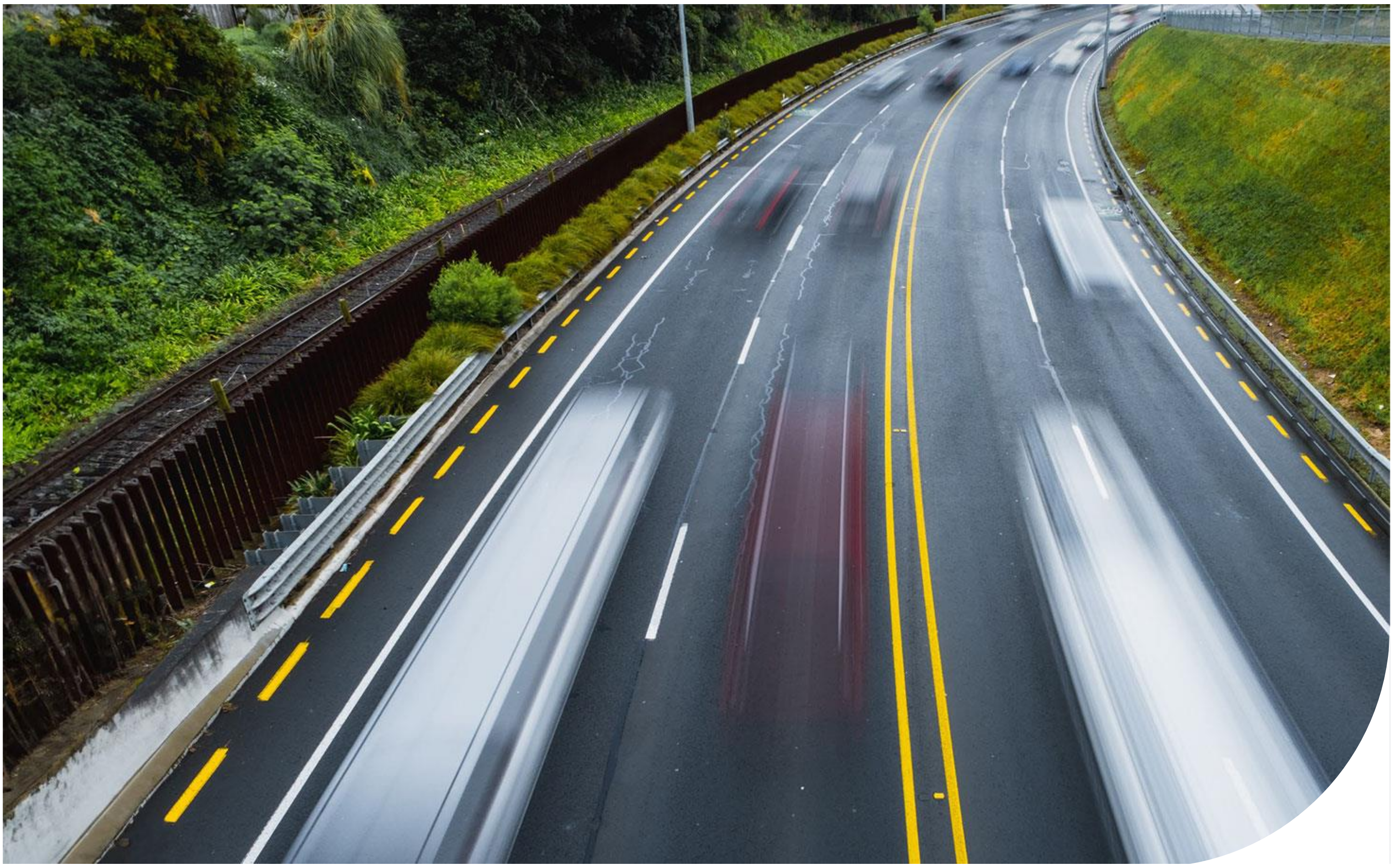

Construction Water Assessment

Alternative to the Brynderwyn Hills – Brynderwyn Hills Section

2 April 2026

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10722-PTA-2B0-PE-RPT-0016

NZ TRANSPORT AGENCY WAKA KOTAHI

Roads of National Significance

Te Kāwanatanga o Aotearoa
New Zealand Government

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Glossary of Acronyms and Abbreviations

The glossary of acronyms and abbreviations tables in Volume A and B of the Substantive Application apply to this Report and should be referred to in addition to the acronyms and abbreviations below.

Abbreviation / Acronym	Term
CESCP	Construction Erosion and Sediment Control Plan
CTMP	Chemical Treatment Management Plan
CIP	Continuous Improvement Programme
CWA	Construction Water Assessment
CWD	Clean Water Diversion
DEB	Decanting Earth Bund
DWD	Dirty Water Diversion
ESC	Erosion and Sediment Control
ESCP	Erosion and Sediment Control Plan
GD05	Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region; June 2016; Guideline Document 2016/005
GLEAMS	Groundwater Loading Effects of Agricultural Management Systems
NTU	Nephelometric Turbidity Unit for measuring turbidity
PAC	Poly Aluminium Chloride
SRP	Sediment Retention Pond
SSF	Super Silt Fence
TSS	Total Suspended Solids

Glossary of Defined Terms

The glossary of defined terms table in Volumes A and B of the Substantive Application apply to this Report and should be referred to in addition to the defined terms below.

Term	Meaning
Construction Water	Water discharges, both surface and groundwater, that result from all construction activities including sediment laden runoff from earthworks.
Earthworks	The disturbance of land surfaces by blading, contouring, ripping, moving, removing, placing or replacing soil or earth, or by excavation, or by cutting or filling operations
Erosion Control	Methods to prevent or minimise the erosion of soil, in order to minimise the adverse effects that land disturbing activities may have on a receiving environment
Flocculation	The process whereby fine particles suspended in the water column clump together and settle. In some instances, this can occur naturally, such as when fresh clay-laden flows mix with saline water, as occurs in estuaries. Flocculation can be used to promote rapid settling in sediment retention ponds by the addition of flocculating chemicals (flocculants).
Rolled Erosion Control Products	Rolled Erosion Control Products are manufactured mats or blankets, typically made from natural or synthetic materials, that are rolled out over soil surfaces to prevent erosion, stabilise slopes, and promote vegetation growth by protecting the soil from wind and water forces.
Sediment Control	Capturing sediment that has been eroded and entrained in overland flow before it enters the receiving environment
Sediment Generation	That sediment that is generated on the site of earthwork activity prior to treatment through any sediment retention device
Sediment Retention Pond	A detention structure that is used during the construction phase of earthworks activity to treat any sediment laden runoff and retain sediment.
Sediment Yield	That sediment which leaves the sediment retention devices and enters the receiving environment.
Stabilisation	The covering or the establishment of vegetation on exposed bare earth (e.g. application of mulch, covering with geotextile material, topsoil and seeding or hydro-seeding). If vegetation is utilised to achieve stabilisation a minimum 80% grass cover must be established

1. Introduction

1.1 Purpose and scope of this report

This Construction Water Assessment (CWA) provides an assessment of potential construction water effects that have the potential to occur following implementation of suggested methods for erosion and Sediment Control (ESC) during construction of the Brynderwyn Hills section of the Alternative to the Brynderwyn Hills project (the Project).

This assessment forms part of a suite of technical assessments prepared for the New Zealand Transport Agency (NZTA) to inform the Substantive Application for the Project under the Fast-track Approvals Act 2024 (FTAA). This CWA should be read in conjunction with Volume A of the Substantive Application.

The scope of this assessment includes:

- A description and understanding of the receiving environment as relevant to the assessment;
- Identification of the construction-related water management issues for the Project;
- Identification of the construction water management principles for the Project;
- Development of construction water management methodologies for key construction activities including identification and recommendation of ESC design principles, methods, practices, and standards to be implemented and complied with as far as practicable during construction;
- Investigation and assessment of the potential sediment yields and sediment yield determining factors;
- Assessment of the environmental risks associated with sediment yields; and
- Methods and practices to be implemented to minimise environmental effects and identification of monitoring procedures.

This CWA confirms:

- I consider that the locations of the sites I have visited and analysed are generally representative of all areas within the Indicative Alignment; and
- The assessment identifies the full extent of measures that may be necessary to manage the impacts of construction water, with the specific measures to be implemented subject to determination at the time of detailed design.

1.2 Qualifications and Experience

My name is Graeme Ridley. I am an ESC expert and the Director of Ridley Dunphy Environmental Limited, an environmental consultancy that specialises in ESC for infrastructure projects.

I have over 30 years' experience in ESC, stormwater management, construction related environmental management, resource consents and compliance, and senior management in local government. As a Certified Professional in Erosion and Sediment Control (Envirocert International) and a Registered Practitioner in Erosion and Sediment Control (Soil Science Australia) my specialist area is focused on construction water management looking at all aspects of construction discharges. I have provided specific technical advice on construction water management on many significant projects while also understanding the complexities and context of other disciplines to ensure consistency in approach and an overall better environmental outcome.

My experience relevant to road corridor projects and this Project includes:

- Acting as the construction water expert for the Warkworth to Wellsford proposed motorway project (12M m^3 of earthworks) including technical work package and consent documentation on behalf of the applicant.

- Provision of specialist ESC advice for the Mount Messenger Alliance project. Development of associated documents for both the multi criteria analysis process and assessment of effects and expert evidence at hearing.
- Provision of construction water management advice and input into the earthquake recovery programme and works for Kaikoura. Specific plan development and site-specific advice and audits.
- Provision of specialist construction water management advice for Auckland's Northern Corridor Improvements project. Development of associated documents for assessment of effects and expert evidence as required for applicant.
- Technical expert role for the Further North Alliance for the Puhoi to Warkworth Motorway project (8M m^3 of earthworks) for the purpose of obtaining consents and the Board of Inquiry process.
- Primary expert for NZTA for the MacKay's to Pekapeka expressway project associated with ESC and general construction related environmental management. Provision of technical reports and BOI process.
- Primary expert for NZTA for the Western Ring Route Waterview motorway project associated with ESC. Provision of technical reports and expert witness.
- Part of wider environmental team preparing resource consent applications for NZTA Waterview Tunnel and Western Ring Route project, Auckland, including preparation of plans, documentation and attending consultation and liaison meetings.

My knowledge of the soils, environmental conditions and the ESC risks and solutions for the Project allows for a focused assessment of associated effects and management measures that can be implemented.

1.3 Code of Conduct

Although this matter is not before the Environment Court, I confirm that I have read the Code of Conduct for expert witnesses as contained in section 9 of the Environment Court Practice Note 2023. As the primary author I agree to comply with that Code. My qualifications as an expert are set out above. I am satisfied that the matters which I address in this CWA are within my area of expertise, except where I state that I am relying on information provided by another person or expert. I have not omitted to consider material facts known to myself that might alter or detract from the opinions I express.

2. Project Description

The Project is described in detail in Volume A, Section C4 of the Substantive Application. A description of the Project works relating to earthworks is provided below.

2.1 Earthworks

The Project is divided into four specific Earthworks Zones with these illustrated below:

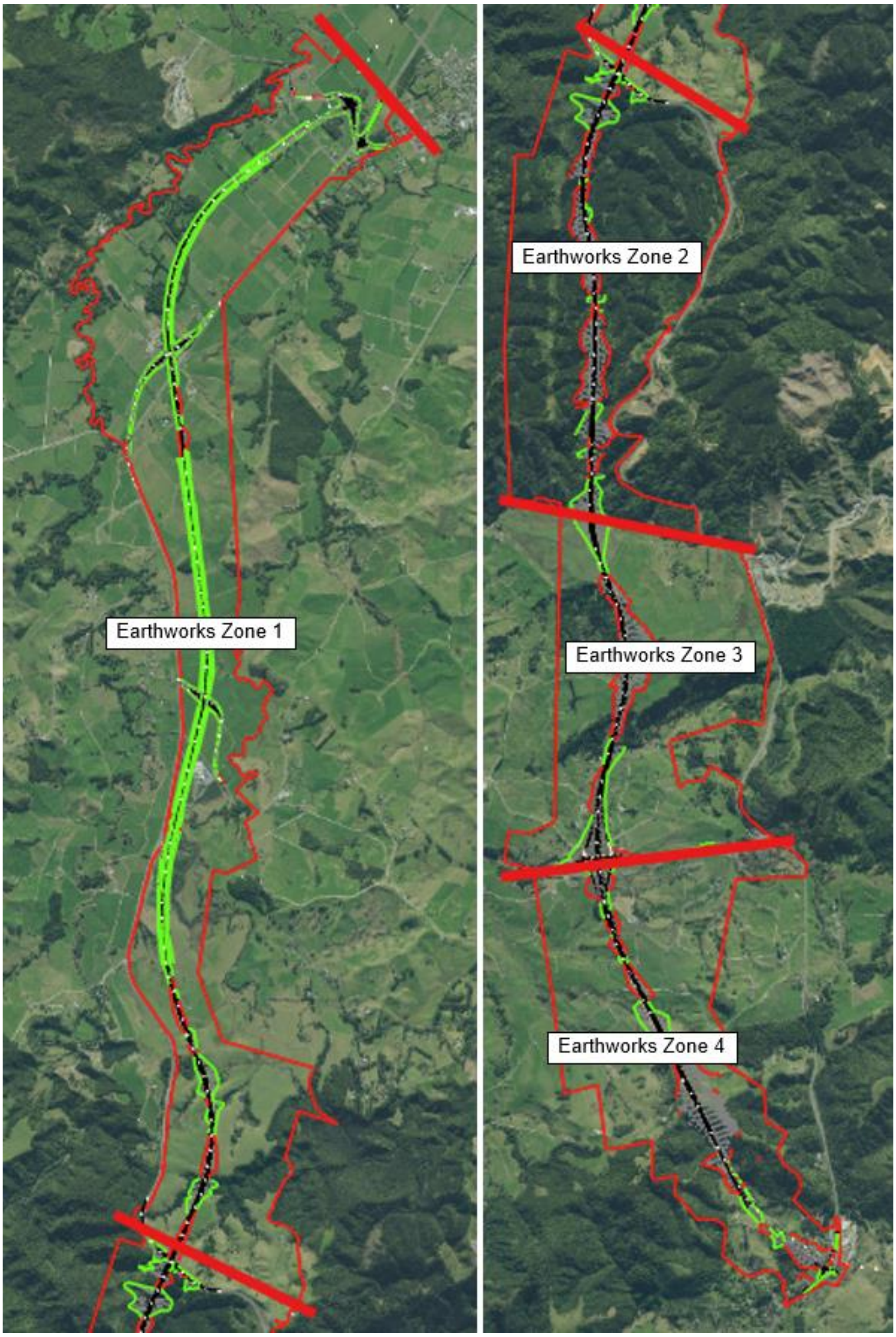

Figure 1: Project Earthworks Zones

The Project earthworks relate to:

- Bulk earthworks, general cut to fill and cut to waste earthworks including spoil sites;
- Services installation, general trenching activities and the installation of permanent stormwater treatment devices;
- Stream work activities; and
- Bridge construction including any associated retaining wall and abutment excavations associated with the new bridge structures.

