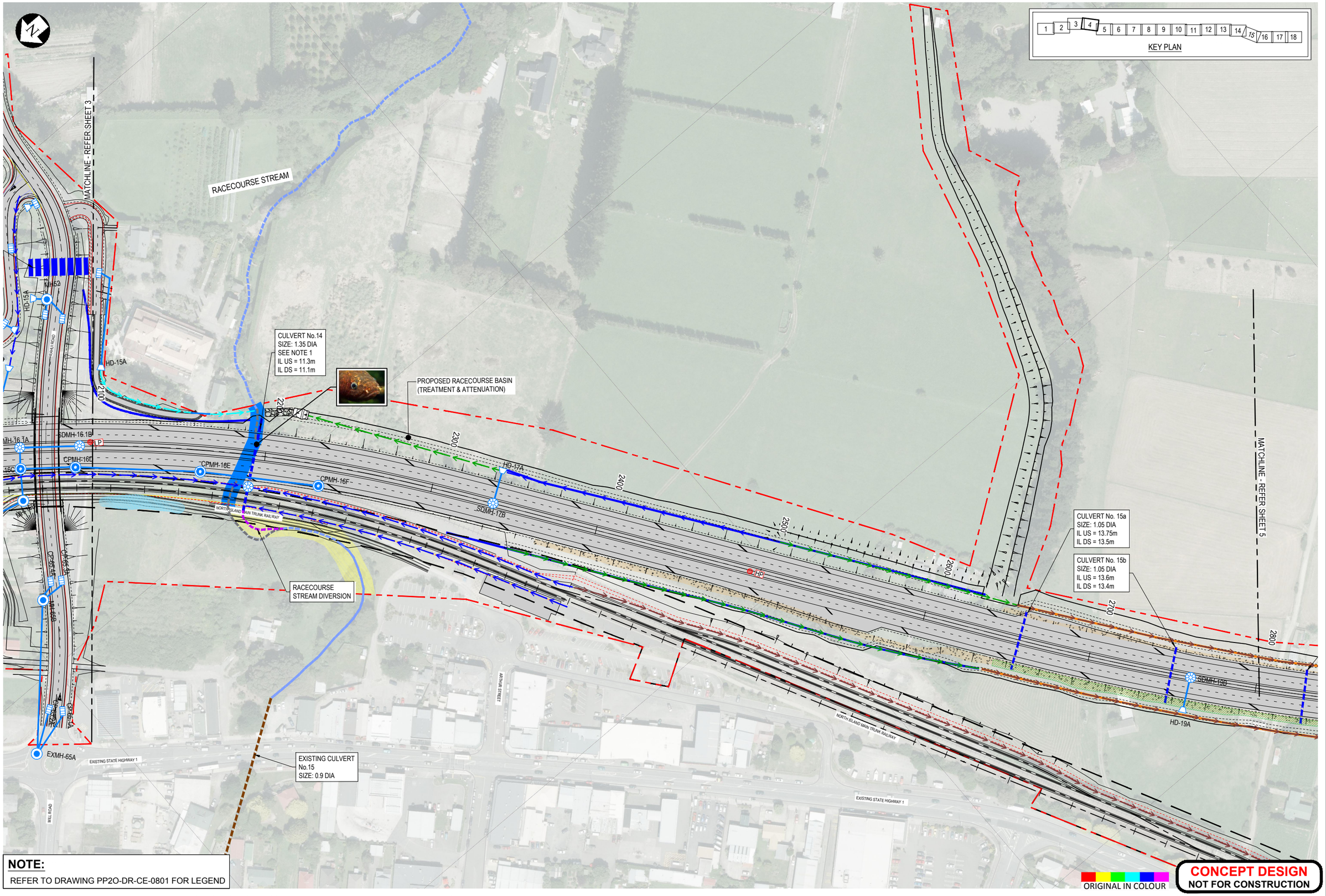

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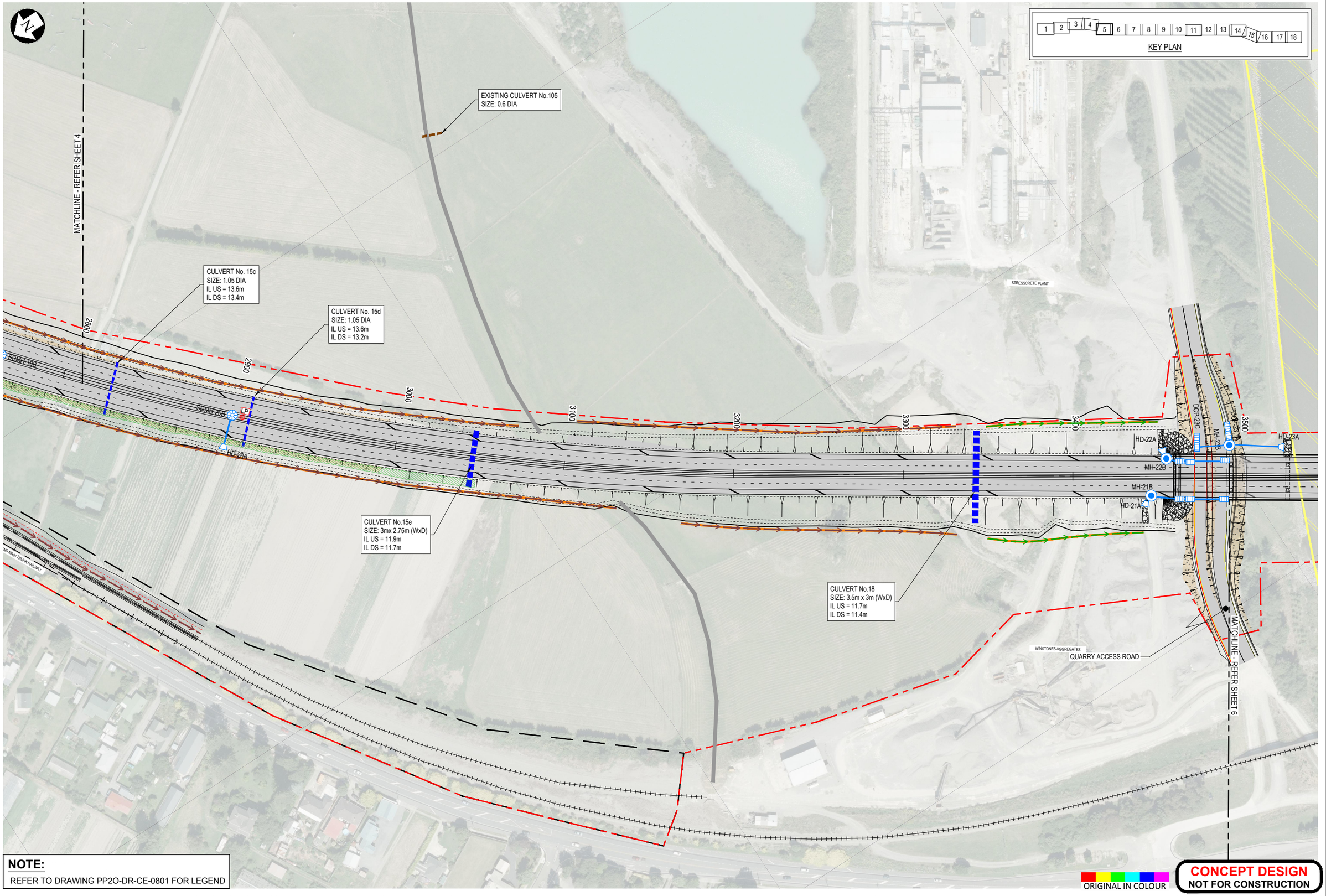

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Discipline: CIVIL
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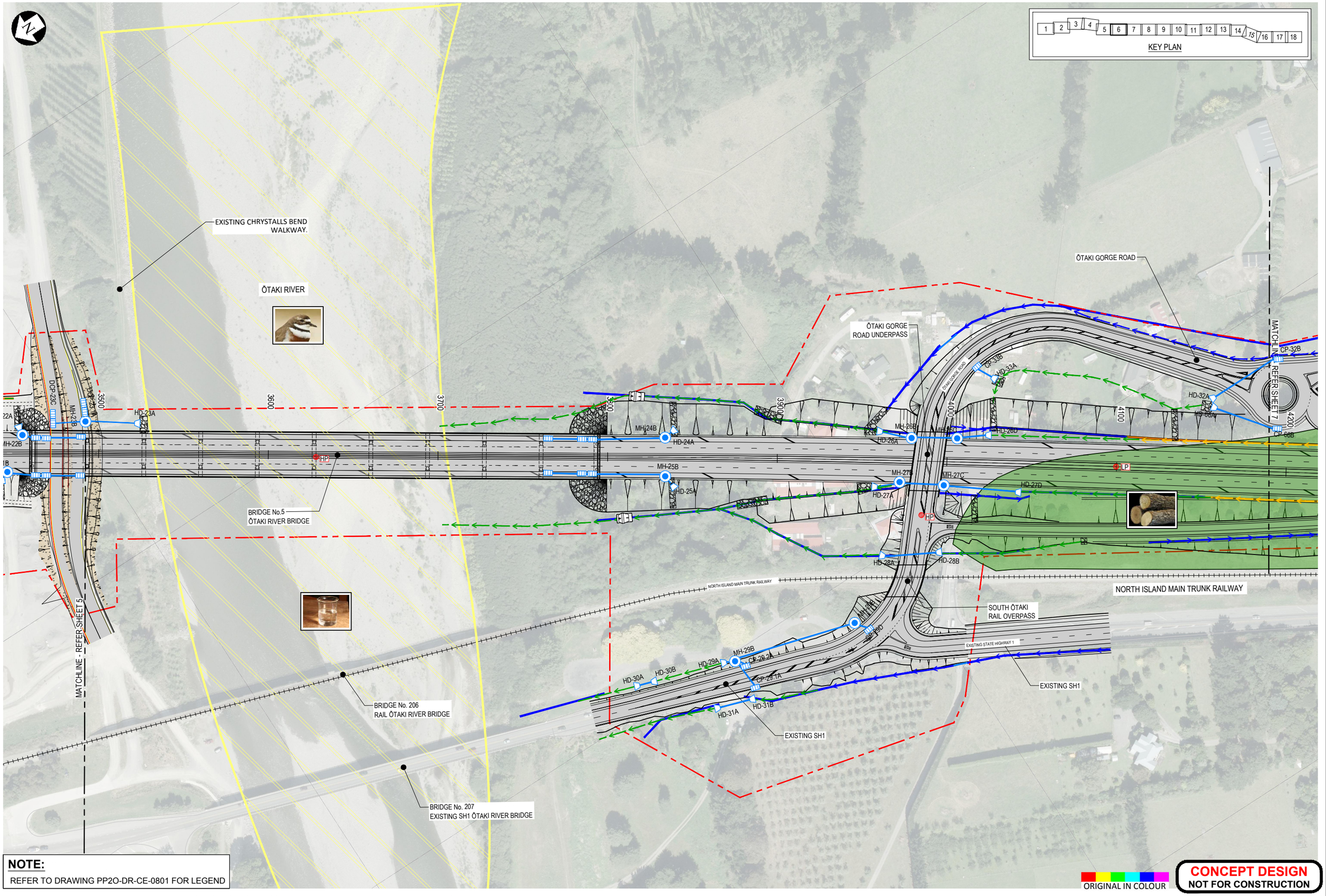