Earthworks (including cut and fill and spoil) for the Project total approximately 299.2 ha.

In the context of earthworks and ESC the following Project parameters apply:

Table 1:Earthworks Areas across Earthworks Zones

Zone	Cut/Fill Earthworks (ha)	Spoil (ha)
Zone 1	62.4	11.4
Zone 2	50.1	20.8
Zone 3	37.3	25.2
Zone 4	40	52.0
Totals	189.80	109.40

It is expected that the Project bulk earthworks will be completed over a 4-year programme.

2.2 Stream works

Construction of the Project will require the installation of a number of culverts to convey various watercourses and existing drainage channels through the alignment along with permanent diversions of sections of stream channel.

Stream diversions will be required during the construction of the Project to divert flows on a temporary basis, to allow construction works to progress or provide access to an area.

Stream diversions are also required on a permanent basis to divert streams around or through a permanent feature of the Project such as embankments and spoil sites.

3. Existing Environment

The existing environment for the Project was confirmed through the following:

- Desk based analysis of the water environment including a review of online topographical, rainfall, hydrological, flood and geological mapping and information.
- Site inspections by the Project team including walkovers of some areas of earthworks and stream works within the Proposed Designation.

3.1 Earthwork zones

The earthwork zones can generally be described as below.

- Zone 1 (Northern Lowlands)

Alluvial floodplains and rolling foothills north of Brynderwyn Range to Waipu. Predominantly Late Pleistocene river deposits comprising poorly consolidated mud, sand, gravel and peat deposits of alluvial, swamp and estuarine origins. This zone also has some smaller areas of Undifferentiated Mangakahia Complex in Northland Allochthon and Ruarangi Formation of Bream Subgroup (Waitemata Group), both of which have sandstone and mudstone characteristics.

This zone is predominately in pastural land use.

- Zone 2 (Brynderwyn Hills)

Steep hill country with high elevation and deep gullies. Predominantly Waipapa Group sandstone and siltstone (Waipapa Composite Terrane) comprising massive to thin bedded, lithic volcaniclastic metasandstone and argillite, with tectonically enclosed basalt, chert and siliceous argillite.

This zone contains significant exotic forestry plantations which will be harvested prior to the Project implementation.

- Zone 3 (Brynderwyn Hills to SH12)

Southern Side of Brynderwyn Range (fault) and rolling foothills extending south and west. This zone contains the Northland Allochthon and Pakiri Formation of Warkworth Subgroup (Waitemata Group). This zone is predominantly in pastural land use.

- Zone 4 (SH12 to Pukekaroro)

Foothills and alluvial floodplains, however this zone is steeper than Zone 1. This zone contains the Northland Allochthon and Pakiri Formation of Warkworth Subgroup (Waitemata Group), Taurikura Subgroup dacite (Coromandel Group) is also present. This zone is predominantly in pastural land use with pockets of native forest.

I have determined that, from an ESC perspective, the Project can be classified into two distinct types of terrain:

- Flat Country – Northern Lowlands (CH 9200 to CH 17700); and
- Hill Country – the Brynderwyn Hills south to Pukekaroro. Zone 4 from SH12 interchange to north of Pukekaroro is comprised of rolling topography, but for the purpose of assessment is still classified as hill country (CH 17700 to CH 26200).

3.2 Rainfall

Table 2 below illustrates the rainfall for the previous 3-year period versus the historic average across a set of representative rain gauges in the area. This confirms that there is an expectation of approximately 1400 mm per year across the Project footprint, however there are periods when more significant rain can occur, as was evidenced in 2023. In addition, the winter period is also recognised as a time of the year when higher rainfall can occur while in the summer period, cyclonic rain events can occur and significantly increase rainfall intensities during the construction season.

Table 2: Rainfall from representative rainfall gauges, Historic vs 2023-2025

Project Earthworks Zone[1]	Historic Mean Annual Rainfall (at 2003)	2023	2024	2025
Zone 1	1341	2180	1186	2181
Zone 2	1384	2342	1169	1452
Zone 3	1440	No Data	No Data	1394
Zone 4	1440	2565	1303	1553

3.3 Freshwater ecology

The Assessment of Effects on Terrestrial Ecology (Appendix D6 of Volume B) and the Assessment of Effects on Freshwater Ecology (Appendix D7 of Volume B) have been prepared and provide further details of the existing freshwater and terrestrial environments, as summarised below.

There are a range of monitoring reports and studies that record measures of water quality, fish presence, macroinvertebrate presence and factors affecting their condition and diversity. One study (John Ballinger, 2012) researched water quality in the Waipū catchment (including the Ahuroa and Waihoihoi stream catchments), sampling and analysing the physical and chemical properties of waters across 10 locations.

The Assessment of Effects on Freshwater Ecology (Appendix D7 of Volume B) shows that the Waipū catchment is heavily impacted by land use, and at that time, failed to meet the majority of relevant water quality guidelines. Total Nitrogen, phosphorus and *E.coli* levels were constantly above recommended levels. Dissolved oxygen was often below recommended guidelines (noting diurnal fluctuations). These results were similar to other highly modified catchments in Northland (including Awanui, Mangere and Mangonui), illustrating general acceptance of the theory that land use and modified natural settings have resulted in universally poor water quality.

Overall, water quality at all sample sites was generally poor. However, upstream sites (in hill country above the general farmland, such as in the Brynderwyn Hills native forest areas) were slightly better than downstream sites. Overall, there was little difference between rivers due to the similar land use ratios, with small amounts of indigenous/plantation forestry in catchments dominated by intensive pastoral farming. Although there are consents to discharge sewage to land, the Assessment of Effects on Freshwater Ecology (Appendix D7 of Volume B) considers that the majority of pollutants are related to pastoral farming (as supported by microbial source tracking).

Overall, it is clear from the studies and data available that water quality is poor in these catchments, and instream habitat is adversely affected by water quality everywhere except for the upper Pukekaroro tributary and native tributaries of the Piroa Stream. All other tributaries suffer from farm related run off issues, or sediment issues from periodic pine forest harvests.

The wider catchment areas within which the Project is located are illustrated in Figure 2 below.

[1] Representative Rain Stations – Northland Regional Council. Water Quantity and Flows – '02/'03 Northland Regional Council Annual Environmental Monitoring Report – 2003 and https://www.nrc.govt.nz/environment/environmental-data/environmental-data-hub/?moduleId=1

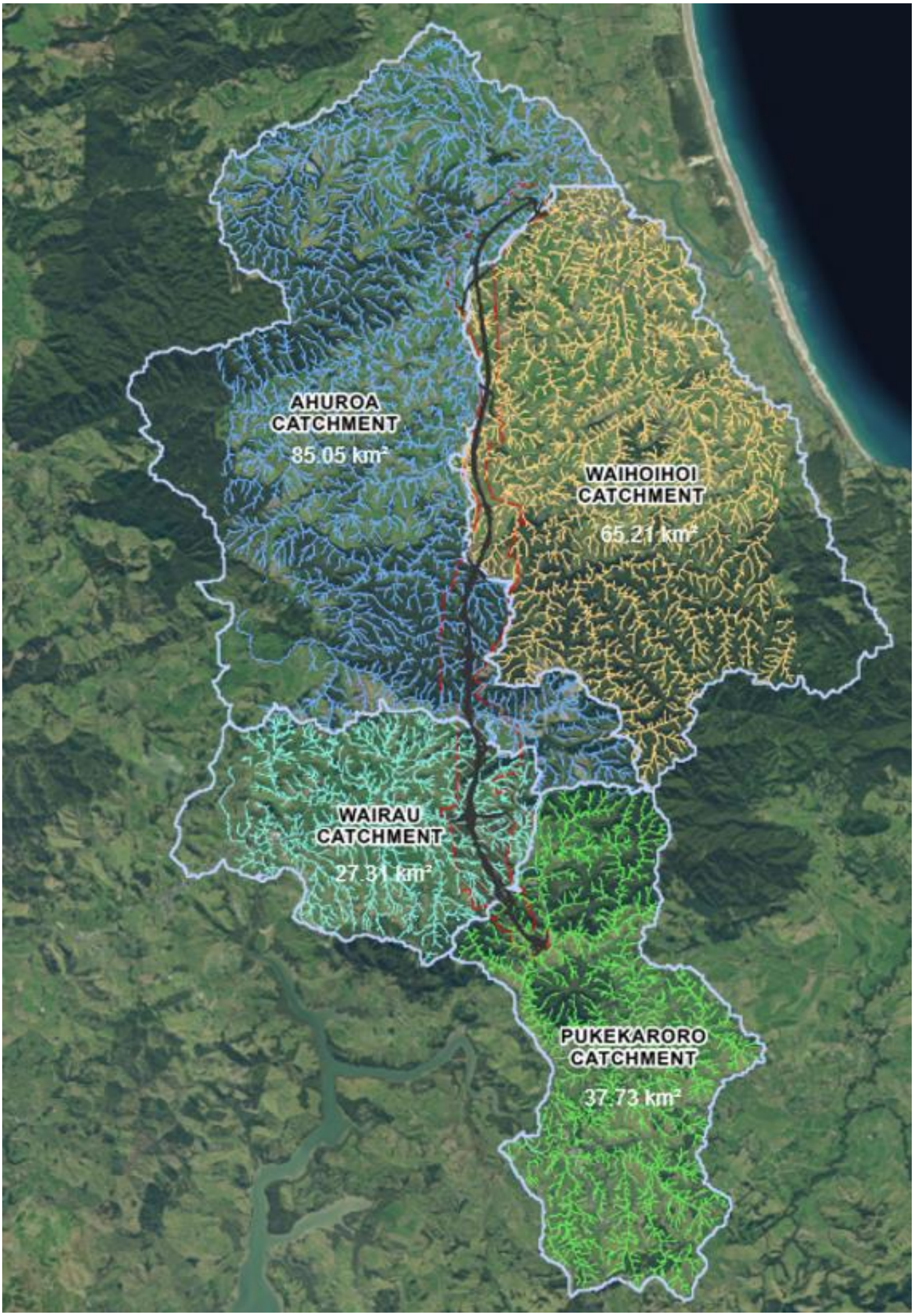

Figure 2: Project Catchments and Indicative Alignment

4. Approach to Erosion and Sediment Control

4.1 Overview of erosion and Sediment Control concepts

In the context of Construction Water Management, **Erosion Control** is based on the practical prevention of sediment generation in the first instance. I have recommended effective Erosion Control measures and practices that will minimise sediment generation, reducing the reliance on Sediment Control measures.

Sediment Control refers to management of the sediment after it has been generated. It is inevitable that some sediment will be generated through land disturbance activities even with best practice Erosion Control measures in place. I have recommended Sediment Control measures designed to capture this sediment and minimise any resultant sediment-laden discharges to waterways.

The physical ESC measures and site management practices I have recommended should be used in combination to minimise the effects of earthworks on the receiving environment. The following hierarchy and priority order will be implemented as follows:

- **Prevention:** Excluding clean water runoff from entering the active work areas, therefore preventing clean water runoff from combining with excavated spoil and/or construction material. This will require the use of clean water diversion (CWD) channels and/or bunds to divert runoff from the upstream side of the work area.
- **Capture:** Any sediment laden runoff generated within the working area will be captured through the use of dirty water diversion (DWD) channels and/or bunds on the downstream side of the construction site which will direct sediment-laden runoff from the site to an appropriate Sediment Control device. Sediment capture will be implemented through one or more Sediment Control measures.
- **Minimisation:** Limiting the length of time and the extent of the area of exposed/disturbed soil to reduce the potential to generate erosion. Timely stabilisation of exposed areas and the construction of impermeable areas will also reduce the potential for erosion to occur.
- **Staging and Sequencing of Works:** Construction activity will be carried out in stages and works within those stages sequenced to manage erosion and sedimentation. Exposed areas will be progressively stabilised as appropriate as the works progress.

It is recognised that in larger rain events, and in high intensity rain events, that the effectiveness of the Sediment Control systems will likely be reduced with higher sediment yields occurring. During these same high intensity periods, the background sediment concentrations and yields will also be higher. The receiving environment associated with the Project area includes a range of freshwater systems with varying ecological values. ESC measures and practices implemented during the construction phase recognise these values and manage the discharge of sediment accordingly however it is important to recognise that irrespective of the values, that best practice ESC measures will be implemented. Through the development of Construction Erosion and Sediment Control Plans (CESCPs), risk identification and planning will address the specific values of the receiving environment at each section of work.

As detailed above, the primary focus for ESC measures is management of sediment generation at source though Erosion Controls. This source control will mean that less sediment laden runoff will need to be intercepted, treated and discharged from the Sediment Control measures. In addition to the ESC structural practices, which include physical measures such as sediment retention ponds (SRP), the Project will also use a series of 'non-structural practices'. Non-structural practices focus on the various site management practices such as staging and sequencing of construction works and providing an appropriate level of resourcing for environmental management and monitoring. These non-structural measures are critical in avoiding significant environmental effects. Examples of structural (physical controls) and non-structural (site management practices) measures include:

Structural Examples

- ESC device installation;

- SRP Baffles;
- SRP decant pulleys; and
- Rainfall activated chemical treatment devices.

Non-Structural Examples

- Avoidance of wet weather periods for high-risk activities;
- Resourcing activities with appropriate skilled and adequate numbers of resources;
- Pre, during and post-rain inspections;
- Implementation of a continuous improvement monitoring programme;
- Staging and sequencing of earthworks;
- Methodologies that consider and address environmental risk; and
- As part of the CESCPs process, the selection of all discharge locations (and the timing) to the receiving environment to ensure sensitive areas and times are avoided where practicable.

The key, and essential, element of successful ESC implementation is that non-structural measures are robust, are given priority and continue to be reviewed through the Project implementation.

4.2 Erosion and Sediment Control principles

It is essential that ESC measures and practices implemented during the construction phase of the Project recognise the values of the receiving environments and manage the discharge of sediment accordingly. This will be achieved through the recognition and adherence to the key ESC principles as set out below which will apply to all earthworks associated with the Project. These principles will also be further detailed and designed within site specific CESCPs. The implementation of site specific CESCPs will allow for further innovation, flexibility and practicality of approach to construction-related water management and in doing so will allow the construction of the Project to continually adapt to changing construction and climatic conditions.

1. Construction water management measures will be outlined in detail in the CESCPs. All ESCs will, where practicable, meet the minimum criteria as detailed in this CWA and will incorporate innovative ideas and procedures to ensure best practice applies and matches the local challenges and opportunities.
2. All ESCs will, where practicable, meet the minimum criteria of Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region; June 2016; Guideline Document 2016/005 (GD05) and will incorporate innovative ideas and procedures to match the local challenges and opportunities.
3. The development of CESCPs, in accordance with the direction and principles of this CWA, will allow for future innovation, flexibility and practicality of approach to ESC and shall allow the ability to adapt appropriately to changing conditions.
4. A register of control measures will be kept at all times with ‘As Built’ information on key controls such as CWDs, DWDs, Decanting Earth Bunds (DEBs), and SRPs available to allow for quick and efficient referencing, identification and understanding of function and location of the various ESC measures installed onsite.
5. All ESC devices will be constructed and maintained in a structurally sound condition and will have appropriate geotechnical approval of location at construction;
6. Progressive and rapid stabilisation of disturbed areas using mulch, hydromulch, aggregate and geotextiles will be on-going during the construction phase. Stabilisation of clean water diversion bunds will also occur using turfing from adjacent grass areas and layering this on exposed soil surfaces. If other stabilisation alternatives such as polymer/soil binder products or natural fibre based Rolled Erosion Control Products are applied, they will need to be verified as a stabilisation media, demonstrated to have no residual impacts and will need to be trialled on site to demonstrate appropriateness prior to use. Temporary stabilisation will apply particularly with respect to stockpiles,

access track batters, ground improvement locations where topsoil is removed and concentrated flow paths. Stabilisation will need to be appropriate to the soil surface geology with the intent of achieving an 80% vegetative cover or non-erodible surface over the entire exposed area of earthworked areas. Stabilisation is designed for both Erosion Control and dust minimisation and will be progressively implemented, including temporary stabilisation of those areas, or sub areas, of earthworks not subject to daily operating earthworks activity for more than a 14-day period.

7. All SRPs and DEBs will be fitted with floating decants with a mechanism to control (or cease) outflow during dewatering pumping activities to these structures if required. Pumping will be such that pump volumes will only be to the same level as that able to be fully captured within the retention structure and discharged out the designed decant structure. Pumping will often occur during dry periods and as such the chemical treatment systems will not be activated automatically. Manually raising the decants (or utilising gate valves on the outlets from such devices) will ensure there is no discharge from the SRPs or DEBs and will assist with increasing sediment capture during dry weather periods. Permit to pump systems may be incorporated into the CESCPs to capture and monitor these pumping activities.
8. All Project SRPs and DEBs (as identified in the CESCPs) will be chemically treated with coagulants/flocculants appropriate for the soil type and discharge location unless the CESCPs for that location confirms that there are no benefits from such use.
9. Stream works will be undertaken in a manner that recognises the higher risk of this activity, from a sediment generation and discharge perspective, and the sensitivity of the receiving environments. Where practical, works within active stream channels, and any associated works within streams will be undertaken in a “dry” environment. This will be based upon diversion of flows around the area of works or undertaking construction “off–line”. Consideration will also be given to downstream water users (if any), peak fish spawning and fish migration periods (if relevant), during which time instream works will be carefully managed.
10. A monitoring and management approach which allows continuous improvement in response to monitoring outcomes will be utilised for the construction activity through:
    - A risk assessment within the CESCPs which will act as a tool to help identify construction risk, identify any specific risk management approaches and advise the construction planning and approach to construction water management;
    - Proactive water quality monitoring, both qualitative and quantitative, will occur as part of the Project implementation as a way of assessing the effectiveness of the treatment and allowing for improvements/modifications as the Project works continue; and
    - Qualitative monitoring which will include visual surveys of the discharges and downstream environment;
    - Quantitative monitoring will include some sampling and testing of Sediment Control device discharges for turbidity (as a proxy for Total Suspended Solids (TSS)) and also upstream and downstream sampling to assess against baseline water quality parameters.
11. ESC measures and practices are used to minimise the effects of earthworks on the receiving environment. In general, steep slopes with long slope lengths, generate a greater amount of energy and hence increase erosion as rainfall lands and runs down a slope. Any reduction of this energy through the use of Erosion Control measures will reduce erosion and hence any subsequent sediment generation and yield.
12. These principles and practices will be further detailed and designed within CESCPs. The implementation of CESCPs will allow for innovation, flexibility and practicality of approach to construction-related water management. In doing so, the CESCPs will allow the construction of the Project to continually adapt.

4.3 Erosion and Sediment Control plan development

Further discussion and approval of the ESC approach (including both structural and non-structural measures) will occur as part of the Project implementation process prior to construction, and this will take place where necessary through the preparation of site and activity-specific CESCPs.

CESCPs are detailed ESC plans which will be submitted for specific work areas or activities within the Project. They will provide the detailed design, specific ESC measure location, staging and sequencing of works for that location. The CESCPs will be developed prior to works commencing in these locations. The CESCPs will determine specific measures to be employed and in this regard will also consider any alternatives that exist.

The CESCPs will take into account the various environmental and ecological values and will then determine the most effective and appropriate form of ESC devices and management practices required to manage erosion and sedimentation on a site-by-site basis, during the construction period.

The CESCPs will demonstrate compliance with this CWA and the associated consent conditions and will as a minimum include the detail as set out below in Table 3. This table also outlines the key criteria that will apply to the overarching approach to ESC.

Table 3: Erosion and Sediment Control Approach

Approach / Principle	Criteria
Erosion and Sediment Control Plan (ESCP)	The ESCP is the overarching ESCP that outlines and confirms the overall approach to water management during construction. The ESCP includes the following elements: ▪ ESCP Design ▪ Education and Training of all site staff; ▪ Implementation of a continuous improvement monitoring programme, which will form part of an overall Construction Environmental Management Plan (CEMP); ▪ Process for the development of CESCPs; ▪ Quality Assurance / Management System; ▪ Proactive and reactive ESC maintenance.
Construction Erosion and Sediment Control Plans (CESCPs)	CESCPs are detailed ESCPs which will be submitted for specific work areas and/or activities within the site. CESCPs will provide the detailed design, specific ESC measure location, staging and sequencing of works for that location and will be developed prior to works commencing in these locations. The CESCPs will determine specific measures to be employed and will also consider any alternatives that exist. The CESCPs will determine the most effective and appropriate form of ESC and management practices required to manage discharges during the construction period with recognition of the environmental values for that location. As part of the Project implementation, the CESCPs will follow the principles and approach outlined within the ESCP and will also confirm specific design details. The implementation of site specific CESCPs will allow for innovation, flexibility and practicality of approach to construction related water management. They will enable the construction team to have ongoing input into the ESC measures and practices prior to and during construction. This CESCP process allows the construction water management measures utilised within the Project to continually adapt to changing construction, environmental and climatic conditions. CESCPs will include: ▪ Contour information; ▪ ESC measures for the works being undertaken within a particular construction area; ▪ Chemical treatment design and details; ▪ Catchment boundaries; ▪ Location of the work; ▪ Details of construction methods; ▪ Design criteria, typical and site-specific details of ESC measures including ensuring that all sediment retention ponds and decanting earth bunds have full access track provisions for maintenance at all times; ▪ Identification of risk and sensitive area locations and the details of management (including contingency measures) around these aspects; ▪ Details of open areas that exist for the Project at the time of the CESCP and a programme for managing ongoing non-stabilised areas;

Approach / Principle	Criteria
	▪ The identification of staff and resources who will manage and maintain ESCs; ▪ The identification of staff who will monitor compliance with conditions; ▪ Details of specific resources and responsibilities for managing environmental issues on site to ensure that any resultant conditions of consent are complied with; ▪ Methods and procedures for decommissioning measures; and ▪ Design details for managing the treatment, disposal and/or discharge of contaminants (e.g. concrete wash water). In addition, each CESCP must clearly illustrate on a plan the specific location and boundaries of the CESCP (in the context of the wider Project) and what activities are addressed within them.
Construction staging and sequencing	Staging and sequencing are both important non-structural measures and will be implemented as necessary to achieve the progressive stabilisation of the Project on an ongoing basis. Detail of the staging and sequencing of works will be detailed within the CESCPs. The staging may include reduced area of working in winter.
Device location and discharges	All ESC devices should be located outside the 20-year ARI flood level unless no other viable alternative exists. All construction related runoff discharges are either to a land environment or direct to freshwater systems with particular emphasis on avoidance of the high risk locations as identified in the CESCPs. Where possible, discharges to land are considered beneficial as a land-based buffer zone will provide some 'polishing' effect of the discharged runoff. Where discharges are direct to freshwater systems, to minimise erosion of the stream bank and bed at that point, the outlet will be protected with geotextile and riprap material in the immediate vicinity of the outlet.
Non-Structural Measures	Non-Structural measures are critical to minimising sediment generation and yields. These elements include: ▪ Proactive monitoring and reporting programme; ▪ Risk identification and management; ▪ Progressive stabilisation as works progress; ▪ Staging and sequencing of specific work/activity programmes; and ▪ Weather forecasting, planning and response.
Progressive stabilisation for erosion and dust management purposes	Progressive and rapid stabilisation of disturbed areas utilising topsoil (where necessary) and seed, mulch and geotextiles will be ongoing throughout the Project. Hydromulch products achieving instant stabilisation will also be used. As part of the Project construction a stabilisation trial will be initiated to determine the most effective form of stabilisation for the various soil types that will be encountered. Consideration of natural fibre based Rolled Erosion Control Products will be included in any stabilisation trial. Stabilisation will be undertaken with three key purposes: ▪ To achieve an effective ESC programme inclusive of progressive stabilisation; ▪ To reduce the exposed earthwork areas within higher risk locations to assist with a reduction in sediment generation; and ▪ In response to the continuous improvement monitoring programme to address any potential effects or undesirable monitoring trends.
Streamworks	Works within or adjacent to freshwater streams and wetlands are generally considered higher risk than other earthwork activities due to the close vicinity of the sensitive receiving environment and the associated increased potential for sediment yield. Within the Project, streamworks will be undertaken in a manner that recognises and responds to this risk. Where practical, streamwork activities and any associated works within these environments will be undertaken in an 'offline' dry environment. This strategy will be based upon the temporary diversion of flows around the area of works or working immediately next to the stream with no formal stream diversion required. All streamworks will also be undertaken with consideration of fish spawning and migration periods.

5. Erosion and Sediment Control Project Measures

5.1 Overview

Table 4 below summarises the key ESC design criteria that are recommended to be utilised for the Project. The table includes a summary of the ESC devices and management practices, relating to Erosion Control and Sediment Control respectively. These ESC measures have been implemented on a number of projects, including NZTA projects, have been proven effective and are recognised within the earthworks industry as representing current best practice.

Table 4: Erosion and Sediment Control Design Criteria

Device/methodology	Criteria
Erosion Control measures	
Clean Water Diversions (CWD)	Clean water diversion channels and bunds will be designed to cater for the 100-year ARI rainfall event.
Contour drains	Contour drains will be designed and implemented in accordance with GD05.
Dirty Water Diversions (DWD)	Dirty water runoff diversion channels will be sized to cater for the 1% ARI rainfall events, including lining or velocity protection measures in accordance with GD05. Sediment sumps with a minimum volume of 2 m^3 to be installed in all DWDs at a maximum distance of 50 m between sumps.
Pipe drop structures/flumes	Flumes will be used to safely transfer runoff from the top of batters to the bottom of the batter slopes, or from DEB/SRP outlets across steep slopes as necessary.
Rock check dams	Rock check dams will be designed and implemented in accordance with GD05.
Stabilised entrance ways	Stabilised entrance ways will be established at all entry and exit points of the site.
Sediment Control measures	
Decanting earth bunds (DEBs)	All DEBs established will be based on a volume of 3% of the contributing catchment area and sized accordingly, subject to a maximum DEB catchment area of 3,000 m^2 unless varied within the CESCPs. All DEBs will be fitted with floating decants. Decants will have a manual control mechanism (to prevent) outflow from the DEB during pumping activities to these structures.
Flocculation	Flocculation will be applied on all SRPs and DEBs based on an approved Chemical Treatment Management Plan (CTMP). For all contributing catchments over 2 ha in area, two flocculation sheds will be installed per device for the purpose of increasing the volume of flocculant available and also for reducing the risk of failure if one of the flocculation systems fails or has reduced performance. Manual batch dosing will be applied as required. The bench testing of soils using a range of coagulants/flocculants will be carried out during the CESCP development, which will include details of the coagulant/flocculant type, dosing rate and floc shed roof area to be applied at specific locations.
Sediment retention ponds (SRPs)	All SRPs will be implemented based on a 3% volume criterion applied in relationship to catchment size (i.e. 300 m^3 SRP volume per 10,000 m^2 of contributing catchment) All SRPS will be subject to a maximum catchment area of 50,000 m^2 unless varied within the CESCPs. ▪ I recommend that as part of the SRP construction and CESCP development, the following activities should be undertaken:

Device/methodology	Criteria
	▪ Check ground conditions through the use of bore holes to undertake a geotechnical assessment of the proposed SRP site; ▪ Determine the need or otherwise for a shear key establishment, or other geotechnical works, for the SRPs; and ▪ Remove any unsuitable material and confirm ground conditions as appropriate for SRP establishment. Baffles, decant pulleys (and/or outlet shut off valves) and reverse base slopes to be installed in all SRPs.
Pumping	Wherever possible, gravity flow into the various sediment retention measures will be used in preference to pumping. However, it may not always be possible to achieve gravity flow to Sediment Control devices during construction and floating decants will be fitted with a mechanism to control outflow, such as a manual decant pulley system or an outlet gate valve, which will enable the SRP outflow to be stopped during pumping activities to these structures. The decants will only be lowered once an acceptable standard of discharge quality, not less than 100 mm clarity and in accordance with the Project's established discharge quality parameters, has been achieved. The pumping rates and volumes to SRPs and DEBs will be controlled so that the total pumped volume can be fully captured within the retention structure. Pumping may also be required for other activities such as bridge or culvert construction where pumping of sediment-laden water may be required during foundation construction. Pumping flows to SRPs and DEBs ensures that any sediment laden flows are discharged to a treatment device prior to entering the receiving environment
Super silt fences and silt fences	All super silt fences and silt fences will be based upon the design criteria within the Transport Agency ESC Guidelines[2]. SSF fabric will be installed with at least 200 mm of fabric upslope at the base of the trench to provide adequate toe support. In areas where Sediment Control devices are within 50 m of a watercourse, SSF will be utilised as a last line of defence such that if a failure of the primary control measure eventuates, then the last line of defence will capture and treat such a discharge.
Construction Water Clarification Units	In some instances where space is at a premium or specific activities are proposed that necessitate their use, portable water clarification units may be utilised. These are utilised in conjunction with pumps to remove sediment-laden water flows from areas where traditional controls such as silt fences, DEBs and SRPs are not achievable. Where these units are proposed, the units must be capable to treating flows from a minimum of a 20-year ARI rainfall event for the area of works. Where utilised, chemical treatment processes will be incorporated in line with the CESCP for the relevant works area.