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Discipline: CIVIL
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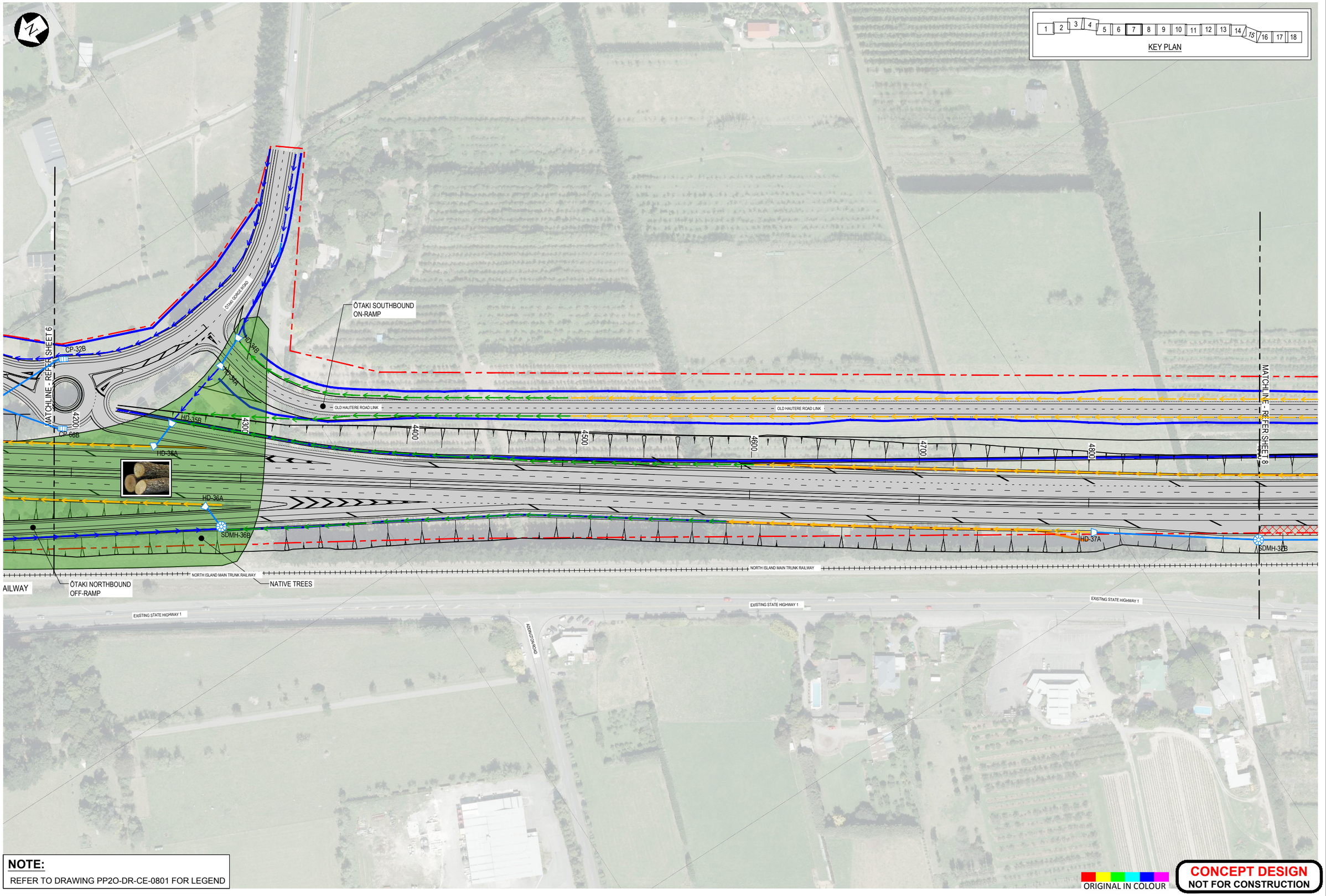

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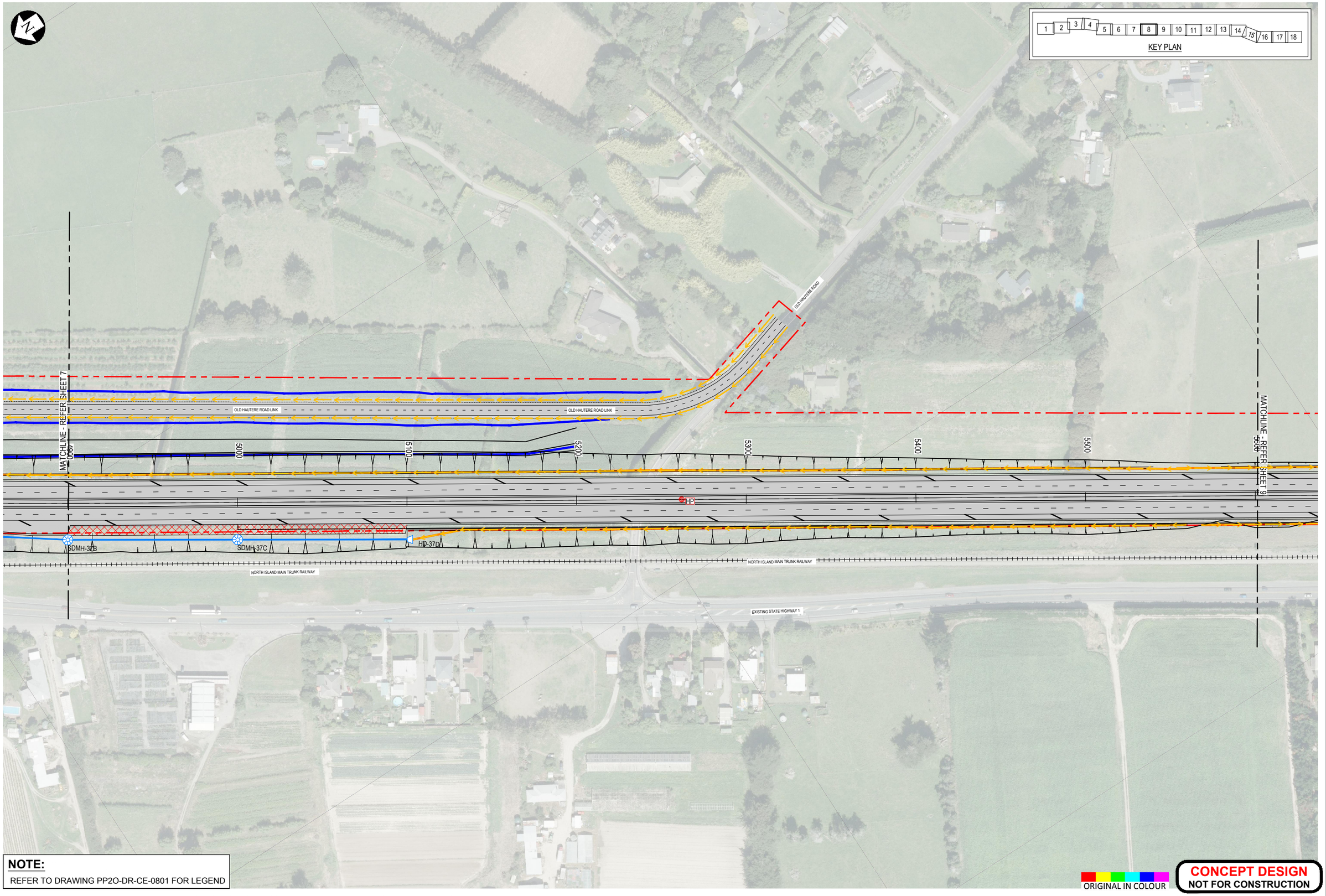