Whilst this CWA refers to various erosion and Sediment Control guidelines, such as GD05, Auckland Council Technical Publication Number 90: Erosion and Sediment Control Guidelines for Land Disturbing Activities (TP90) and the Erosion and Sediment Control Guidelines for State Highway Infrastructure (Transport Agency ESC Guidelines) (2014) (Transport Agency ESC Guidelines), the adopted design will ensure that best practice and knowledge applies. Key measures identified for the Project that may "exceed" the current guidelines criteria to ensure effects are managed include:

- All sediment retention ponds and decanting earth bunds are sized at 3% of the catchment area with full access track provisions for maintenance at all times;
- The adopted silt fence design, follows the design provided in the Transport Agency ESC Guidelines with a return upslope to ensure robustness of the device;
- The sizing of temporary CW and DW diversions is for the 100-year ARI rainfall event;

[2] Erosion and Sediment Control Guidelines for State Highway Infrastructure (Transport Agency ESC Guidelines) (2014).

- I propose quantitative monitoring of the performance of devices and the receiving environment to inform design and operational improvements over time (continuous improvement); and
- Through the design and construction phases of the Project, I recognise that there will be scope for innovation and alternative means of achieving a best practice approach.

5.2 Erosion Control project staging and stabilisation management

In general, the Erosion Control measures and practices (structural and non-structural) to be applied to the Project will be more specifically confirmed through the CESCP process. However, typical measures are described as follows.

5.2.1 Construction staging and sequencing

The extent of exposed soil and length of time that an area is exposed directly influences the sediment yield leaving a particular area. Bulk earthworks and construction activities will be staged and sequenced in order to minimise open areas and only open areas that are subject to active earthworks with progressive stabilisation in place. This progressive stabilisation will be reinforced through those areas, or sub areas, of earthworks not subject to daily operating earthworks activity for more than a 14-day period. This requirement is a critical risk reduction element, and will in itself, encourage progressive stabilisation.

5.2.2 Stabilisation

Stabilisation is a key feature of the Project to reduce the erosion potential of disturbed earth. GD05 defines stabilisation as *“the application of measures, such as vegetative or structural practices that will protect exposed soil and prevent erosion.”*

Progressive and rapid stabilisation of disturbed areas will be ongoing throughout the Project. Mulch will include hay/straw, hydromulch products and wood bark generated on site though the removal and mulching of existing vegetation as appropriate. Stabilisation will particularly apply at stockpile areas and batter establishment to reduce both erosion and dust generation.

Mulching will typically apply up to slopes of less than 15 degrees, above which alternatives such as hydromulch, geotextile or polymers will need to be considered. Natural fibre based Rolled Erosion Control Products may also be utilised through the stabilisation trial process, and/or where these have been confirmed to meet the stabilisation requirements of the Project and are considered best practice alternatives.

The development of the CESCPs will determine the specifics of this stabilisation technique and timing and a stabilisation trial will also occur to ensure that the stabilisation media is appropriate for achieving the required stabilisation outcomes and objectives. This stabilisation trial will include determination of effectiveness of various stabilisation media on Project soils in reducing sediment generation and yield.

Stabilisation will be undertaken with three key purposes:

- To assist with the reduction of overall disturbed areas of earth;
- To minimise the open area extents in higher risk locations and to assist with a reduction in sediment generation; and
- In response to the continuous improvement monitoring programme to address any potential effects or undesirable monitoring trends.

5.3 Erosion and Sediment Control guidelines and standards

Northland Regional Council (NRC) does not have a region-specific erosion and Sediment Control guideline. However, it places reliance on the following:

- GD05 provides information on the appropriate use, design and construction of ESC practices. I consider GD05 generally represents industry best practice and generally provides the accepted design criteria for ESC measures.

- TP90 provides information on the appropriate use, design and construction of ESC practices. TP90 was superseded by GD05, however contains some specific measures that are of a more stringent design than GD05 and these have been incorporated as part of the suite of best practice where required.
- Transport Agency ESC Guidelines. This document contains guidelines for State Highway infrastructure and was developed to assist roading practitioners with the selection and design of ESC practices. These ESC Guidelines have been considered as appropriate for the Project, such as for dirty water diversions, which will be sized for the 100-year ARI rainfall event.
- While forestry harvesting does not form part of this CWA assessment (as harvesting of the existing exotic forestry within the Proposed Designation will be undertaken prior to the Project construction and in accordance with controls under the National Environmental Standard Construction Forestry) for completeness, reference is made to guidance documents for harvesting of exotic forests as follows:
- Forestry Operations in the Auckland Region a Guideline for Erosion and Sediment Control; September 2007; Technical Publication 223 (TP223); Auckland Regional Council - TP223 provides a specific set of guidelines for earthworks and general land disturbing activities associated with forestry operations and builds on the concepts and guidance provided by TP90 or its replacement GD05 and is therefore applicable to plantation forestry clearance activities.
- New Zealand Forestry Owners Association Forest Practice Guides[3]; This provides various options in a toolbox approach for the various forestry management practices. The guide notes that in describing management practices that will form part of a forestry earthworks management plan and harvest plan, that reference to this guide, or part of the guide, will occur.

5.4 Activity specific erosion and Sediment Control methodologies

The works methodologies discussed below have been developed to provide details of the various ESC measures and practices to be put in place to address erosion and sedimentation issues during the construction phase. It is noted that the various construction activities discussed below will be further developed and specific detail will be provided in the CESCPs, which will be produced prior to construction works commencing. In addition, for some of the key activities to be undertaken I have developed specific ESC methodologies and plans to support the approach and demonstrate the feasibility and practicality of implementing such methods.

I have 'tested' the methodologies within specific locations of the site to ensure practicality and workability, with specific plan examples included in **Appendix B**.

5.4.1 Permanent stormwater treatment devices

The Project will include the installation of a number of permanent stormwater treatment wetlands for the treatment of stormwater runoff from impervious surfaces during the operational phase of the Project.

Permanent stormwater treatment and detention devices could be installed early in the Project where the location of a SRP coincides with a permanent stormwater treatment device, and the stormwater treatment device could be used on a temporary basis as a SRP to reduce ground disturbance. If this option was adopted, then these devices could then be converted to long term stormwater treatment devices at the completion of the earthworks activity within that sub-catchment.

No existing natural wetlands should be used for primary treatment of sediment-laden runoff from the construction phase.

5.4.2 Stockpile establishment and management

A stockpile is a temporary store of material which is placed and stored prior to re-use or disposal. The majority of materials to be stockpiled on the Project will be topsoil, subsoil, and unsuitable material gained

[3] Version 2 updated January 2020

from the bulk earthworks operations, or hardfill material such as crushed rock. Imported hardfill will also be stockpiled. These stockpiles exclude the permanent spoil site locations.

The establishment of stockpiles will be subject to the development of CESCPs. From an ESC perspective, the establishment of material stockpiles will have regard to the following to reduce the risk of sediment-laden runoff from entering the receiving environment.

- ESC measures should be established and managed to minimise or prevent pollutant material entering waterways, and stockpiles should not be established below the level of the 20-year ARI rainfall event;
- CWDs will be established on the 'high' side of the stockpile to direct upslope runoff away from the stockpile area. This will prevent erosion of the base of the stockpile, which could affect the stability of the stockpile and induce a slip within the stockpiled material;
- DWDs will be established downslope of the stockpile and will discharge to a DEB (or an SRP if catchments exceed 0.3 ha);
- As an alternative, SSFs will be established downslope of the stockpile to intercept and treat any sediment laden runoff from the stockpile prior to its discharge to the receiving environment.
- Material stockpiled for longer than one month will be stabilised using mulch, geotextile or other alternatives as outlined in the CESCPs;
- Stockpile stability will be monitored, particularly near high-risk receiving environments and during winter, to ensure that sudden collapse of stockpiles does not occur, resulting in uncontrolled discharges of sediment-laden water.

The specific location of temporary stockpiles has not been determined at this stage of the Project and will be confirmed and outlined within CESCPs.

5.4.3 Spoil site establishment

Unsuitable and surplus material will be excavated and transported from the various cut locations within the Project and disposed of within various spoil disposal sites and landscape works associated with the Project. The locations of the areas identified for the deposition of unsuitable material form part of the plan set with an example spoil site ESCP included in **Appendix B** of this CWA.

I note that a large degree of value engineering will likely occur prior to Project implementation which could significantly reduce the spoil volumes.

Conceptually the ESC measures required during the establishment and management of the spoil disposal sites will be similar to that required for the establishment of the various cut and fill zones proposed throughout the Project. The various activities would likely be as follows:

- Temporary and Permanent Stream Diversions (Discussed in Section 5.4.4 of this CWA);
- Clearing vegetation and stripping of topsoil;
- Pumping of groundwater and surface water runoff (discussed in Section 5.4.7 of this CWA).
- Haul Road and access road construction – (Discussed in Section 5.4.10 of this CWA);
- Construction of gully/subsoil drains;
- Stockpiling of excavated material;
- Bulk Earthworks (Excavation and Filling operations);
    - Cut to Fill within the Site; and
    - Import of cut material to disposal site.
- Drying / Dewatering of unsuitable material.
- Final stabilisation.

The establishment and management of spoil disposal sites will require site specific CESCPs to be prepared prior to works commencing within these areas. To demonstrate that erosion and sedimentation can be managed effectively during the establishment of the spoil disposal sites I have developed a conceptual ESCP for indicative spoil disposals with the plan included within **Appendix B**.

The conceptual construction sequence discussed above is a description of only one possible method of establishing a spoil disposal site. It demonstrates that spoil sites can be managed effectively to control effects from erosion and subsequent sedimentation.

5.4.4 Temporary or permanent stream diversions

Stream diversions will be required during the construction of the Project to divert flows on a temporary basis and allow construction works to progress or provide access to an area.

They are also required on a permanent basis to divert the stream around or through a permanent feature of the Project such as an embankment, spoil site, bridge or culvert. In all cases, the stream diversion will be necessary in order to establish an 'off-line' environment to allow construction works to be completed outside of the active stream channel.

The following discusses a conceptual sequence of works required to complete a temporary or permanent stream diversion:

- Excavation of the diversion channel will be carried out offline from the existing stream, so that excavation works can be carried out in a dry environment. A clay plug will be left in place at each end of the diversion channel to ensure that the existing stream cannot breach and flow through the new channel prior to it being stabilised;
- In the case of temporary stream diversions, the dimensions of the diversion will be such that it will have sufficient capacity to cater for the 20-year ARI rainfall event in addition to provision for overland flow, in accordance with GD05. Permanent stream diversions will be established in accordance with the detailed design and will be detailed within the CESCPs;
- Where the flow volume capacity of the diversion differs from the GD05 requirements, this will be explained and justified within the CESCP;
- Stabilisation of the newly constructed diversion channel will be carried out to ensure it does not become a source of sediment. The option adopted will also be dependent upon ecological considerations and may be achieved using geotextile fabrics, rip rap material or rock armour;
- Once the diversion channel is fully stabilised, the downstream clay plug will be removed to allow stream flows to enter the diversion channel. The upstream clay plug can then be removed allowing stream flows through the diversion channel;
- Removing the downstream clay plug first helps to reduce scour in the diversion channel by keeping some water within it when the upstream plug is removed;
- A non-erodible dam will then be placed within the original channel immediately downstream of the inlet to the diversion channel to divert flows into the diversion channel. A non-erodible dam will also be immediately placed at the downstream end of the original channel, upstream of the diversion channel outlet to prevent backflow into the construction area. Once the flows have been diverted and the dams placed, fish removal from the original channel can be completed. Construction activity can then take place within the original channel as required;
- The non-erodible dam will initially comprise the formation of a sandbag barrier with an impermeable lining to avoid seepage through the sand-bags. Clay will then be placed immediately behind the sand-bags to prevent water flowing through the sand-bag barrier and into the construction area, with the full dam then being fully stabilised;
- Any water remaining within the works area will be pumped to a DEB or SRP. Pumped volumes will be minor and the decants within the DEB or SRP will be manually raised during the pumping process to allow for settlement of sediment and chemical treatment with flocculant if necessary;

- Once the original channel has been de-watered, construction activity (such as removal of weak and unsuitable material, filling, and culvert construction) within the original channel can then occur;
- CWDs will then be installed above the area of work to ensure that no stormwater runoff from the existing catchment outside of the works can enter the area during the construction period;
- Material excavated from the diversion channel will be placed in stockpiles away from the stream diversion and outside of the identified flood plain area;
- Although the works will not commence until a fine weather window is forecast, geotextile material will be available on site to cover any exposed areas in the event of an unexpected change in weather;
- The works will be staged such that if flood conditions are predicted, the area can be fully stabilised in a few hours. Any sediment deposited within the newly formed channel will then be pumped and removed to a DEB or SRP;
- Once the works within the original channel have been completed, other appropriate controls, such as silt fences, will be installed below the area of works; and
- Once the new culvert has been constructed and the surrounding area stabilised, then flows from the existing to the new channel and culvert can be transferred.

If rainfall occurs during the course of construction this will be managed as below. In the event of forecast rain, or before leaving the work area for more than 24 hours the following will occur:

- Any loose material that could enter a watercourse is to be removed from the work area, depending on the quality of the material this will be either to a soil disposal site or to a stockpile area;
- Where possible, all exposed areas will be covered with geotextile to ensure no flows overtopping the stream banks create scour issues. It is expected that this will be achieved through geotextile with the geotextile appropriately trenched in at the head and toe of the area;
- All existing and additional ESC measures will be inspected, secured and maintained where required;
- Additional mulch and geotextile / polythene will be kept on site at all times to cover exposed areas and stockpiled material; and
- Extended working hours will be considered if it is believed significant benefit with regard to programme and environment impact is either required or possible.

I consider that the above process, methodology and controls can be effectively implemented on site during construction. Where the pumping of flows around the work area is required, this will be carried out in accordance with the methodology described in Section 5.4.7 of this CWA.

The establishment of any stream diversion will require site specific CESCPs to be prepared prior to works commencing within these areas. To demonstrate that erosion and sedimentation can be managed effectively during the establishment of the stream diversions I have developed a conceptual ESCP for the Piroa Stream embankment culvert at CH 20600. A further ESCP conceptual plan has also been developed for the Waihoihoi River works location at CH 14650. These are contained within **Appendix B**.

5.4.5 Culvert construction

Temporary and permanent culvert construction will be required in a number of locations throughout the Project. Temporary culverts will be provided to allow construction vehicles to cross watercourses and overland flowpaths, and these temporary culverts will be removed when no longer needed.

As with the stream diversion methodology discussed in Section 5.4.4 above it is important that the culvert construction activities are undertaken early in the construction program to ensure that the surrounding earthworks can be completed.

Fish migration, spawning and other freshwater ecological values are important considerations to be taken into account during the construction of culverts and stream diversions. These are addressed in the Assessment of Effects on Freshwater Ecology (Appendix D7 of Volume B).

Prior to undertaking the works at a particular culvert location, a specific construction methodology will be developed and will be detailed within the CESCP for the particular location.

Culverts and their associated stream diversions will generally be constructed within an offline location, isolated from the existing stream flows. A stream diversion will be required either prior to construction works commencing on the culvert or to direct flows into the culvert once construction works have been completed.

Where culvert installation or an extension is required within a stream channel, and it is not possible to divert the stream, the culvert works (depending on stream flows and fish passage requirement) could be carried out either by bypassing the flows around the culvert footprint by establishing a stream diversion as discussed in Section 5.4.4 of this CWA, or by pumping the flows around the culvert works areas as described below.

Pumping of flows from an existing stream will only be carried out in situations where it is not practical to construct a diversion channel.

Where pumping is to occur, the operation will be carried out as follows:

- Place a temporary non-erodible dam within the existing stream channel upstream of the work area and install a pump approximately 5 m upstream of the dam. The pump will pump flows upstream of the works around the work area and discharge them back into the existing watercourse downstream of the culvert works;
- Sandbags or similar will be used to impound flows for the pump. The inlet of the pump will be supported above the base of the stream and will contain a fish grill, to prevent fish from entering the pump intake structure;
- The pump flow rate will be equal to the expected dry weather flow for the particular stream;
- Initial excavation works will remove the vegetation from the work area followed by the excavation of any unsuitable material. This excavated material will be removed from the work area and disposed within one of the identified potential soil disposal sites;
- Once all unsuitable and soft material has been removed from the extent of the culvert to be constructed, the area will be backfilled with the required amount of structural fill and the culvert along with all associated wingwalls, retaining walls and backfill will be constructed;
- Any other construction activity associated with the culvert construction, such as the placement of fill, will only be carried out once ESC measures such as super silt fences, CWDs DWDs, SRPs and DEBs have been put in place. When the works have been completed, any disturbed and exposed areas of bare earth will be fully stabilised through mulching or vegetation establishment;
- Once the necessary approval has been obtained from the Project Ecologist in relation to any necessary fish passage or morphological requirements, the pump and bund will be removed and the stream flows can then be passed through the new culvert structure; and
- Where an existing culvert is to be extended, a plywood bulkhead, or equivalent, with a flexible bypass pipe fixed into the bulkhead of the culvert will be installed. The bulkhead will be sealed into the base and sides of the existing culvert. If required a supplementary pump will be used to ensure a dry working environment. The flexible bypass pipe will be a sufficient length to allow low flows to discharge beyond the works area.

The following will be required for the construction of all culverts:

- Confirmation of any fish passage design requirements will be confirmed by the Project Ecologist;
- Prior to any works commencing on the construction of a particular culvert, a period of forecast dry weather sufficient to construct the culvert will be confirmed through appropriate weather monitoring system;
- Culverts are expected to be installed in sections and sections will be fully constructed and the immediate area stabilised at the end of each working day;

- Any water present within the work area will be pumped to a DEB which will be located away from, and discharge away from, the stream environment;
- On completion of the culvert extension, all plant, materials and labour will be demobilised and the site will be permanently stabilised in accordance with the CESCP for that work area; and
- Any rock armouring required for stabilisation purposes at the outlet of the culvert will be placed and accommodated as required.

5.4.6 Bridges

Bridge construction will typically involve piling operations to form a stable foundation onto which precast reinforced concrete columns will be constructed. Pre-cast and pre-stressed concrete elements required for the construction of the bridges will be cast in a precast concrete construction yard and then transported to the particular bridge or viaduct location, where they will be placed in position. Once fixed in position the top slab will be poured in-situ to the required depth.

In some cases, construction of the bridge will involve establishing structures with sheet piling on either side of a stream system with no instream works required. The placement of a concrete slab over the stream without diverting the stream will complete the bridge structure. In these occasions ESC will be based around placement of controls below the sheet pile locations but above the stream bank profile and will be confirmed in the CESCPs for the relevant works stage.

5.4.7 Pumping from excavations

Pumping operations will be mainly required for the removal of groundwater and collected surface water from excavations such as those required to construct foundations for structures and trenches for pipelines. Dewatering of excavations will be required to allow construction personnel and equipment to undertake construction activities in a dry environment.

Where pumping is required from excavations for foundations or trenches, it will typically be carried out and managed as follows:

- The pump intake will sit on hard fill material, which will provide a filter media to ensure debris and larger particles are not sucked into the pump intake. The filter media will also act as an ESC pre-treatment system and will also reduce the risk of direct damage to the internal workings of the pump;
- If the discharge water quality is satisfactory with a minimum 100 mm clarity, the pump discharge will be directly to a vegetated environment away from any watercourse;
- Where a suitable vegetated area is not available within the vicinity of the working area, the discharge from the pump will be to a DWD and subsequently to a SRP or DEB; and
- If the water clarity is not satisfactory, pumping will be to a DEB or SRP, and during pumping operations the decant of the DEB or SRP will be manually raised and will remain in that position until sufficient settlement of suspended solids within the discharged water has occurred.
- If required, manual batch dosing of the SRP and DEB with chemical flocculant will be carried out to increase the level of sediment retention in the SRP or DEB. Once pumping operations have been completed and the sediment sufficiently settled out, the discharge and normal operation can resume.

5.4.8 Chemical treatment

Flocculation is a method of increasing the retention of suspended solids from earthworks runoff. Flocculant is added to the inflows of an SRP or DEB via a rainfall activated system, automated flow activated system or by manual batch dosing.

The flocculant is a chemical additive which works by neutralising the negative charge of soil particles, thereby accelerating coagulation and increasing the rate of settlement of soil particles. The use of flocculation chemicals increases the efficiency of SRPs and DEBs and reduces the amount of sediment discharged to the receiving environment.

There are a number of flocculants available on the market, with Poly Aluminium Chloride (PAC) being widely used throughout New Zealand. There are also other alternatives available in the marketplace, each varying in their effectiveness depending on the soil condition of the site.

Flocculation is a key structural management tool and with appropriately trained personnel managing and using this measure, it has proven to be a critical feature of successful ESC.

Given the varying soil conditions through the length of the Project, I consider that flocculation is a viable and effective method of management of sediment yield on the Project and I recommend that bench testing be carried out on various soil samples from the Project area using a range of available flocculants to determine the most appropriate type of flocculant and also the dosing rate that the flocculant is applied to the various ESC measures. This bench testing will then form the basis for a CTMP for the Project, with dosage rates then confirmed in each CESCP.

5.4.9 Rip rap placement

Riprap material is a permanent erosion protection measure and is most commonly used along stream banks and at culvert outlets. Riprap resists the erosive action of water flowing across the surface of a stream bank, which can lead to erosion or failure and collapse of the bank.

Riprap will be used on the Project in a number of locations as permanent erosion protection measures. This will typically be associated with the inlet and outlets of culverts and also be used for stabilisation in stream diversions. From a temporary perspective, riprap will be utilised to provide erosion protection at the outlet of the SRPs to be installed as well.

While placement of riprap is a relatively simple process, I have outlined the methodology that will be used for the placement of a riprap within an existing stream environment and also discuss the ESC measures required.

A conceptual construction sequence for riprap placement in a stream channel is described below:

- A clear weather window will be established prior to commencing works on the riprap. Clearance of the stream bank can commence and will only be carried out to allow sufficient room for the riprap to be placed;
- A temporary flow diversion will be established to keep water away from the works during the placement of the riprap. The bank slope will be cleared of bushes, trees, stumps or other organic material, loose and soft material will be removed from the bank and a smooth, uniform surface formed;
- A separation layer of geotextile and a filter layer of stone will be placed and spread evenly across the extent of the riprap location, using an excavator; and
- The riprap material will be free of any silt, clay or organic material such as silt and will be carefully placed to the required depth. Larger rocks will be placed at the toe of the riprap and will be evenly distributed across its width.

The placement and use of riprap will be used widely on the Project and will not create any associated environmental effects. The final design details of all riprap placement areas will be confirmed through the CESCPs for each work area.

5.4.10 Access track and haul road establishment

Access tracks and haul roads will be required on the Project to transport plant machinery, personnel, materials and fill material throughout and between construction zones on the Project.

All-weather access, access tracks and haul roads will be required and will be constructed using rock to form a stabilised surface.

DWDs will be constructed on each side of the access track and haul road to receive runoff. These DWDs will discharge to the receiving environment via a DEB, or SRP, depending on the catchment size.

During the construction period, water carts will be used to spray the access tracks and haul road with a fine spray to wet the surfaces to suppress dust. These haul roads are considered relatively simple to manage and can be treated as isolated areas of works with the associated ESCs in place.

Where haul roads form a component of the larger earthworks footprint, the control measures will likely be incorporated into the wider site ESC measures and the relevant CESCPs.

5.4.11 Site compounds and laydown areas

Construction compounds will be required for the duration of construction and will be required for repairs, maintenance, re-fuelling of earthmoving equipment, lay down and storage areas for materials delivery, workshops, Project offices, messing, and ablution facilities. They are likely to operate throughout the construction period.

ESC devices to be used for the establishment and operation of construction yards will be as follows:

- Stabilised construction entrances will be established as the entry point to the proposed construction yard to reduce transfer of sediment onto the external road network;
- If necessary, CWDs will be established at the perimeter of the site to intercept and divert offsite water and overland flow from the catchment uphill of the construction yard from entering the areas;
- DWDs will be constructed to intercept and divert runoff from the surface of the earthwork areas within the work area and will discharge it to an SRP to assist with removal of sediment from the runoff prior to discharging to the receiving environment;
- Super Silt fencing – These will be placed during the yard establishment phase of works if necessary;
- The construction yard establishment is recognised as a quick process whereby earthworks activity to establish the platform is completed as a single operation. The topsoil stripping and any subsoil stockpiles will be managed as per Section 5.4.2 above;
- Immediately on reaching grade, the yard area will be stabilised with a 50 to 100 mm thick layer of clean, hard fill material. This has the purpose of achieving immediate stabilisation but also ensuring traffic movement to and from the site will not be a generator of any further sediment yields;
- Where runoff from the yard area is intercepted and flows to an SRP or DEB, the device will remain after the yard is stabilised and will act as an attenuation device for the short-term operational aspect of the yard. The device will be sized in accordance with the requirements of GD05 and will provide for treatment during the earthworks activity while also providing water quality treatment and extended detention treatment for the impervious areas associated with the construction yard;
- In accordance with the Transport Agency ESC Guidelines, the decant structure from the device will remain through the entire duration of the construction yard life with the decant design providing the required extended detention flow rates; and
- The device will remain in place until the yard is no longer required and is returned to a vegetated or final land use state.

Further water management practices to be used in the operation of the construction yards during construction will be as follows:

- Vehicle movements and parking will only be within designated areas of hardstanding;
- Non-Sediment Contaminants (Chemicals, petroleum and solvent based) products are to be stored within appropriately designed bunded areas, with spill kits available;
- Regular clearing of sealed hardstanding areas will be carried out using a road sweeper to remove deposited material from the surface that could become mobilised during rain events;
- All material stockpiles located within the yard confines will ensure treatment through the SRP; and
- Sediment will be removed from the DEB or SRP associated with the individual construction yards when accumulated sediment exceeds 20% of the available storage volume for the particular device.

The specific detail of these yards will be highlighted within the CESCPs to be submitted prior to construction commencing.

- I consider that the above process, methodology and controls can be effectively implemented on site during construction.

5.4.12 Works within flood plain

Where works are required within flood plains, the risk of sediment discharges reaching the receiving environment is higher during construction, and ESC measures will be established, operated and maintained to minimise this risk.

Given the extent of the flood plain, some works are required within identified flood plains, such as the construction of culverts and stream diversions and the placement of fill to embankments. Importantly however, the modelling demonstrates that in a 1% event the flood depths outside the major watercourses are mostly less than 200 mm and are therefore minimal.

This primarily relates to the area of works referred to as flat contour between CH 9200 and CH 17700 but includes other isolated works areas as well. Within these locations, Sediment Control devices will be located outside the 20-year ARI flood level, unless no other viable alternative exists. If Sediment Control devices are required within the 20-year ARI flood level, they will be designed to capture the minimum catchment area (0.3 to 5.0 ha) and will be subject to an increased inspection, monitoring and maintenance regime.

Measures that can minimise the risk of sediment discharges are listed below. I note that no one methodology will reduce the risk on its own or be applicable to all construction activity, and consequently the preparation of CESCPs during construction will need to consider the following risk mitigation measures:

1. Undertake works during a dry weather window – This is particularly relevant in the construction of culverts, stream diversions and works adjacent to streams and watercourses and avoid working (and ensure the site is stabilised) during forecast flood events for the area of concern;
2. Undertake increased levels of pro-active maintenance such as:
    a. Undertake Regular – (Daily, Weekly and Long-range) - weather monitoring;
    b. Programme construction and stabilisation works in response to forecast weather events;
    c. Regularly remove retained sediment from the sediment retention devices. Sediment should be cleaned out when the sediment levels reach 10% of the normal operating capacity of the device, to ensure that retained sediment is not re-suspended in the event of an extreme rainfall event;
    d. Make necessary repairs to ESC devices regularly and especially prior to forecast rainfall events; and
    e. Undertake pre and post rainfall event inspections of ESC measures, as well as monitoring devices during rainfall where safe to do so.
3. Provide stabilised flow paths for flood flows to bypass the working area;
4. Provide stabilised working platforms during construction around bridge foundations and piers adjacent to stream and watercourses.

An indicative ESCP for the Zone 1 flood plain location is included within **Appendix B** of this CWA.

5.4.13 Concrete works

Concrete works will be necessary for many of the bridges and other ancillary structures within the Project.

During construction of the bridges, it is proposed to minimise the amount of in-situ concrete that will be required through the use of pre-cast elements which will be manufactured off site and transported to the work area as required.

Any cement contaminated water that does result from concrete placement, will require treatment before discharge. This will be achieved by either onsite treatment tanks with the water pH tested before discharge, or the water removed from site through the use of sucker trucks and transported offsite for treatment elsewhere.

Concrete placement will be carefully controlled to ensure no losses to the environment through the use of pumps and skips. Concrete truck wash and pumps will be provided on site with a dedicated concrete wash facility, designed to accept such waste. These controls will all be confirmed through the CESCPs for each site for the Project.

5.5 Overall project earthworks

Project cut and fill volumes by Earthworks Zone are provided in Table 5 below.

Table 5: Project earthworks volume summary

Consent Volumes					
	Zone 1	**Zone 2**	**Zone 3**	**Zone 4**	**Total**
Total Cut (m^3)	**821,984**	**5,427,645**	**1,790,649**	**4,605,427**	**12,645,705**
Cut Unsuitable (m^3)	371,527	490,009	404,375	3,412,634	4,678,545
Cut Unsuitable Additional (m^3)	74,305	98,002	80,875	0	253,182
Cut Suitable (m^3)	18,715	3,527,488	1,055,819	1,021,077	5,632,099
Cut Borrow – Suitable (m^3)	0	671,102	0	0	671,102
Cut Borrow – Unsuitable (m^3)	0	200,000	0	0	200,000
Undercut (m^3)	357,437	441,044	249,580	171,716	1,219,776
Cut moved in or out of zone (m^3)	1,389,248	-1,389,248	0	0	
Total Fill (m^3)	**1,747,744**	**3,168,489**	**991,865**	**947,174**	**6,855,272**
Structural Fill (m^3)	1,407,963	2,809,342	719,025	821,388	5,757,718
Landscape Fill (m^3)	339,781	359,146	272,840	125,786	1,097,554
Suitable Fill/Required Structural Fill	100%	100%	147%	124%	
Total Spoil [1] (m^3)	**713,653**	**1,304,863**	**1,097,137**	**3,698,191**	**6,813,844**
Unsuitable (factored by 1.5) (unsuitable + undercut)	713,653	1,304,863	692,985	3,458,564	6,170,064
Suitable (factor by 1.2)	0	0	404,152	239,627	643,780

5.6 Erosion and Sediment Control innovation and lessons learnt

Sections 5.3 and 5.4 of this CWA outlines the nature of the ESC measures that will be used within the Project. While I consider that innovation will apply to all earthworks activity, those activities with an identified higher risk profile (identified through the CESCP process) will also be subject to more stringent management of both structural and non-structural measures.