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Discipline: CIVIL
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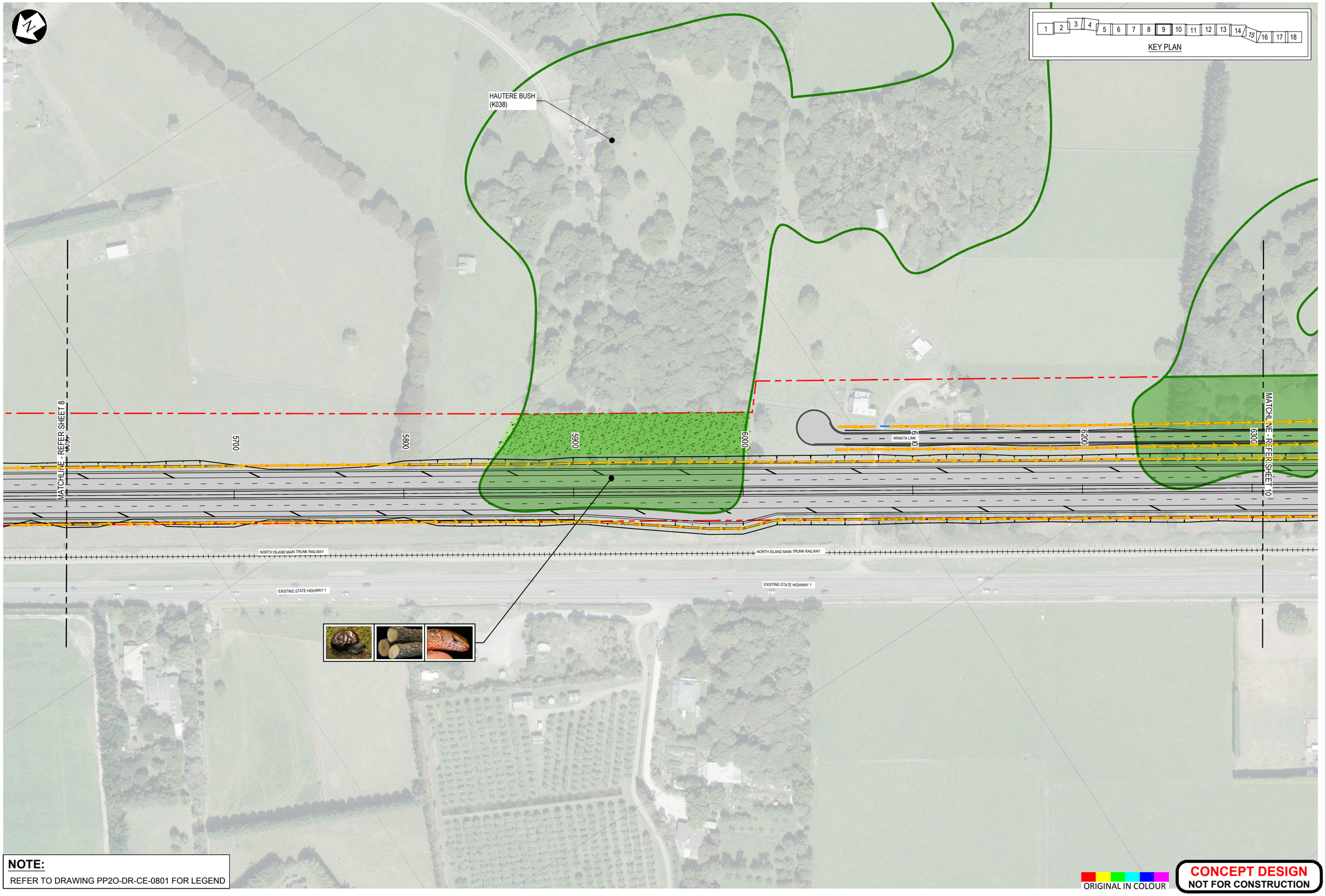

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Discipline: CIVIL
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Title:	LAYOUT PLAN SHEET 10 OF18
Discipline	CIVIL
Drawing No.	PP2O-DR-CE-0810
Rev.	0

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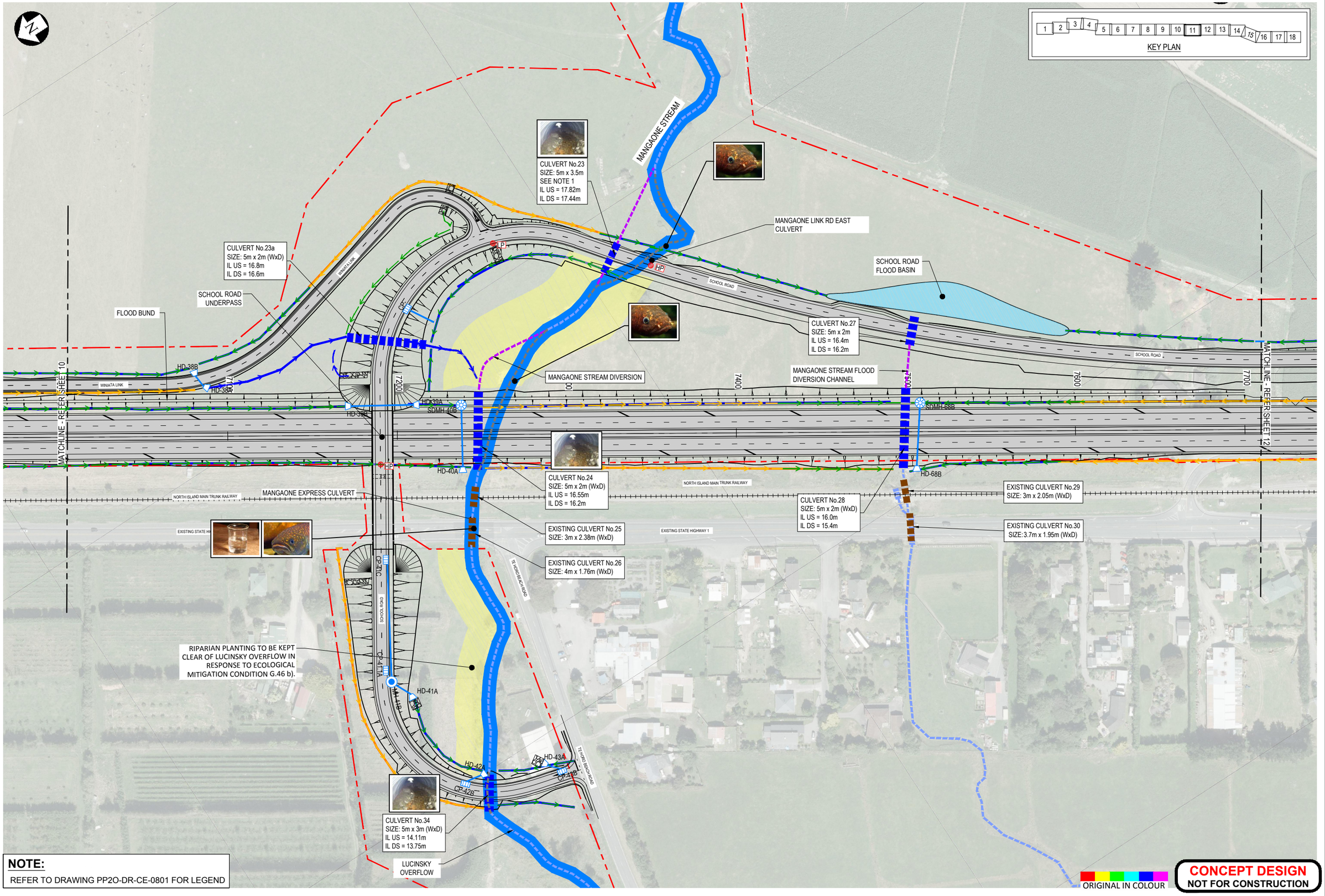

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Discipline: CIVIL
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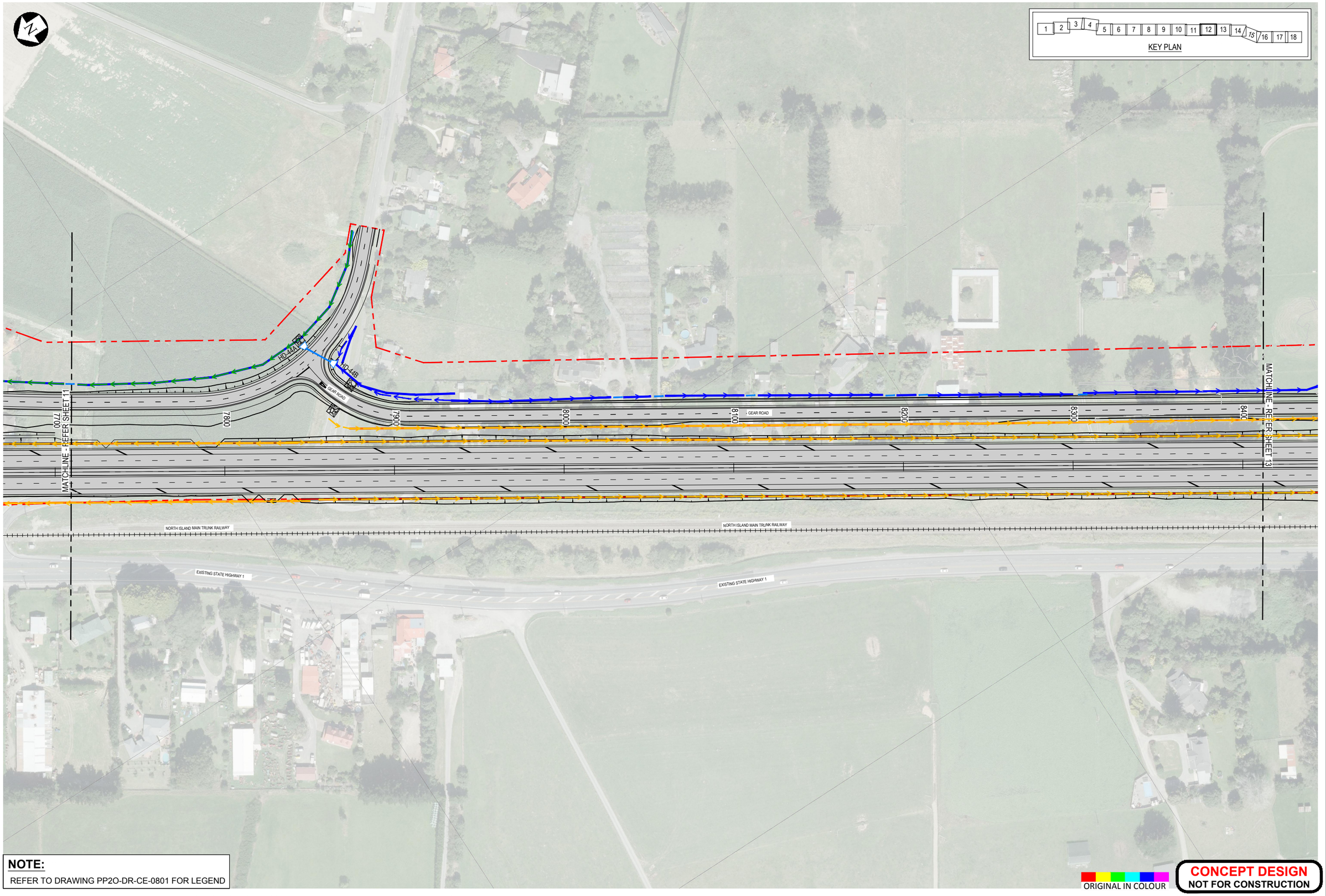