Innovative measures are outlined below, and while some of these measures are outlined within GD05, they are identified as innovative for this Project and will assist with ensuring sediment yields are minimised.

- SRP baffles to assist with retention and settlement of sediment within the SRPs;
- SRP reverse slopes towards the inlet better in the base of the main pond structure to assist with settlement of sediment at the entrance to the SRP;
- Sediment sumps in all diversion channels;
- Installation of a last line of defence for all ESCs;
- Stabilisation trials early in the construction process to determine the most appropriate and effective forms of stabilisation for the soil types and environmental conditions. This may incorporate trials of natural fibre based Rolled Erosion Control Products;
- Monitor the results of the water quality sampling (Section 7 of this CWA) to establish a direct link between earthworks activity, stabilisation techniques and their direct effect on sediment yields;
- The use of soil stabilising agents (soil binders) to prevent or reduce the movement of dust from disturbed soil surfaces. Soil binders can also reduce the effect of raindrop erosion and therefore, minimise sediment runoff;
- Email and text notifications for site personnel in response to forecast rain events and heavy rainfall triggers;
- Significant pre, during and post rainfall inspections;
- Educational 'Toolbox' meetings for all site staff on ESC measures;
- Implementation of an adaptive monitoring programme including the continuous sampling and testing of water samples from selected SRP discharge locations; and
- Placing emphasis on engagement of skilled resources with experience in specific activities for where those activities are identified as high risk in the CESCP process.
  - As a key component to this assessment in this CWA, I have assessed previous project implementation, the associated monitoring outcomes and key areas of maintenance issues that were identified. The monitoring outcomes from the Long Bay Development and Puhoi to Warkworth Motorway projects have been further analysed4 and this concludes:
  - The primary reasons recorded for this increased risk (assessed based on site experience and recorded from Long Bay and the NZTA Puhoi to Warkworth Project) is based on maintenance items and a lack of consideration to changing design with catchment areas and associated erosion and Sediment Control devices and chemical treatment systems. In addition, the importance of progressive stabilisation has been emphasised throughout and is a primary consideration for earthworks design.

These maintenance items were illustrated to primarily be non-structural elements and issues. They resulted from on-site resources not implementing actions or lack of design and detail which lead to sediment generation and yield issues. This analysis further reinforces the need to place significant

[4] Appendix A of CWA

emphasis on the non-structural aspects of projects and ensure that appropriate progressive stabilisation remains as a key element of successful Project implementation.

Significant advances in weather forecasting are available from Government agencies such as MetService and Earth Sciences New Zealand that provide detailed ensemble forecasting over longer time periods than those available on publicly available forecasting services. These services provide a higher level of forecast confidence, allowing work planning to be undertaken at the weekly and monthly time scales around weather themes. Given the lineal nature of the Project, and the time period that the works will occur over, I recommend that the Project team investigate the use of advanced weather forecasting services during construction to enable detailed works planning and ESC implementation. This service could be embedded in Project implementation and lead to further reductions in sediment yield through work planning around the weather in advance.

6. Assessment of Effects

6.1 Sediment yield methodology and assessment

The Project works have the potential to result in changes to water quality during the construction phase as a result of:

- discharge of sediment to surface water from sediment retention devices during both rain and flood events;
- discharge of sediment from in-stream activities and changes to flow; and
- discharge of other contaminants (such as oils, fuels and cement).

The methodology applied within this CWA to assess changes in water quality associated with the Project construction works accounts for design and best practice principles, as outlined within Section 4 of this CWA. With recognition of the best practice ESC techniques, it is anticipated that sediment yield due to earthwork and streamwork operations is likely to be the main driver of changes to surface water quality during Project construction. These changes to water quality, and the associated assessment of effects, have been determined through a risk assessment approach considering items such as rainfall, topography, receiving environment values and location and nature of the construction activity including reduced spoil volumes. To obtain a more thorough understanding of the quantum of specific changes to water quality, a sediment yield analysis has been undertaken, based on previous project water quality monitoring results, including from the Puhoi to Warkworth Motorway project, which allows for comparison between the catchment background and Project specific sediment yields as outlined below.

The sediment yield methodology is contained within **Appendix A** of this CWA and is based on analysis of water quality automated monitoring outcomes from various sediment retention devices over the construction period of two separate projects being the Puhoi to Warkworth Motorway project and the Long Bay development. These projects were determined to be suitable for this purpose due to the significant water quality data collection that occurred for them during construction earthworks and also the recent and relevant nature of the Puhoi to Warkworth Motorway.

For this Project, site visits to the Proposed Designation and Indicative Alignment have occurred as part of this CWA development and assessment. These visits have focused on understanding the locations of the major cut and fill activities, spoil sites and also the significant watercourse crossings and activities. These locations include:

- Spoil site locations;
- Flood plain locations north of the Brynderwyns;
- Waihoihoi River; and
- Piroa Stream.

Understanding sediment yield from the proposed earthworks is beneficial and necessary to assist with determination of effects (particularly on freshwater ecology) and to also provide a robust assessment of the need for specific earthworks staging.

To assess the environmental effects related to erosion and sediment yields, the two terrain types (Flat and Hill Country) were assigned a sediment yield based on findings from previous project work and associated monitoring data and outcomes. This monitoring data and outcomes are summarised as below.

Within recent projects, NZTA have utilised a sediment yield model referred to as GLEAMS[5], however due to reasons outside of the control of NZTA, this modelling was not possible for this Project. In addition, where GLEAMS modelling has been previously used on other projects, it has been demonstrated to

[5] Groundwater Loading Effects of Agricultural Management Systems administered by NIWA

overestimate sediment yields. Further to this, previous projects have undertaken extensive water quality monitoring programmes and have collected significant actual data, from similar earthwork activities in similar geographies, which allows for a more accurate determination of likely sediment yields from this Project to be determined.

Universal Soil Loss Equations also provide an option for sediment yield analysis. This approach has some limitations however, as it only provides an annual average sediment yield, does not provide TSS concentrations and primarily identifies comparative sediment yield risk throughout a project.

As a result, the preferred approach for sediment yield modelling for this Project is to rely on existing monitoring data from recent comparable projects and to utilise experienced professional judgement, especially from similar NZTA projects within the same region.

To develop the sediment yield calculations, I have reviewed the quarterly implementation reports produced for the NZTA Puhoi to Warkworth Project, as they provided a comprehensive overview of all samples taken.

Automated monitoring data from the four automated flow and sediment sampling units was analysed to determine the difference between the outlet TSS concentration at the time manual grab samples were taken, and the peak outlet TSS concentration measured during the rain event. This allowed for the results from the automated flow and sediment sampling units to be confirmed.

In addition, Long Bay bulk earthworks monitoring data was also analysed as these earthworks utilised automated sampling with both flow rates and TSS concentrations to determine the resultant sediment yield per hectare.

The data collected for both the NZTA Puhoi to Warkworth Project and Long Bay Project is comprehensive and has been through a robust review process, including an Auckland Council compliance overview. I confirm that this data is representative of the nature of earthworks sediment yields for the Project as the sites have similar soils, contours, methodologies and construction approaches. The NZTA Puhoi to Warkworth Project in particular, also represents a recent NZTA project.

Both the Puhoi to Warkworth and Long Bay projects identify, within independent audit reports, a series of issues for ESC that were experienced during implementation. In addition to the wider site experience of the expert team in ESC implementation, these documented issues allow for a focus on key areas and risk items which can assist in identifying where lessons can be learnt, and where effort can be applied to further reduce sediment generation and yield.

As a general rule, four key conclusions can be drawn from that monitoring data:

- Hill country sediment yields are typically higher than flat country. There is a direct relationship between slope of the earthwork area and sediment generation and yield, with steeper areas generating and yielding more sediment;
- Typically, SRPs performed better than DEBs, representing a more efficient and robust Sediment Control device;
- There are times when very high TSS concentrations were recorded across devices, usually attributable to significant periods of high intensity rainfall spatially distributed across storm events. These were typically short duration periods and not always reflective of the overall eventual sediment yield from a given device or Project; and
- The issues identified as part of the manual grab sampling programme confirmed the importance of effective implementation, as built certification plans updated on a regular basis, and maintenance of all ESC devices.

In the context of the sediment yield analysis therefore, it is recommended that the Project utilise the full knowledge gained from these other projects and, with respect to sediment yields, utilise the worst-case scenario from the NZTA Puhoi to Warkworth Project for a conservative approach. This results in application of the following recommended sediment yield variables:

- For CH 9200 to CH 17700 (8.5 km) a sediment yield of 9.6 tonnes per ha per year for the earthwork activities. This chainage represents the easier flat contour on the northern side of the Brynderwyn Hills.
- For CH 17700 to CH 26200 (8.5 km) a sediment yield of 13.3 tonnes per ha per year for the earthworks activities is to be utilised. This chainage represents the steeper parts of the alignment and also incorporates the rolling contour to the south of the Brynderwyn Hills which is conservatively incorporated into the steeper contour category for the purpose of sediment yield assessments.

As a general principle, the Project should implement an approach that will further reduce the overall sediment loads and will achieve this through applying effort in the individual high intensity rain events. In particular this will be addressed through strategies such as:

- Winter work restrictions;
- Staging areas and having a robust stabilisation strategy;
- Rainfall forecasting, planning and response;
- A focused and dedicated monitoring team; and
- Risk management – knowing where the risks are and addressing those accordingly.

The primary reasons recorded for increased risk of high sediment release (assessed based on site experience and recorded from Long Bay and the NZTA Puhoi to Warkworth Project) is maintenance of ESC measures, and a lack of consideration to changing design within catchment areas with ESC devices and chemical treatment systems. In addition, the importance of progressive land stabilisation has been emphasised throughout and is a primary consideration for earthworks design.

6.2 Sediment yield from forestry harvesting and pasture

For the existing forestry landuse within the Proposed Designation, it is assumed that the exotic forestry will be harvested prior to this Project commencing. As such, the existing environment for these locations is based on a cleared forest landscape. Based on site experience, this "landscape" is expected to be a cleared forest area with existing slash and forest haul roads and access and skid site formations in place. It is further acknowledged that this forest harvesting activity is undertaken in accordance with the National Environmental Standards for Commercial Forestry (NES-CF) which was established to manage the effects of forestry in New Zealand. The forest area requires a harvest plan to be developed and within this the details of ESC measures documented. It is further widely accepted that while these harvesting activities do implement such measures, that they are not to the same standard or scrutiny that applies to bulk earthworks associated with development and roading projects.

While it is assessed that during the forest harvesting operation there will be an increase in sediment generation and yield, it is uncertain as to what the sediment yield will be from the post harvested land use immediately prior to Project earthworks.

In summary it can be concluded from previous forestry experience that:

- Forest harvesting will result in higher sediment yields than the current forested catchment areas and as such the receiving environment will be subject to some sediment inputs from the harvesting activities;
- ESC implementation for forestry harvesting does not reflect the same level expected from bulk earthworks activities and therefore it is assessed that the risk of sediment yield is elevated during that phase; and
- The forest harvesting activities will have a major influence on what this Project "inherits". It is assessed that this could be an impacted downstream environment which is a direct result of the harvesting process and associated earthworks.
- With respect to existing pasture sediment yields, this also is dependent upon the soil types and slope classification for the area in question. While not directly comparable to this Project from a topography

perspective, with this Project having recognised steep topography in Zones 2 to 4, an Auckland Regional Council Study[6] determined that following 17 years of monitoring records, a pasture catchment yielded 0.49 tonnes per ha per year.

- Further studies[7] have confirmed pasture sediment yields between 0.5 and 1.0 tonnes per ha per year.

Overall, while the existing landuse and associated sediment yields do not change the approach this Project will take when commencing earthworks (ESC measures will be installed immediately in accordance with this CWA and future CESCPs), the importance of a water quality monitoring programme pre-Project implementation and post-forestry harvesting, will be important to ensure that the baseline conditions are understood and accounted for within these catchments. This will enable a full understanding of the baseline water quality and erosion and sedimentation of the freshwater system impacted by forest operations.

6.3 Overall Sediment Yield Analysis

The overall cut and fill volumes and associated areas of works is confirmed in Table 5 above.

Overall earthwork areas (including spoil sites) for each zone of works per year is confirmed as below in Table 6. This analysis also accounts for the winter period where it is assessed that a reduced area (and consequential volume) of earthworks will occur in particular a reduced area of works in Earthworks Zones 3 and 4 due in particular to soil types.

[6] Storm Sediment Yields from, Basins with Various Landuses in Auckland Area. Technical Publication No 51. November 1994

[7] Sediment yields from a forested and a pasture catchment, coastal Hawke's Bay, North Island, New Zealand. Landcare Research January 2000 and Map of Total Sediment Yield and Reduction Potential – Our Land & Water Science Challenge - Ag Research

Table 6: Overall Project Earthwork Areas by Catchment

Location Of Earthworks	Construction Year	Percentage of Zone Open	Area of Earthworks (ha) Summer Period	Area of Earthworks (ha) Winter Period	Waihoihoi Summer (ha)	Waihoihoi Winter (ha)	Ahuroa Summer (ha)	Ahuroa Winter (ha)	Wairau Summer (ha)	Wairau Winter (ha)	Pukekaroro Summer (ha)	Pukekaroro Winter (ha)
Zone 1	Year 1	50%	23.4	7.8	16.8	5.6	6.6	2.2	-	-	-	-
Zone 2		50%	18.8	6.3	-	-	18.8	6.3	-	-	-	-
Zone 3		50%	16.8	1.9	-	-	6.0	0.7	10.7	1.2	-	-
Zone 4		25%	9.0	1.0	-	-	-	-	4.9	0.5	4.0	0.4
Spoil Sites Zone 1		50%	4.3	1.4	4.3	1.4	-	-	-	-	-	-
Spoil Sites Zone 2		50%	7.8	2.6	-	-	7.8	2.6	-	-	-	-
Spoil Sites Zone 3		50%	11.3	1.3	-	-	2.2	0.2	9.2	1.0	-	-
Spoil Sites Zone 4		25%	11.7	1.3	-	-	-	-	10.2	1.1	1.5	0.2
Zone 1	Year 2	100%	46.8	15.6	33.7	11.2	13.1	4.4	-	-	-	-
Zone 2		100%	37.6	12.5	-	-	37.6	12.5	-	-	-	-
Zone 3		100%	33.5	3.7	-	-	12.1	1.3	21.5	2.4	-	-
Zone 4		25%	9.0	1.0	-	-	-	-	4.9	0.5	4.0	0.4
Spoil Sites Zone 1		100%	8.5	2.8	8.5	2.8	-	-	-	-	-	-
Spoil Sites Zone 2		100%	15.6	5.2	-	-	15.6	5.2	-	-	-	-
Spoil Sites Zone 3		100%	22.7	2.5	-	-	4.3	0.5	18.4	2.0	-	-
Spoil Sites Zone 4		25%	11.7	1.3	-	-	-	-	10.2	1.1	1.5	0.2
Zone 1	Year 3	100%	46.8	15.6	33.7	11.2	13.1	4.4	-	-	-	-
Zone 2		100%	37.6	12.5	-	-	37.6	12.5	-	-	-	-
Zone 3		100%	33.5	3.7	-	-	12.1	1.3	21.5	2.4	-	-
Zone 4		25%	9.0	1.0	-	-	-	-	4.9	0.5	4.0	0.4
Spoil Sites Zone 1		100%	8.5	2.8	8.5	2.8	-	-	-	-	-	-
Spoil Sites Zone 2		100%	15.6	5.2	-	-	15.6	5.2	-	-	-	-
Spoil Sites Zone 3		100%	22.7	2.5	-	-	4.3	0.5	18.4	2.0	-	-
Spoil Sites Zone 4		25%	11.7	1.3	-	-	-	-	10.2	1.1	1.5	0.2
Zone 1	Year 4	67%	31.4	10.5	22.6	7.5	8.8	2.9	-	-	-	-
Zone 2		67%	25.2	8.4	-	-	25.2	8.4	-	-	-	-
Zone 3		67%	22.5	2.5	-	-	8.1	0.9	14.4	1.6	-	-
Zone 4		25%	9.0	1.0	-	-	-	-	4.9	0.5	4.0	0.4
Spoil Sites Zone 1		67%	5.7	1.9	5.7	1.9	-	-	-	-	-	-
Spoil Sites Zone 2		67%	10.5	3.5	-	-	10.5	3.5	-	-	-	-
Spoil Sites Zone 3		67%	15.2	1.7	-	-	2.9	0.3	12.3	1.4	-	-
Spoil Sites Zone 4		25%	11.7	1.3	-	-	-	-	10.2	1.1	1.5	0.2
Zone 1	Year 5 (No Earthworks)	0%	-	-	-	-	-	-	-	-	-	-
Zone 2		0%	-	-	-	-	-	-	-	-	-	-
Zone 3		0%	-	-	-	-	-	-	-	-	-	-
Zone 4		0%	-	-	-	-	-	-	-	-	-	-
Spoil Sites Zone 1		0%	-	-	-	-	-	-	-	-	-	-
Spoil Sites Zone 2		0%	-	-	-	-	-	-	-	-	-	-
Spoil Sites Zone 3		0%	-	-	-	-	-	-	-	-	-	-
Spoil Sites Zone 4		0%	-	-	-	-	-	-	-	-	-	-

Based on these areas of works, the following sediment yield analysis findings for each catchment area is provided in Table 7 below.

Table 7: Project Sediment Yield Analysis

Waihoihoi Summer Sed Yields (tonnes)	Waihoihoi Winter Sed Yields (tonnes)	Ahuroa Summer Sed Yields (tonnes)	Ahuroa Winter Sed Yields (tonnes)	Wairau Summer Sed Yields (tonnes)	Wairau Winter Sed Yields (tonnes)	Pukekaroro Summer Sed Yields (tonnes)	Pukekaroro Winter Sed Yields (tonnes)
97.0	21.6	37.7	8.4	-	-	-	-
-	-	149.9	33.3	-	-	-	-
-	-	48.2	3.6	85.6	6.3	-	-
-	-	-	-	39.5	2.9	32.3	2.4
24.6	5.5	-	-	-	-	-	-
-	-	62.3	13.9	-	-	-	-
-	-	17.2	1.3	73.3	5.4	-	-
-	-	-	-	81.3	6.0	12.1	0.9
194.1	43.1	75.5	16.8	-	-	-	-
-	-	299.8	66.6	-	-	-	-
-	-	96.3	7.1	171.3	12.7	-	-
-	-	-	-	39.5	2.9	32.3	2.4
49.2	10.9	-	-	-	-	-	-
-	-	124.7	27.7	-	-	-	-
-	-	34.4	2.5	146.6	10.9	-	-
-	-	-	-	81.3	6.0	12.1	0.9
194.1	43.1	75.5	16.8	-	-	-	-
-	-	299.8	66.6	-	-	-	-
-	-	96.3	7.1	171.3	12.7	-	-
-	-	-	-	39.5	2.9	32.3	2.4
49.2	10.9	-	-	-	-	-	-
-	-	124.7	27.7	-	-	-	-
-	-	34.4	2.5	146.6	10.9	-	-
-	-	-	-	81.3	6.0	12.1	0.9
130.0	28.9	50.6	11.2	-	-	-	-
-	-	200.9	44.6	-	-	-	-
-	-	64.6	4.8	114.8	8.5	-	-
-	-	-	-	39.5	2.9	32.3	2.4
33.0	7.3	-	-	-	-	-	-
-	-	83.5	18.6	-	-	-	-
-	-	23.0	1.7	98.3	7.3	-	-
-	-	-	-	81.3	6.0	12.1	0.9
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-

Tonnes Sediment	Waihoihoi	Ahuroa	Wairau	Pukekaroro
Year 1 Sed Yields	148.7	375.7	300.4	47.7
Year 2 Sed Yields	297.3	751.5	471.1	47.7
Year 3 Sed Yields	297.3	751.5	471.1	47.7
Year 4 Sed Yields	199.2	503.5	358.4	47.7
Year 5 Sed Yields	-	-	-	-

Importantly, this sediment yield provides an indicative tonnage of sediment that will leave the Sediment Control devices assuming that the full area of earthworks is open at any one time as per Table 7 above. Some key assumptions can be made regarding the earthworks:

- The Project will be subject to bulk earthworks for a 4-year period.
- Earthworks will progressively increase in area over the first year of construction.
- Winter works restrictions between 1 May and 30 September will apply due to wet weather and cold soil conditions over that period which will restrict earthwork areas that can be effectively managed.
- Zone 1 and 2 earthworks over the winter period are reduced to 25% of summer works – this is a reflection of the earthwork material types.

- Zone 3 and 4 earthworks over the winter period are reduced to 10% of summer works – this is a reflection of the earthwork material types not permitting a lot of winter earthworks.
- Specific to Zone 4 earthworks are spread over 4 years and assumed that each year the earthworks undertaken will effectively be stabilised that same year.

When these sediment yields are assessed in the context of the wider catchment areas and background sediment yields, the percentage contribution from the Project to the wider catchment can be determined for the full 4-year bulk earthworks construction period. To determine the wider catchment sediment yield the pasture sediment yield from previous studies[8] has been used based on 0.75 tonne per ha per year. This is calculated in Table 8 below.

Table 8: Project Catchment Sediment Contribution

Catchment	Catchment Area (ha)	Catchment Wide Sediment Yield (tonnes) Without Project	Catchment Wide Sediment Yield (tonnes) with Project	Project Sediment Yield Contribution (%)
Waihoihoi	6521	19,563	20,505.50	4.60
Ahuroa	8505	25,515	27,897.20	8.54
Wairau	2731	8,193	9,794.10	16.35
Pukekaroro	3773	11,319	11,509.90	1.66

The Assessment of Effects on Freshwater Ecology (Appendix 7D of Volume B) has confirmed that overall, stream quality across these catchments are low to moderate, reflecting a mix of remnant natural headwater values and widespread modification. While some catchments (notably Waihoihoi, parts of Wairau and Pukekaroro, and limited tributaries such as the Piroa east and west) retain relatively higher-quality headwater habitats associated with native or plantation forest, most streams are affected by historic land use, reduced riparian cover, elevated sedimentation, water quality issues, and invasive species. Many reaches intersected by the Proposed Designation occur high in catchments and are partially intermittent, further limiting ecological value.

Overall, the sediment yields estimated from the Project for the 4-year bulk earthworks construction period are confirmed to be of an overall low percentage of the full catchment area sediment yield of the Waihoihoi, Ahuroa and Pukekaroro catchments. When this is considered in association with the conservative nature of the sediment yield estimate, being the worst-case sediment yield scenario from the NZTA Puhoi to Warkworth Project, it is assessed overall that there is no requirement for an earthworks open area limitation for the Project within these catchments. However, the importance of progressive stabilisation and ensuring that effective structural and non-structural ESC are implemented remains a key consideration.

In further support of the overall progressive stabilisation approach, it remains a key assessment criteria that a provision of a 14-day maximum period be applied over the full Project whereby earthworks not subject to daily operating earthworks activity for more than a 14-day period will require full stabilisation. This has the immediate effect of preventing areas of earthworks being exposed unless they are subject to an active earthworks programme and as soon as those earthworks are completed, the area of works will require immediate stabilisation.

For the Wairau Catchment the sediment yield contribution from the Project earthworks for the 4-year bulk earthworks construction period for the catchment is 16%. This higher percentage yield is due to the smaller overall catchment area and the relatively large area of spoil sites that are required within this location.

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[8] Section 6.2 of CWA

Spoil sites within this catchment have been subject to further analysis to ensure they reflect more accurately the ground contours, existing infrastructure limitations and also avoidance where possible of stream systems. Through the sediment yield analysis process this spoil site rationalisation exercise has resulted in a greatly reduced sediment yield for the catchment than that previously assessed which was based on generalised spoil site locations. This percentage Project sediment contribution has also been assessed within the Assessment of Effects on Freshwater Ecology (Appendix D7 of Volume B) as having a 'low impact'.

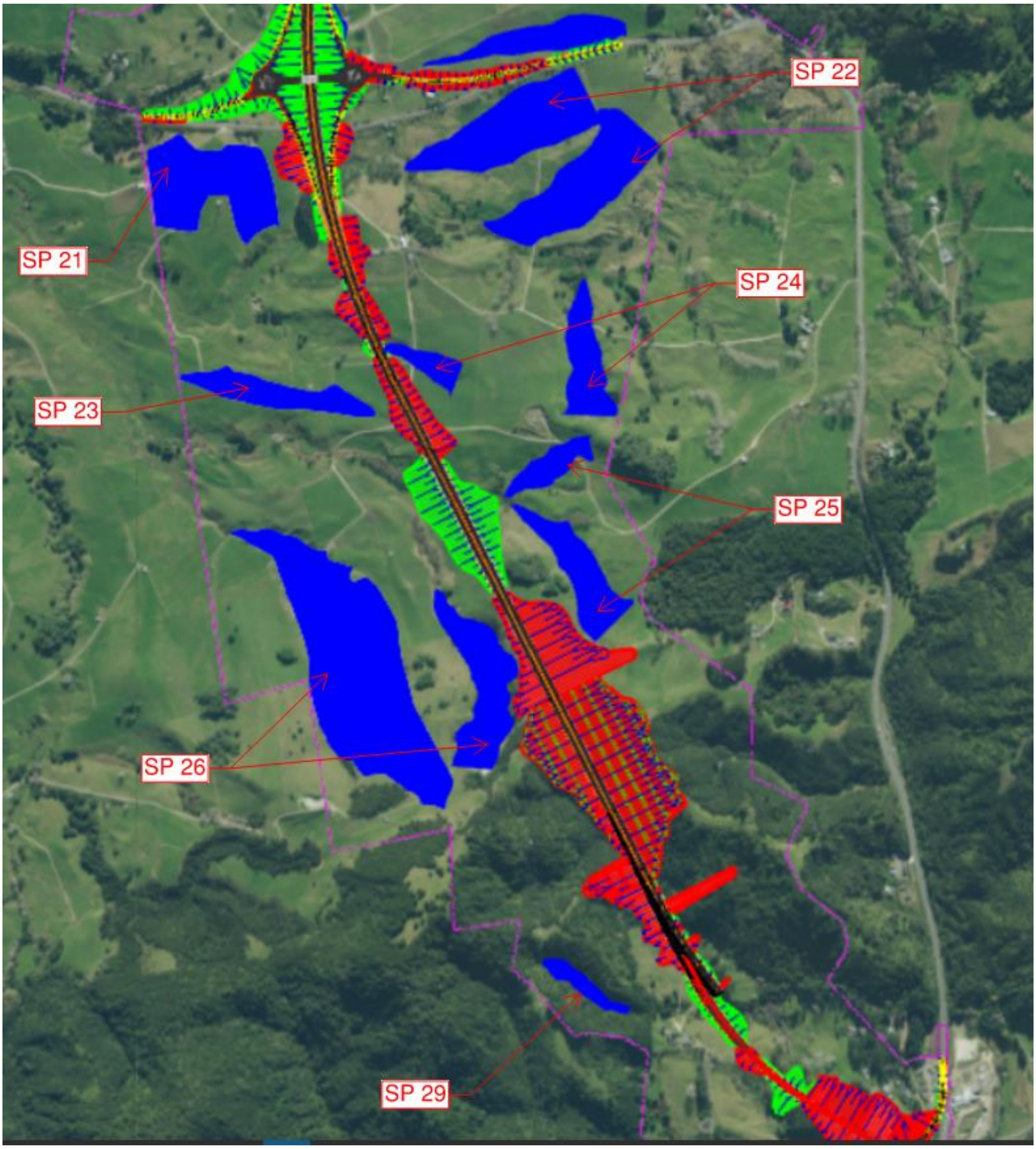


Figure 3: Updated Spoil Site Locations Wairau Catchment

As with the rest of the Project, it is recommended that all earthworks in this catchment location, including the spoil sites, be subject to a detailed risk assessment and management approach to be developed within the CESCP process. Through these CESCPs, emphasis should continue to be based on the 14-day stabilisation period and use of non-structural techniques.

6.4 Erosion and Sediment Control risk management

6.4.1 Overall risk approach

The Project is linear in nature and will involve works occurring on several fronts. The earthworks areas will be subject to ongoing stabilisation as works progress to minimise the potential for erosion.

I consider the key elements of construction related environmental risk for this Project to be the exposure of bare land, the steep nature of the topography in sections of the Project within which earthworks activity be carried out and works within or adjacent to watercourses.

Key sources of this risk are assessed as:

- Works within and adjacent to watercourses and wetlands such as culvert placement, stream diversions and bridge works. This includes the Piroa Stream work activities;
- Cut and fill operations in steep areas; and
- Spoil site establishment and operation.

To assist with an understanding of the nature and magnitude of this risk I have evaluated the existing topography and location of freshwater systems through site visits and plan assessments. In addition, through the development of CESCPs, The Project will confirm and identify steeper locations as higher risk and will manage this accordingly.