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Discipline: CIVIL
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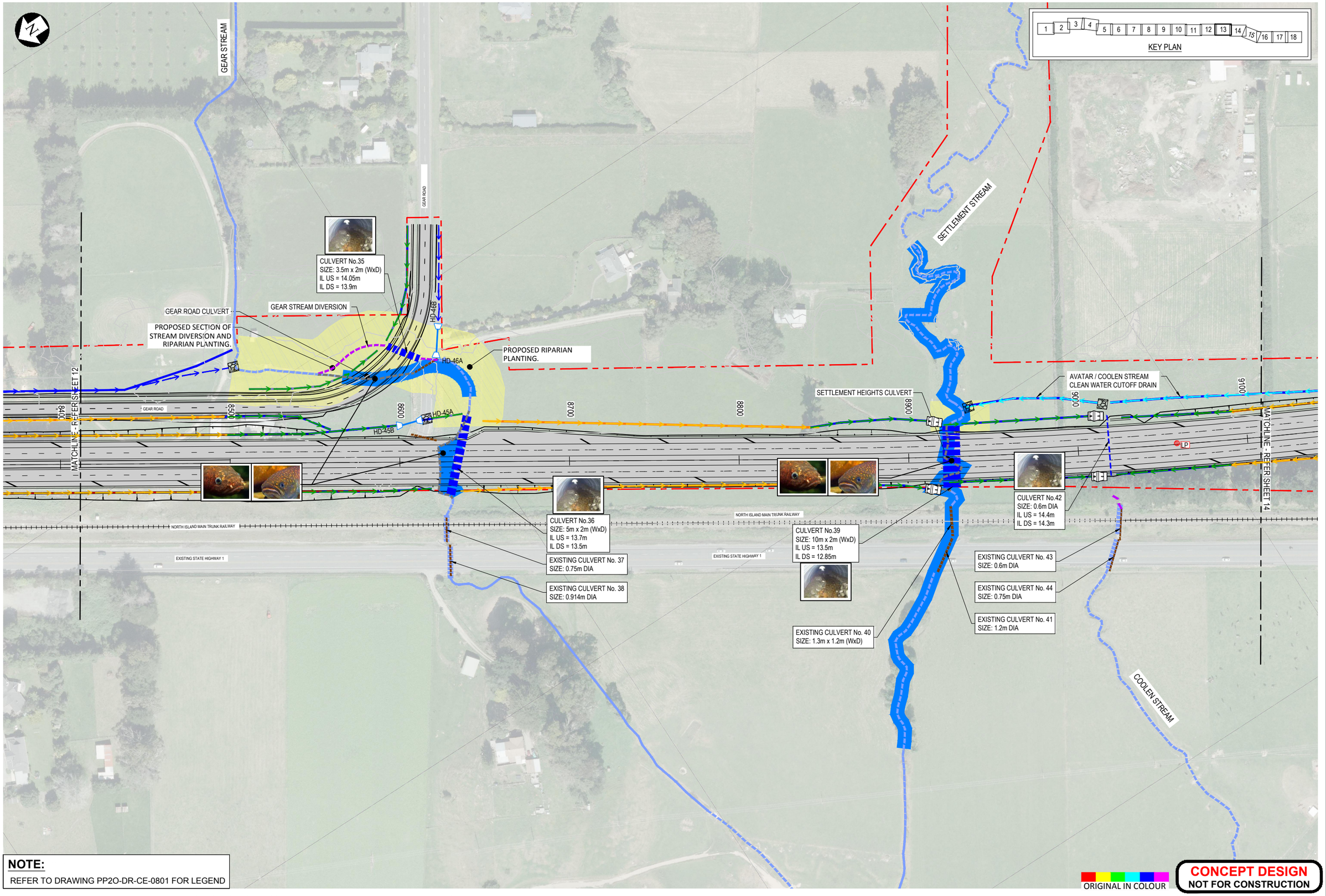

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Discipline: CIVIL
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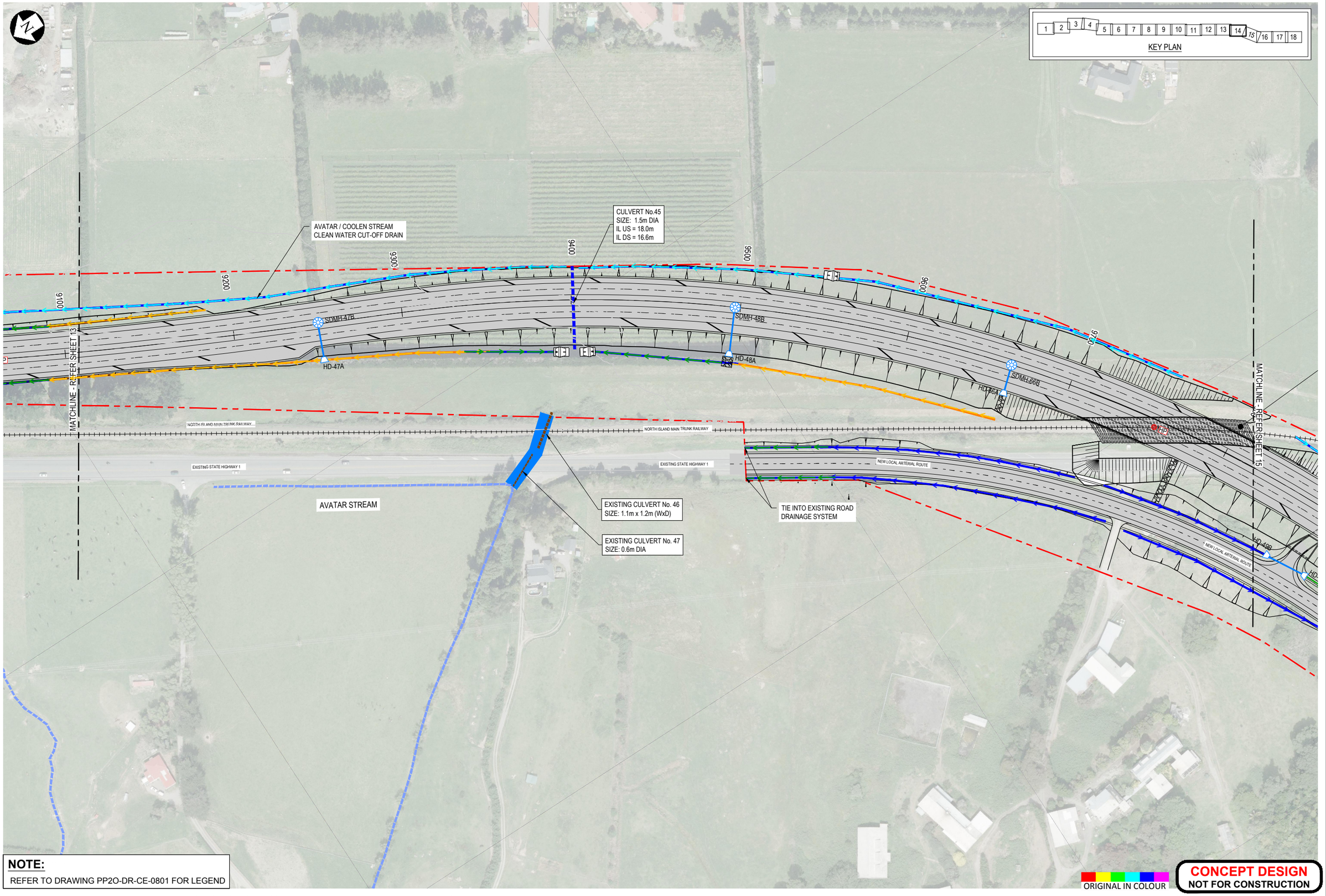

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Peka Peka to Ōtaki Expressway
Fletcher HIGGINS
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Subject: ECOLOGY
Title: LAYOUT PLAN SHEET 14 OF18

Discipline: CIVIL
Drawing No.: PP2O-DR-CE-0814
Rev.: 0

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LEGEND:

- DESIGNATION
- RAILWAY DESIGNATION
- EXISTING STREAMS
- PROPOSED STREAMS DIVERSIONS
- EXISTING CULVERTS
- PROPOSED CULVERTS
- STORMWATER WETLAND/POND

ECOLOGICAL PLANTING:

- RIPARIAN PLANTING
- TERRESTRIAL MITIGATION PLANTING
- WETLAND BUFFER PLANTING
- SWAMP FOREST PLANTING
- LOW STATURE WETLAND PLANTING
- EXISTING VEGETATION RETAINED

MARY CREST
RAIL OVERPASS

EXISTING CULVERT No.48
SIZE: 0.91m x 0.9 (WxD)

EXISTING CULVERT No.49
SIZE: 0.9m DIA

EXISTING CULVERT No.51
SIZE: 1.2m x 1.3m (WxD)

EXISITING CULVERT No.52
SIZE: 1.2m DIA

CULVERT No.53
SIZE: TWIN 2.5m x 2m
SEE NOTE 1
IL US = 20.0m
IL DS = 19.2m

HW-50A
HW-50B
EDWIN CULVERT
HW-49B
HW-49A
HW-67A
HW-51A
HW-53B
HW-53A
HW-54A

PROPOSED VALENTINE WETLAND
(TREATMENT & ATTENUATION)

CULVERT No.50
SIZE: 1.2m DIA
IL US = 22.1m
IL DS = 20.2m

EDWIN STREAM
DIVERSION

SWALE CROSSES
OVER CULVERT

JEWEL STREAM
DIVERSION

EXISTING STREAM
TO BE REMOVED

ORIGINAL IN COLOUR

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No.	Revision	By	Chk	Appd	Date
A	SSEMP FOR INFORMATION	SJH	GD	AN	-

Design	AN	13.07.17	Approved For Construction
Drawn	SJH	10.08.17	.
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Peka Peka to Ōtaki Expressway
Fletcher HIGGINS
Beca Tonkin+Taylor

Subject: ECOLOGY
Title: LAYOUT PLAN
SHEET 15 OF 18

Discipline: CIVIL
Drawing No.: PP2O-DR-CE-0815
Rev.: A

Document No. R:\30OD - DESIGN DEVELOPMENT GENERAL\09 CAD\DRAWINGS\CE\PP2O-DR-CE-0801-0818.DWG

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KEY PLAN

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

MATCHLINE - REFER SHEET 15

EXISTING CULVERT No.55
SIZE: 0.9m DIA

EXISITING CULVERT No.56
SIZE: 0.75m DIA

MARY CREST BASIN
(ATTENUATION)

NORTH ISLAND MAIN TRUNK RAILWAY

EXISTING STATE HIGHWAY 1

CAVALLO STREAM

10500

10600

10790

10800

10900

11000

11100

11200

HD-54A

SDMH-54B

HD-55A

HD-56A

SDMH-55R

HD-55B

SDMH-57B

HD-57A

SDMH-58A

SDMH-59A

LP

NEW LOCAL ARTERIAL ROUTE

EXISTING CULVERT No.60
SIZE: 0.45m DIA

CORDING CULVERT

CULVERT No.59
SIZE: 1.6m DIA
IL US = 11.4m
IL DS = 11.0m

CAVALLO STREAM DIVERSION

CULVERT No.61
SIZE: 0.45m DIA
IL US = TBC
IL DS = TBC

TE HOPAI ROAD

SWALE TO TIE
INTO EXISTING
ROAD DRAINAGE

MATCHLINE - REFER SHEET 17

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Subject: ECOLOGY

Title: LAYOUT PLAN
SHEET 16 OF18

Discipline: CIVIL

Drawing No.: PP2O-DR-CE-0816

Rev.: 0

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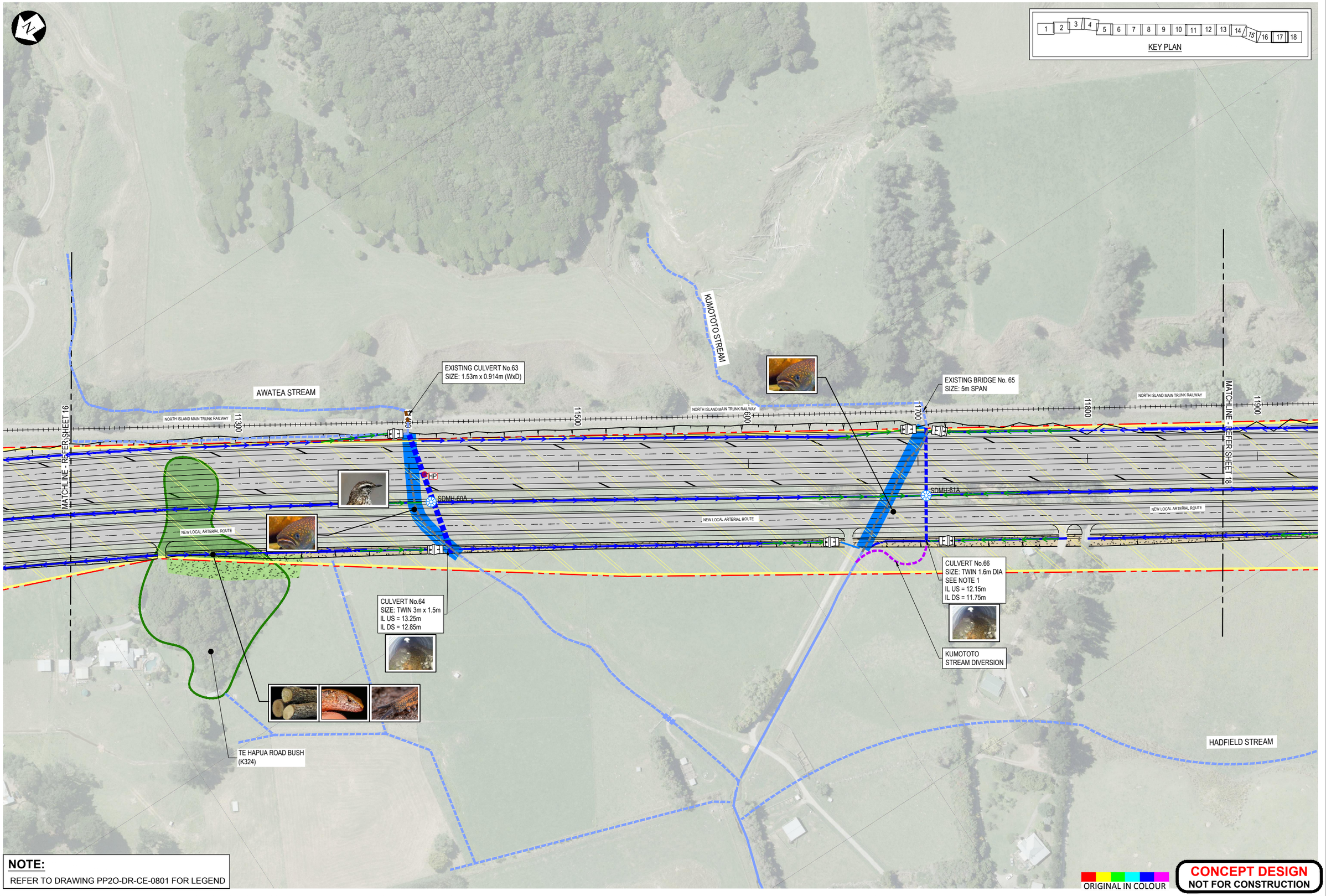

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Title: LAYOUT PLAN SHEET 17 OF18

Discipline: CIVIL
Drawing No.: PP2O-DR-CE-0817
Rev.: 0

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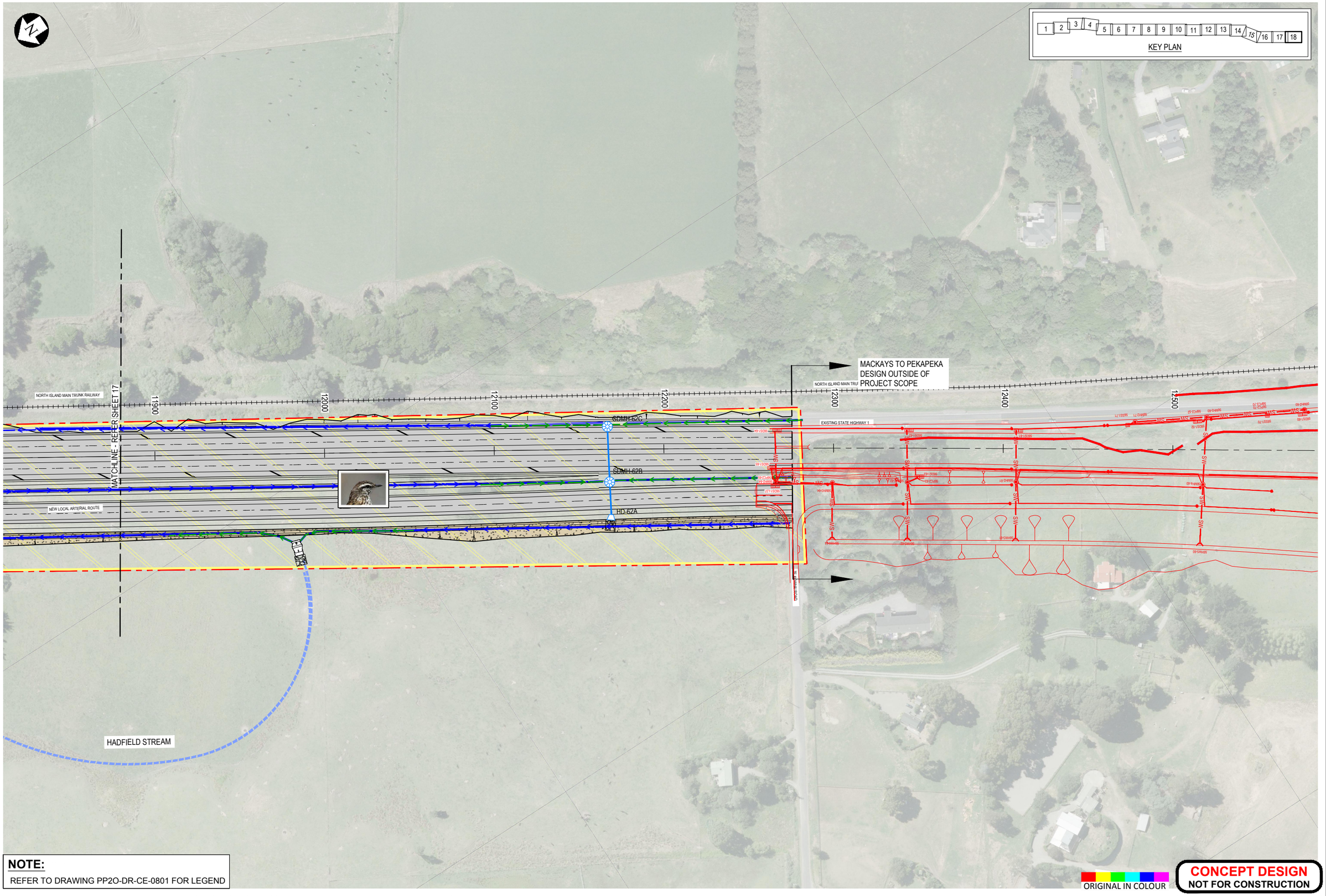

NOTE:
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0	.	SJH	.	.	10.05.17

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	Dsg Verifier	.	.
	Drg Check	.	.

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NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

Fletcher HIGGINS Beca Tonkin+Taylor

Subject: ECOLOGY

Title: LAYOUT PLAN
SHEET 18 OF18

Discipline: CIVIL

Drawing No. PP2O-DR-CE-0818

Rev. 0

Document No. R130DD - DESIGN DEVELOPMENT GENERAL\09 CAD\DRAWINGS\CE\DG-CE-0801-0818.DWG

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APPENDIX D: SCHEDULE OF FISH MIGRATION AND PASSAGE REQUIREMENTS

PP2O EMP Appendix B - Schedule of fish migration and passage requirements

Catchment	Stream name	Culvert description	Culvert No.	Chainage	Type	Size (m)	Invert Level (m NZVD (2009) Wellington)		Length (m)	Slope (%)	Stream classification	Culvert Use	Fish species / habitat	Climbing ability	Mudfish survey required	Fish passage required	Proposed Design Fish Passage Treatment	Fish Migration Management for in-stream works
							u/s	d/s										
Waitohu Stream + floodplain	Greenwood Stream	Greenwood subcatchment	1	390	Box	3.5 x 2	22.7	22.4	45	0.66	Intermittent	Stream Conveyence	Intermittent eel habitat	High	Yes	Yes	Embedded invert, grouted low flow channel	1 - To be confirmed following mudfish survey 2 - schedule works when stream is dry or minimal water is present. 3 - avoid peak upstream migration period for eels (December to March) where possible.
	Unnamed tributary of Waitohu Stream	Southern approach to Waitohu Stream bridge	3	940	Box	3 x 3 & 5 x 2	23.5	23.1	64	0.62	Intermittent	Flood Event	Intermittent eel habitat	High	No	Yes	Embedded invert, grouted low flow channel	1 - schedule works when stream is dry or minimal water is present. 2 - avoid peak upstream migration period for eels (December to March) where possible. 3 - minimise works period and undertake fish rescue.
Mangapouri Stream + Wetland System	Otaki Railway Wetland	Remnant Railway wetland connection pipe	70	1520	Circular	1.05Ø	17.3	16.96	87	0.39	Wetland connection	Wetland Connection/Outlet	Eels	High	No	Yes	For eels only. Spat rope through culvert and within the outlet structure.	1 - avoid peak upstream migration period for eels (December to March) where possible. 2 - minimise works period and undertake fish rescue.
	Otaki Railway Wetland	Remnant railway wetland culvert on connection to Kennedy Wetland	12	1680	Circular	1.05Ø	17.06	15.76	75	1.73	Wetland connection	Wetland Connection/Outlet	Eels	High	No	Yes	For eels only. Spat rope through culvert and within the outlet structure.	1 - avoid peak upstream migration period for eels (December to March) where possible. 2 - minimise works period and undertake fish rescue.
	Kennedy Wetland	Outlet from Kennedy Wetland	13	1960	Circular	0.9Ø	12.3	11.9	22	1.82	Wetland connection	Wetland Outlet	Eels	High	No	Yes	For eels only. Spat rope through culvert and within the outlet structure.	1 - avoid peak upstream migration period for eels (December to March) where possible. 2 - minimise works period and undertake fish rescue.
	Mangapouri Stream	Culvert at Expressway and Realigned railway	9 & 10	2000	Box	3 x 3	10.6	10.2	80	0.50	Permanent	Stream Conveyence	Permanent stream habitat, only eels confirmed	High	No	Yes	Minimum 0.5 m thick layer of cobbles along the culvert invert in accordance with Condition WS.4.	1 - avoid peak upstream migration period for eels (December to March) where possible. 2 - minimise works period and undertake fish rescue.
	Unnamed overland flow path	Rahui Rd overbridge	7	2080	Box	Twin 5 x 1	13.79	13	37	2.14	Ephemeral	Flood Event	None	N/A	No	No	N/A	No timing restrictions or specific ecology requirements
Racecourse Stream	Racecourse Stream	Combined Expressway / realigned railway	14	2200	Circular	1.35Ø	11.3	11.1	52	0.38	Intermittent	Stream Conveyence	Intermittent habitat, rarely flows	N/A	Yes	No	N/A	To be determined following mudfish survey
Otaki River + floodplain	Unnamed overland flow path	Existing SH1	15 (a-e)	2650 to 3000	Circular/Box	Various	-	-	-	-	Flood conveyance	Flood Event	None	N/A	No	No	N/A	No timing restrictions or specific ecology requirements
	Unnamed overland flow path	Off-channel storage basin	18	3340	Box	3.5 x 3	11.7	11.4	60	0.50	Flood conveyance	Flood Event	None	N/A	No	No	N/A	No timing restrictions or specific ecology requirements
Mangaone Stream	Mangaone Stream	Expressway	24	7250	Box	5 x 2	16.55	16.2	46	0.76	Permanent	Stream Conveyence	Diverse fish community	Low to high	No	Yes	Minimum 0.15 m thick layer of glued gravels along the culvert invert in accordance with Condition WS.4.	Peak fish migration period for the species known to be present covers most of the year. Focus to be on minimising disturbance and keeping migration pathways open
	Mangaone Stream	Local link road (Eastern side)	23	7350	Box	5 x 3.5	17.82	17.44	21	1.81	Permanent	Stream Conveyence	Diverse fish community	Low to high	No	Yes	Minimum 0.5 m thick layer of existing gravels along the culvert invert in accordance with Condition WS.4.	Peak fish migration period for the species known to be present covers most of the year. Focus to be on minimising disturbance and keeping migration pathways open
	Mangaone Stream	Local link road (Western side)	34	7250	Box	5 x 3	14.11	13.75	24	1.50	Permanent	Stream Conveyence	Diverse fish community	Low to high	No	Yes	Minimum 0.5 m thick layer of existing gravels along the culvert invert.	Peak fish migration period for the species known to be present covers most of the year. Focus to be on minimising disturbance and keeping migration pathways open
Mangaone overflow	Unnamed overland flow path	Local Link Road	27	7500	Box	5 x 2	16.4	16.2	20	1.00	Ephemeral	Flood Event	None	N/A	No	No	N/A	No timing restrictions or specific ecology requirements
	Unnamed overland flow path	Expressway	28	7500	Box	5 x 2	16	15.4	47	1.28	Ephemeral	Flood Event	None	N/A	No	No	N/A	No timing restrictions or specific ecology requirements
Gear Stream	Gear Stream	Gear culvert at Gear Rd	35	8600	Box	3.5 x 2	14.05	13.9	15	1.00	Intermittent	Stream Conveyence	Intermittent habitat, potential for mudfish	Low to high	Yes	Yes	Buried inverts sufficient	To be determined following mudfish survey
	Gear Stream	Gear culvert at Expressway	36	8620	Box	5 x 2	13.7	13.5	37	0.54	Intermittent	Stream Conveyence	Intermittent habitat, potential for mudfish	Low to high	Yes	Yes	Buried inverts sufficient	To be determined following mudfish survey
Settlement Heights	Settlement Stream	Settlement Heights	39	8920	Box	Twin 5 x 2	13.5	12.85	47	1.37	Intermittent	Stream Conveyence	Intermittent habitat for Eels and banded kokopu.	High	Yes	Yes	Embedded invert, accumulation of in-situ gravels, concentrated low flow on aprons	1 - To be confirmed following mudfish survey 2 - schedule works when stream is dry or minimal water is present. 3 - avoid peak upstream migration period for banded kokopu and eels (September to March) where possible.
Coolen Stream	Coolen Stream	Coolen culvert	42	9020	Circular	0.6Ø	14.4	14.3	35	0.29	Intermittent	Stream Conveyence	Intermittent habitat for eels	High	No	Yes	Embedded invert, accumulation of in-situ gravels, spat rope through culvert	1 - schedule works when stream is dry or minimal water is present. 2 - avoid peak upstream migration period for eels (December to March) where possible. 3 - minimise works period and undertake fish rescue.
Avatar Stream	Avatar Stream	Avatar culvert	45	9400	Circular	1.5Ø	18	16.6	52	2.69	Intermittent / Ephemeral	Stream Conveyence	Very limited	High	No	No	No specific requirements. Buried inverts sufficient	No timing restrictions or specific ecology requirements
Edwin Stream	Edwin Stream	Edwin culvert	50	9950	Circular	1.2Ø	22.1	20.2	80	2.38	Intermittent / Ephemeral	Stream Conveyence	Very limited	High	Yes	Yes	Buried inverts sufficient	To be determined following mudfish survey
Jewell Stream	Jewell Stream	Jewell culvert	53	10080	Box	Twin 2.5 x 2	20	19.2	70	1.14	Intermittent	Stream Conveyence	Intermittent habitat for Eels and banded kokopu	High	Yes	Yes	Embedded invert, accumulation of in-situ gravels, concentrated low flow on aprons	1 - To be confirmed following mudfish survey 2 - schedule works when stream is dry or minimal water is present. 3 - avoid peak upstream migration period for banded kokopu and eels (September to March) where possible.
Cording Stream	Cavallo Drain	Cavallo culvert	59	10830	Circular	1.6Ø	11.4	11	66	0.61	Ephemeral	Stream Conveyence	None	N/A	Yes	Yes	No specific requirements but dependent on slope. Buried inverts likely sufficient.	To be determined following mudfish survey
	Cording Stream	Existing road culvert	61	10970	Circular	0.45Ø	TBC	TBC	82	TBC	Ephemeral	Stream Conveyence	None	N/A	Yes	No	No specific requirements. Buried inverts sufficient.	To be determined following mudfish survey
Awatea Stream	Awatea Stream	Awatea culvert	64	11380	Box	Twin 3 x 1.5	13.25	12.85	64	0.63	Intermittent	Stream Conveyence	Intermittent habitat for eels	High	No	Yes	Embedded invert, accumulation of in-situ gravels, concentrated low flow on aprons	1 - schedule works when stream is dry or minimal water is present. 2 - avoid peak upstream migration period for eels (December to March) where possible. 3 - minimise works period and undertake fish rescue.
Kumototo Stream	Kumototo Stream	Kumototo culvert	66	11680	Circular	Twin 1.6Ø	12.15	11.75	68	0.59	Intermittent	Stream Conveyence	Intermittent habitat for eels	High	No	Yes	Embedded invert, accumulation of in-situ gravels, spat rope through culvert	1 - schedule works when stream is dry or minimal water is present. 2 - avoid peak upstream migration period for eels (December to March) where possible. 3 - minimise works period and undertake fish rescue.

APPENDIX E: SCHEDULE OF STREAM IMPACTS

PP2O EMP Appendix D - Schedule of fish rescue works

Catchment	Stream name	Culvert description	Culvert No.	Stream classification	Culvert Use	Actual or likely fish species present	Climbing ability	Culvert Length (m)	Rip rap / other works (m)	Reclamation / diversion (m)	Total stream impact (m)	Mudfish survey required	Fish passage required	Fish Migration Management for in-stream works	Fish rescue methods	Likely works and fish rescue timing (TBC)
Waitohu Stream + floodplain	Greenwood Stream	Greenwood subcatchment	1	Intermittent	Stream Conveyence	Eels and potentially mudfish	High	25	30	0	55	Yes	Yes	1 - to be confirmed following mudfish survey. 2 - schedule works when stream is dry or minimal water is present. 3 - avoid peak upstream migration period for eels (December to March) where possible. 4 - minimise works period and undertake fish rescue.	1 - Mudfish survey to confirm presence and trapping. 2 - Fish rescue only required if works are undertaken when water is present. 3 - Methods - netting and electric fishing	From June 2018
	Unnamed tributary of Waitohu Stream	Southern approach to Waitohu Stream bridge	3	Intermittent	Flood Event	Eels and potentially mudfish	High	64	0	0	64	No	Yes	1 - schedule works when stream is dry or minimal water is present. 2 - avoid peak upstream migration period for eels (December to March) where possible. 3 - minimise works period and undertake fish rescue.	1 - Mudfish survey to confirm presence and trapping. 2 - Fish rescue only required if works are undertaken when water is present. 3 - Methods - netting and electric fishing	From June 2018
Mangapouri Stream + Wetland System	Otaki Railway Wetland	Remnant Railway wetland connection pipe	70	Wetland connection	Wetland Connection/Outlet	Eels	High	0	0	0	0	No	Yes	1 - avoid peak upstream migration period for eels (December to March) where possible. 2 - minimise works period and undertake fish rescue.	Fish rescue in reclaimed wetland area using netting techniques.	November 2017
	Otaki Railway Wetland	Remnant railway wetland culvert on connection to Kennedy Wetland	12	Wetland connection	Wetland Connection/Outlet	Eels	High	0	0	0	0	No	Yes	1 - avoid peak upstream migration period for eels (December to March) where possible. 2 - minimise works period and undertake fish rescue.	Fish rescue in reclaimed wetland area using netting techniques.	November 2017
	Kennedy Wetland	Outlet from Kennedy Wetland	13	Wetland connection	Wetland Outlet	Eels	High	0	0	0	0	No	Yes	1 - avoid peak upstream migration period for eels (December to March) where possible. 2 - minimise works period and undertake fish rescue.	Constructed wetland - no fish rescue requirements.	NA
	Mangapouri Stream	Culvert at Expressway and Realigned railway	9 & 10	Permanent	Stream Conveyence	Permanent stream habitat, only eels confirmed	High	80	10	0	90	No	Yes	1 - avoid peak upstream migration period for eels (December to March) where possible. 2 - minimise works period and undertake fish rescue.	Fish rescue to comprise netting and electric fishing techniques.	From April 2018
	Unnamed overland flow path	Rahui Rd overbridge	7	Ephemeral	Flood Event	None	N/A	37	0	0	0	No	No	No timing restrictions or specific ecology requirements	NA - ephemeral watercourse	NA
Racecourse Stream	Racecourse Stream	Combined Expressway / realigned railway	14	Intermittent	Stream Conveyence	Potentially mudfish	N/A	52	10	13	75	Yes	No	To be determined following mudfish survey	To be determined following mudfish survey	From April 2018
Otaki River + floodplain	Unnamed overland flow path	Existing SH1	15 (a-e)	Flood conveyance	Flood Event	None	N/A	0	0	0	0	No	No	No timing restrictions or specific ecology requirements	NA - flood conveyance watercourse	NA
	Unnamed overland flow path	Off-channel storage basin	18	Flood conveyance	Flood Event	None	N/A	0	0	0	0	No	No	No timing restrictions or specific ecology requirements	NA - flood conveyance watercourse	NA
Mangaone Stream	Mangaone Stream	Expressway	24	Permanent	Stream Conveyence	Diverse fish community	Low to high	46	15	35	96	No	Yes	Peak fish migration period for the species known to be present covers most of the year. Focus to be on minimising disturbance and keeping migration pathways open	Fish rescue to comprise netting and electric fishing techniques.	From February 2018
	Mangaone Stream	Local link road (Eastern side)	23	Permanent	Stream Conveyence	Diverse fish community	Low to high	21	10	55	86	No	Yes	Peak fish migration period for the species known to be present covers most of the year. Focus to be on minimising disturbance and keeping migration pathways open	Fish rescue to comprise netting and electric fishing techniques.	From February 2018
	Mangaone Stream	Local link road (Western side)	34	Permanent	Stream Conveyence	Diverse fish community	Low to high	24	29	20	73	No	Yes	Peak fish migration period for the species known to be present covers most of the year. Focus to be on minimising disturbance and keeping migration pathways open	Fish rescue to comprise netting and electric fishing techniques.	From February 2018
Mangaone overflow	Unnamed overland flow path	Local Link Road	27	Ephemeral	Flood Event	None	N/A	20	20	0	40	No	No	No timing restrictions or specific ecology requirements	NA - ephemeral watercourse	NA
	Unnamed overland flow path	Expressway	28	Ephemeral	Flood Event	None	N/A	47	21	0	68	No	No	No timing restrictions or specific ecology requirements	NA - ephemeral watercourse	NA
Gear Stream	Gear Stream	Gear culvert at Gear Rd	35	Intermittent	Stream Conveyence	Intermittent habitat, potential for mudfish	Low to high	15	17	55	87	Yes	Yes	To be determined following mudfish survey	1 - Mudfish survey to confirm presence and trapping. 2 - Fish rescue only required if works are undertaken when water is present. 3 - Methods - netting and electric fishing	From March 2018
	Gear Stream	Gear culvert at Expressway	36	Intermittent	Stream Conveyence	Intermittent habitat, potential for mudfish	Low to high	37	10	0	47	Yes	Yes	To be determined following mudfish survey	1 - Mudfish survey to confirm presence and trapping. 2 - Fish rescue only required if works are undertaken when water is present. 3 - Methods - netting and electric fishing	From March 2018
Settlement Heights	Settlement Stream	Settlement Heights	39	Intermittent	Stream Conveyence	Intermittent habitat for Eels and banded kokopu.	High	47	10	13	71	Yes	Yes	1 - To be confirmed following mudfish survey 2 - schedule works when stream is dry or minimal water is present. 3 - avoid peak upstream migration period for banded kokopu and eels (September to March) where possible.	1 - Mudfish survey to confirm presence and trapping. 2 - Fish rescue only required if works are undertaken when water is present. 3 - Methods - netting and electric fishing	From March 2018
Coolen Stream	Coolen Stream	Coolen culvert	42	Intermittent	Stream Conveyence	Intermittent habitat for eels	High	35	10	5	50	No	Yes	1 - schedule works when stream is dry or minimal water is present. 2 - avoid peak upstream migration period for eels (December to March) where possible. 3 - minimise works period and undertake fish rescue.	1 - Fish rescue only required if works are undertaken when water is present. 2 - Methods - netting and electric fishing	From March 2018
Avatar Stream	Avatar Stream	Avatar culvert	45	Intermittent / Ephemeral	Stream Conveyence	Very limited	High	52	25	0	77	No	No	No timing restrictions or specific ecology requirements	NA - Intermittent / ephemeral watercourse	From April 2018
Edwin Stream	Edwin Stream	Edwin culvert	50	Intermittent / Ephemeral	Stream Conveyence	Very limited	High	18	16	90	186	Yes	Yes	To be determined following mudfish survey	1 - Mudfish survey to confirm presence and trapping. 2 - Fish rescue only required if works are undertaken when water is present. 3 - Methods - netting and electric fishing	From April 2018
Jewell Stream	Jewell Stream	Jewell culvert	53	Intermittent	Stream Conveyence	Intermittent habitat for Eels and banded kokopu	High	70	20	50	140	Yes	Yes	1 - To be confirmed following mudfish survey 2 - schedule works when stream is dry or minimal water is present. 3 - avoid peak upstream migration period for banded kokopu and eels (September to March) where possible.	1 - Mudfish survey to confirm presence and trapping. 2 - Fish rescue only required if works are undertaken when water is present. 3 - Methods - netting and electric fishing	From April 2018
Cording Stream	Cavallo Drain	Cavallo culvert	59	Ephemeral	Stream Conveyence	None	N/A	66	14	165	245	Yes	Yes	To be determined following mudfish survey	1 - Mudfish survey to confirm presence and trapping. 2 - Fish rescue only required if works are undertaken when water is present. 3 - Methods - netting and electric fishing	From April 2018
	Cording Stream	Existing road culvert	61	Ephemeral	Stream Conveyence	None	N/A	82	5	0	87	Yes	No	To be determined following mudfish survey	NA - Ephemeral watercourse	NA
Awatea Stream	Awatea Stream	Awatea culvert	64	Intermittent	Stream Conveyence	Intermittent habitat for eels	High	64	15	0	79	No	Yes	1 - schedule works when stream is dry or minimal water is present. 2 - avoid peak upstream migration period for eels (December to March) where possible. 3 - minimise works period and undertake fish rescue.	1 - Fish rescue only required if works are undertaken when water is present. 2 - Methods - netting and electric fishing	From May 2018
Kumototo Stream	Kumototo Stream	Kumototo culvert	66	Intermittent	Stream Conveyence	Intermittent habitat for eels	High	68	12	50	130	No	Yes	1 - schedule works when stream is dry or minimal water is present. 2 - avoid peak upstream migration period for eels (December to March) where possible. 3 - minimise works period and undertake fish rescue.	1 - Fish rescue only required if works are undertaken when water is present. 2 - Methods - netting and electric fishing	From May 2018

APPENDIX F: FISH RESCUE SCHEDULE

PP2O EMP Appendix D - Schedule of fish rescue works

Catchment	Stream name	Culvert description	Culvert No.	Stream classification	Culvert Use	Actual or likely fish species present	Climbing ability	Culvert Length (m)	Rip rap / other works (m)	Reclamation / diversion (m)	Total stream impact (m)	Mudfish survey required	Fish passage required	Fish Migration Management for in-stream works	Fish rescue methods	Likely works and fish rescue timing (TBC)
Waitohu Stream + floodplain	Greenwood Stream	Greenwood subcatchment	1	Intermittent	Stream Conveyence	Eels and potentially mudfish	High	25	30	0	55	Yes	Yes	1 - to be confirmed following mudfish survey. 2 - schedule works when stream is dry or minimal water is present. 3 - avoid peak upstream migration period for eels (December to March) where possible. 4 - minimise works period and undertake fish rescue.	1 - Mudfish survey to confirm presence and trapping. 2 - Fish rescue only required if works are undertaken when water is present. 3 - Methods - netting and electric fishing	From June 2018
	Unnamed tributary of Waitohu Stream	Southern approach to Waitohu Stream bridge	3	Intermittent	Flood Event	Eels and potentially mudfish	High	64	0	0	64	No	Yes	1 - schedule works when stream is dry or minimal water is present. 2 - avoid peak upstream migration period for eels (December to March) where possible. 3 - minimise works period and undertake fish rescue.	1 - Mudfish survey to confirm presence and trapping. 2 - Fish rescue only required if works are undertaken when water is present. 3 - Methods - netting and electric fishing	From June 2018
Mangapouri Stream + Wetland System	Otaki Railway Wetland	Remnant Railway wetland connection pipe	70	Wetland connection	Wetland Connection/Outlet	Eels	High	0	0	0	0	No	Yes	1 - avoid peak upstream migration period for eels (December to March) where possible. 2 - minimise works period and undertake fish rescue.	Fish rescue in reclaimed wetland area using netting techniques.	November 2017
	Otaki Railway Wetland	Remnant railway wetland culvert on connection to Kennedy Wetland	12	Wetland connection	Wetland Connection/Outlet	Eels	High	0	0	0	0	No	Yes	1 - avoid peak upstream migration period for eels (December to March) where possible. 2 - minimise works period and undertake fish rescue.	Fish rescue in reclaimed wetland area using netting techniques.	November 2017
	Kennedy Wetland	Outlet from Kennedy Wetland	13	Wetland connection	Wetland Outlet	Eels	High	0	0	0	0	No	Yes	1 - avoid peak upstream migration period for eels (December to March) where possible. 2 - minimise works period and undertake fish rescue.	Constructed wetland - no fish rescue requirements.	NA
	Mangapouri Stream	Culvert at Expressway and Realigned railway	9 & 10	Permanent	Stream Conveyence	Permanent stream habitat, only eels confirmed	High	80	10	0	90	No	Yes	1 - avoid peak upstream migration period for eels (December to March) where possible. 2 - minimise works period and undertake fish rescue.	Fish rescue to comprise netting and electric fishing techniques.	From April 2018
	Unnamed overland flow path	Rahui Rd overbridge	7	Ephemeral	Flood Event	None	N/A	37	0	0	0	No	No	No timing restrictions or specific ecology requirements	NA - ephemeral watercourse	NA
Racecourse Stream	Racecourse Stream	Combined Expressway / realigned railway	14	Intermittent	Stream Conveyence	Potentially mudfish	N/A	52	10	13	75	Yes	No	To be determined following mudfish survey	To be determined following mudfish survey	From April 2018
Otaki River + floodplain	Unnamed overland flow path	Existing SH1	15 (a-e)	Flood conveyance	Flood Event	None	N/A	0	0	0	0	No	No	No timing restrictions or specific ecology requirements	NA - flood conveyance watercourse	NA
	Unnamed overland flow path	Off-channel storage basin	18	Flood conveyance	Flood Event	None	N/A	0	0	0	0	No	No	No timing restrictions or specific ecology requirements	NA - flood conveyance watercourse	NA
Mangaone Stream	Mangaone Stream	Expressway	24	Permanent	Stream Conveyence	Diverse fish community	Low to high	46	15	35	96	No	Yes	Peak fish migration period for the species known to be present covers most of the year. Focus to be on minimising disturbance and keeping migration pathways open	Fish rescue to comprise netting and electric fishing techniques.	From February 2018
	Mangaone Stream	Local link road (Eastern side)	23	Permanent	Stream Conveyence	Diverse fish community	Low to high	21	10	55	86	No	Yes	Peak fish migration period for the species known to be present covers most of the year. Focus to be on minimising disturbance and keeping migration pathways open	Fish rescue to comprise netting and electric fishing techniques.	From February 2018
	Mangaone Stream	Local link road (Western side)	34	Permanent	Stream Conveyence	Diverse fish community	Low to high	24	29	20	73	No	Yes	Peak fish migration period for the species known to be present covers most of the year. Focus to be on minimising disturbance and keeping migration pathways open	Fish rescue to comprise netting and electric fishing techniques.	From February 2018
Mangaone overflow	Unnamed overland flow path	Local Link Road	27	Ephemeral	Flood Event	None	N/A	20	20	0	40	No	No	No timing restrictions or specific ecology requirements	NA - ephemeral watercourse	NA
	Unnamed overland flow path	Expressway	28	Ephemeral	Flood Event	None	N/A	47	21	0	68	No	No	No timing restrictions or specific ecology requirements	NA - ephemeral watercourse	NA
Gear Stream	Gear Stream	Gear culvert at Gear Rd	35	Intermittent	Stream Conveyence	Intermittent habitat, potential for mudfish	Low to high	15	17	55	87	Yes	Yes	To be determined following mudfish survey	1 - Mudfish survey to confirm presence and trapping. 2 - Fish rescue only required if works are undertaken when water is present. 3 - Methods - netting and electric fishing	From March 2018
	Gear Stream	Gear culvert at Expressway	36	Intermittent	Stream Conveyence	Intermittent habitat, potential for mudfish	Low to high	37	10	0	47	Yes	Yes	To be determined following mudfish survey	1 - Mudfish survey to confirm presence and trapping. 2 - Fish rescue only required if works are undertaken when water is present. 3 - Methods - netting and electric fishing	From March 2018
Settlement Heights	Settlement Stream	Settlement Heights	39	Intermittent	Stream Conveyence	Intermittent habitat for Eels and banded kokopu.	High	47	10	13	71	Yes	Yes	1 - To be confirmed following mudfish survey 2 - schedule works when stream is dry or minimal water is present. 3 - avoid peak upstream migration period for banded kokopu and eels (September to March) where possible.	1 - Mudfish survey to confirm presence and trapping. 2 - Fish rescue only required if works are undertaken when water is present. 3 - Methods - netting and electric fishing	From March 2018
Coolen Stream	Coolen Stream	Coolen culvert	42	Intermittent	Stream Conveyence	Intermittent habitat for eels	High	35	10	5	50	No	Yes	1 - schedule works when stream is dry or minimal water is present. 2 - avoid peak upstream migration period for eels (December to March) where possible. 3 - minimise works period and undertake fish rescue.	1 - Fish rescue only required if works are undertaken when water is present. 2 - Methods - netting and electric fishing	From March 2018
Avatar Stream	Avatar Stream	Avatar culvert	45	Intermittent / Ephemeral	Stream Conveyence	Very limited	High	52	25	0	77	No	No	No timing restrictions or specific ecology requirements	NA - Intermittent / ephemeral watercourse	From April 2018
Edwin Stream	Edwin Stream	Edwin culvert	50	Intermittent / Ephemeral	Stream Conveyence	Very limited	High	18	16	90	186	Yes	Yes	To be determined following mudfish survey	1 - Mudfish survey to confirm presence and trapping. 2 - Fish rescue only required if works are undertaken when water is present. 3 - Methods - netting and electric fishing	From April 2018
Jewell Stream	Jewell Stream	Jewell culvert	53	Intermittent	Stream Conveyence	Intermittent habitat for Eels and banded kokopu	High	70	20	50	140	Yes	Yes	1 - To be confirmed following mudfish survey 2 - schedule works when stream is dry or minimal water is present. 3 - avoid peak upstream migration period for banded kokopu and eels (September to March) where possible.	1 - Mudfish survey to confirm presence and trapping. 2 - Fish rescue only required if works are undertaken when water is present. 3 - Methods - netting and electric fishing	From April 2018
Cording Stream	Cavallo Drain	Cavallo culvert	59	Ephemeral	Stream Conveyence	None	N/A	66	14	165	245	Yes	Yes	To be determined following mudfish survey	1 - Mudfish survey to confirm presence and trapping. 2 - Fish rescue only required if works are undertaken when water is present. 3 - Methods - netting and electric fishing	From April 2018
	Cording Stream	Existing road culvert	61	Ephemeral	Stream Conveyence	None	N/A	82	5	0	87	Yes	No	To be determined following mudfish survey	NA - Ephemeral watercourse	NA
Awatea Stream	Awatea Stream	Awatea culvert	64	Intermittent	Stream Conveyence	Intermittent habitat for eels	High	64	15	0	79	No	Yes	1 - schedule works when stream is dry or minimal water is present. 2 - avoid peak upstream migration period for eels (December to March) where possible. 3 - minimise works period and undertake fish rescue.	1 - Fish rescue only required if works are undertaken when water is present. 2 - Methods - netting and electric fishing	From May 2018
Kumototo Stream	Kumototo Stream	Kumototo culvert	66	Intermittent	Stream Conveyence	Intermittent habitat for eels	High	68	12	50	130	No	Yes	1 - schedule works when stream is dry or minimal water is present. 2 - avoid peak upstream migration period for eels (December to March) where possible. 3 - minimise works period and undertake fish rescue.	1 - Fish rescue only required if works are undertaken when water is present. 2 - Methods - netting and electric fishing	From May 2018

APPENDIX G: ECOLOGICAL ACCOUNTING FOR STREAM LOSS

PP2O EMP Appendix E - Ecological accounting for stream loss

Catchment	Stream name	Culvert name	Culvert No.	BOI Value	BOI Design total loss/effects (m)	BOI Comp Ratio	BOI Mitigation (m)	Construction Design total loss (m)	Difference in lineal metre	Construction Mitigation requirement (m)
Waitohu Stream + floodplain	Greenwood Stream	Greenwood subcatchment	1	Low	55	0.7	38.5	86	31	60
	Unnamed tributary of Waitohu Stream	Southern approach to Waitohu Stream bridge	3	Low	60	0.7	42	64	4	45
Mangapouri Stream	Mangapouri Stream	Culvert for the expressway and the railway	9 & 10	Moderate	160	1.5	240	90	-70	135
Racecourse Stream	Racecourse Stream	Combined Expressway / realigned railway	14	Low	220	0.7	154	75	-145	53
Mangaone Stream	Mangaone Stream	Expressway	24	High	80	2	160	96	16	192
	Mangaone Stream	Local link road (Eastern side)	23	High	35	2	70	86	51	172
	Mangaone Stream	Local link road (Western side)	34	High	0	2	0	73	73	146
Mangaone overflow	Unnamed Tributary	Local Link Road	27	High	16	2	32	40	24	80
	Unnamed Tributary	Expressway	28	High	50	2	100	68	18	136
School Road	School Road Drain	School Road culvert	-	Low	520	0.7	364	250	-270	175
Gear Rd	Gear Stream	Gear culvert at Gear Rd	35	Low	150	0.7	105	87	-63	61
	Gear Stream	Gear culvert at Expressway	36	Low	90	0.7	63	47	-43	33
Settlement Heights	Settlement Stream	Settlement Heights	39	Moderate	170	1.5	255	71	-99	107
Coolen Stream	Coolen Stream	Coolen culvert	42	Low	44	0.7	30.8	50	6	35
Avatar Stream	Avatar Stream	Avatar culvert	45	Low	64	0.7	44.8	77	13	54
Jewell Stream	Edwin Stream	Edwin culvert	50	Low	200	0.7	140	186	-14	130
	Jewell Stream	Jewell culvert	53	Moderate	140	1.5	210	140	0	210
Cording Stream	Cavallo Drain	Cavallo culvert	59	Low	320	0.7	224	245	-75	172
	Cording Stream	Cording culvert	61	Low	75	0.7	52.5	87	12	61
Awatea Stream	Awatea Stream	Awatea culvert	64	Low	90	0.7	63	79	-11	55
Kumototo Stream	Kumototo Stream	Kumototo culvert	66	Moderate	115	1.5	172.5	80	-35	120
				Totals	2654		2561	2077	-577	2231