My assessment confirms:

- Slopes exceeding 15 degrees will be subject to a high level of detailed design and ongoing contractor monitoring, as defined through the continuous improvement monitoring programme;
- The continuous improvement monitoring programme will focus on pre-forecast rainfall monitoring and post rainfall monitoring to ensure all controls are in place, have worked as intended and are achieving effective outcomes;
- The area of Project earthworks will be undertaken in various stages. The risk from the earthworks themselves can be reduced by reducing exposed open areas at any one time and to achieve this through progressively stabilising as works proceed with a 14-day maximum period as noted above; and
- It is recommended that as part of the CESCP process, that risk be specifically identified, the nature of the risk understood, the exposure of works to heavy rainfall are assessed and specific actions to manage this risk are identified and implemented.

6.4.2 Winter works

It is also recognised that wetter periods of the year (e.g. May to September), which also corresponds to colder air and soil temperatures, may pose a higher risk for sediment discharges. This is due to increased rainfall, saturated soil profiles and also cooler temperatures reducing the ability for revegetation to occur. Earthworks within this period will need to reflect this higher risk which will be achieved through the CESCP process, whereby works during wetter periods will require additional management procedures. This is supported by winter works “restrictions” where works over that period will be aligned with the climatic conditions and also the CESCP process which includes the identification of risk and risk management.

In some areas, earthworks activities will likely to be required during the winter months and in accordance with the Northland Regional Council winter works standard procedures, should winter works be required in any given year, a winter works application will be prepared and submitted in writing by 1 April. This application will include:

- The nature of the proposed winter works, including the proposed locations;
- Identification of higher risk activities and locations;

- The proposed ESC methodologies and any additional ESCs required to manage the higher risk associated with working during the wetter winter period (e.g. chemical treatment of sediment retention ponds); and
- The proposed monitoring and maintenance schedule of the proposed ESC methodologies.

For the winter period, the risk assessment which shall be undertaken within the CESCP process will specifically consider:

- The scope/nature of the proposed works;
- Structural controls proposed, or existing, that will be/are installed;
- Additional non-structural controls to be implemented (e.g. increased on site monitoring and staging);
- Stabilisation measures and procedures appropriate to winter conditions; and
- Maintenance consideration of structural controls to ensure effective access can be achieved to undertake the maintenance and controls continue to work efficiency.

6.5 Recommendations

Key recommendations from my assessment are as follows:

- All earthworks will be subject to:
  - Detailed CESCP processes;
  - Winter work restrictions;
  - Staging areas and having a robust stabilisation strategy;
  - Rainfall forecasting, planning and response;
  - Emphasis on non-structural ESC elements at all times;
  - A focused and dedicated monitoring team; and
  - Risk management – knowing where the risks are and addressing those accordingly.
- As part of the Project construction, a stabilisation trial will be initiated to determine the most effective form of stabilisation for the various soil types that will be encountered.
- For all Project earthworks, a 14-day maximum period will be applied whereby earthworks not subject to daily operating earthworks activity for more than a 14-day period will require full stabilisation.
- Risk management will form part of all earthworks and be reflected in the CESCP process where the risk will be specifically identified, the nature of the risk understood, the exposure of works to heavy rainfall are assessed and specific actions to manage this risk are identified and implemented.
- Key Project locations of risk are assessed as:
  - Works within and adjacent to watercourses and wetlands such as culvert placement, stream diversions and bridge works. This includes the Piroa Stream work activities;
  - Cut and fill operations in steep areas;
  - Spoil site establishment and operation; and
  - Slopes exceeding 15 degrees.
- A water quality monitoring programme, pre-Project implementation and post-forestry harvesting, will be important to ensure that the baseline conditions are understood and accounted for within these catchments.

- A Continuous Improvement Programme (CIP) will be implemented which will focus on pre-forecast rainfall monitoring and post rainfall monitoring to ensure all ESC structural and non-structural devices are in place, have worked as intended and are achieving effective outcomes.

6.6 Summary of assessment

From an overall Project perspective, I assess that, provided this CWA is implemented effectively and the recommendations within Section 6.5 above are complied with, the effects of Project earthworks and any associated sediment yield will be minor.

The following key points are noted for the Project.

- Works associated with the steep topography of the Project are of a higher risk and need careful and pro-active management and monitoring to ensure that the construction effects are minor.
- A range of ESC measures, including innovative approaches, are proposed on the Project. ESCs will be based on both structural and non-structural measures with an emphasis placed on the non-structural management techniques as detailed above.
- The Project's will rely on CESCPs to be submitted at a later date, before any construction activity takes place, to allow for contractor input.
- A continuous improvement monitoring programme will be implemented which will allow for ongoing continuous improvement of the construction water methodologies.

I confirm the importance of the recommendations that reflect the approach as outlined within this CWA and in particular the CESCP process and continuous improvement monitoring regime.

If the ESC measures outlined in this CWA are designed, implemented and maintained as best practice, I consider that any sediment yields, resulting from the earthworks and construction activities can be managed with minor effects.

6.7 Alignment changes within the Proposed Designation

The Indicative Alignment within the Proposed Designation represents a possible alignment which has been developed for assessment purposes and to illustrate what the Project's final design might look like, and the effects generated by its construction and associated earthworks. The alignment that gets built, including the design and placement of bridges, culverts, stormwater systems, soil disposal areas and landscaping, will be refined and confirmed during the detailed design stage.

As a result, this assessment has anticipated impacts within the Proposed Designation, rather than just the Indicative Alignment. The recommended mitigation methods and proposed conditions establish outcome-based criteria that will ensure effects on the environment are adequately avoided, remedied or mitigated, regardless of the final design and construction methodology for the Project. As such, should the final alignment within the Proposed Designation change, the effects assessment, proposed mitigation and recommendations outlined in this CWA are anticipated to remain appropriate although some review maybe necessary.

7. Monitoring Recommendations

7.1 Monitoring Requirements

I recommend that a continuous improvement monitoring programme be developed (referred to as a CIP) and implemented for the construction phase of the Project.

The primary objectives for the CIP are outlined as follows:

- To provide information for making effective decisions on necessary continuous improvement of ESC measures (both structural and non-structural);
- To assist in understanding the outcome of on-site decisions to water quality and stream ecology, and support any determination of potential ecological effects from sediment discharged by the Project earthworks; and
- To quantify potential sediment discharges from the Project and enable appropriate site management responses and mitigation to be identified to reflect sediment yields.

As part of this process, there is also the ability to understand the potential for downstream effects and managing the construction activity and associated controls to minimise any effects.

The CIP will be implemented by suitably qualified and experienced staff in construction water management to identify changing site conditions and continuous improvement opportunities in response to the monitoring outcomes. This is a key element of success.

Overall, the CIP provides certainty that the construction activity continues to utilise best practice, allows for innovation to be implemented, allows for identification of risk, provides a scientific and robust basis (based on water quality outcomes) for making decisions on site and finally, provides a realistic and effective "backstop", should effectiveness of the measures be compromised, prior to any effects occurring.

This CIP includes ongoing site monitoring to check that the proposed water management measures have been installed correctly and that methodologies are being followed and are functioning effectively throughout the duration of the works.

The key components of the CIP will include:

- Weather forecasting;
- On-site monitoring of devices;
- Receiving environment visual assessments;
- Flocculation monitoring; and
- Quantitative water quality and flow monitoring.

7.1.1 Weather forecasting

Weather forecast monitoring will form an important part of the Project implementation to ensure that higher risk activities, such as those associated with the stream diversions, will only occur during a suitable fine weather window.

I note the extensive use of weather forecasting that now occurs with most land-disturbing activities and the value that it provides in informing contractors of upcoming weather systems. The forecasting tools include publicly available forecasting services (i.e. MetService, Earth Sciences NZ and MetVUW) and this has proven successful in the past and will continue to be utilised for this Project.

I further recommend that the use of commercial weather forecasting models be investigated for the Project to provide a more detailed, longer range forecasting model for implementation on the Project.

Weather forecasting has proven to be a successful management tool in avoiding high risk stream works over wetter periods of the year and protecting works prior to forecast intense rainfall periods. It also provides guidance for activities such as when temporary stabilisation must occur.

7.1.2 On site implementation of devices

Monitoring of onsite devices is based upon the appropriate installation, location, maintenance, and monitoring of control devices. It is important that within the context of monitoring, the devices are not restricted to physical structures and will also include work practices and methodologies.

The purpose of the devices monitoring is to check that all practices, control measures and devices are designed, constructed, operated and maintained so they remain fully effective at all times. The requirement to undertake as-built certification of the control measures once constructed will assist with ensuring that controls are appropriately installed to the necessary design criteria.

7.1.3 Receiving environment visual assessments

Visual assessments of the receiving environment will be undertaken regularly throughout the works period with particular attention paid before, during and after periods of rainfall. In the context of visual assessment, the receiving environment is defined as the immediate receiving environment adjacent to the area of works including receiving rivers and streams.

Any noticeable change in water clarity in a receiving river or stream as a result of the earthworks activity, compared to the water clarity prior to the rainfall event or upstream of the site of works, will result in a review of the ESC measures. Additional measures may need to be implemented, and changes made as necessary under the continuous improvement management procedures.

7.1.4 Flocculation monitoring

While the careful use of chemicals (e.g. coagulants and flocculants) at SRP's and DEBs at the correct dose rate has the positive effect of improving treatment efficiencies, overdosing can have negative impacts if residual compounds leave with the pond discharge and enter receiving waters. Overdosing should, as far as practicable, be avoided or addressed by identifying the indicators below.

Low pH and residual dissolved aluminium in any SRP or DEB outflow is an indication of overdosing with PAC and a common visual indicator is that the water appears to be tinted blue-green.

When utilising PAC, it is proposed to adopt visual observation and pH testing to monitor SRPs and DEBs where this chemical treatment is used, and apply the following management triggers:

- Water visually appears to be tinted blue-green; and/or
- pH of less than 5.5 at the SRP or DEB outflow.

Chemical use should be reassessed if data shows that the current chemical flocculation methods are exceeding the above triggers. It is noted that some of the flocculants available have no effect on pH levels and if such chemicals are used on this Project, then there will be no requirement to monitor discharge pH levels. Where other chemical flocculants are used, specific monitoring parameters (if any) shall be set out in the relevant CESCPs.

7.1.5 Quantitative monitoring

In addition to the on-site qualitative monitoring of water management devices, quantitative monitoring is recommended on the Project. The objective of this monitoring programme is to provide water quality data for an array of rainstorms of different magnitudes and intensities, as well as providing information on the total sediment yield from the site during the earthworks period. This information will further assist with the interpretation of the ecological monitoring during construction.

The quantitative sediment monitoring programme will assist with determination of any effects that may result downstream, the need for modifications to the ESC mechanisms, including any determination of effects on the freshwater environment.

Rain Event Trigger Levels

It is recommended that following a rainfall trigger event (defined as 25 mm within a 24-hour period or 15 mm within a 1 hour period) that manual monitoring of outflows associated with a selection of high risk SRPs and a selection of high-risk DEBs will occur where practicable. This manual monitoring supplements the automatic sampling (as below) and allows for comparative analysis between samples. In addition, monitoring of the receiving environment through manual sampling, both upstream and downstream of discharges, will occur where practicable.

Continuous Flow and Discharge Monitoring

It is recommended that continuous discharge flow monitoring will occur on the outflows from four selected SRPs with two of these to best represent a high-risk location of the earthworks on the Project and two of these to represent the design and construction for general earthwork activities. The process for identification of the location of these devices is recommended to be detailed within the CIP. The flow monitoring device can be moved as the Project progresses. Flows will be recorded electronically, and this information will enable sediment yields to be calculated.

Automatic continuous sediment sampling will also occur to measure turbidity (as an indicator of total suspended solids concentration through calibration) through storm events from the same four SRPs subject to flow measurement. Sediment monitoring will be undertaken using an automatic water sampler at the flow monitoring site to take samples spaced at volume (flow proportional) intervals that will be selected to ensure that as close as practicable to the total construction runoff from a major rainstorm event is monitored. It is recommended that the suspended solids concentrations of the samples be tested (or an alternative water quality parameter that can be related to suspended solids concentrations), and in association with the flow data will be used to determine the sediment yields for that location. This data will also inform the total Project actual sediment yields over time.

Management Triggers

Management triggers will be identified as part of the CIP and will include a percentage increase over baseline (or upstream values) of suspended solids or turbidity.

These management triggers are not indicative of actual effects occurring, however they do allow early detection of potential on site issues and the ability to take action on these. Baseline monitoring of freshwater receiving environments prior to commencement of works will assist with determination of these triggers.

If monitoring results confirm management triggers are exceeded, the following steps are recommended:

- In the first instance, investigate a possible (cause-effect) association with the Project;
- Should this investigation establish linkages between any effect and on-site practices, then investigate alterations to the operational methods (including modifications to environmental control measures and methodologies) as a first order response;
- Assess the effectiveness of the alterations in construction methods by conducting further monitoring to alleviate/avoid adverse effects on the environment; and
- Assess the need for, and nature of, any remedial action including ecological response.

I consider that the implementation of the overall CIP will provide ‘checks and balances’ and will ensure that potential effects are identified early to allow intervention and that there is the opportunity for continuous improvement as necessary throughout the construction period. Importantly the monitoring programme will include a reporting requirement where rainfall trigger events will result in event reporting to NRC.

8. Conclusion

Effects from earthwork activities during the construction phase of the Project could occur as a result of the area and volumes of earthworks required. Within this CWA I have confirmed a suite of structural and non-structural measures that will require implementation throughout the construction period. These measures and methodologies are proven in previous projects, and it is my assessment these will remain effective for this Project.

Key Project considerations and recommendations include:

- Emphasis on non-structural elements and ensuring that conditions of consent and implementation strategies clearly identify these for implementation;
- The use of CESCPs allows for ongoing flexibility and input into earthwork methodologies and ESC measures to be implemented. This process will allow for ongoing adaption of ESC measures as necessary;
- The progressive stabilisation of earthworks as they progress with a maximum 14-day period of "inactive" earthworks remains as a key tool in ensuring sediment generation and yield from open areas is reduced; and
- The CIP forms a key recommendation and will provide confirmation of the actual water quality outcomes from construction activities which will feed into the ongoing continuous improvement of all ESC aspects.

With implementation of the CWA recommendations, potential adverse effects caused by construction earthworks will be mitigated such that the overall effect of the Project on the environment will be minor.


APPENDICES

Appendix A

Sediment Yield Memo

Technical Memorandum

To: NZTA – Alternative to the Brynderwyn Hills (Brynderwyn Hills Section)

From: Graeme Ridley, Ridley Dunphy Environmental Limited.

Reviewer: Glenn Pope, Ridley Dunphy Environmental Limited

Date: 27th March 2026

Re: Sediment Yield Option Analysis – NZTA : Alternative to Brynderwyn Hills – Brynderwyn Hills Section (the Project)

1.0 SCOPE

Through the development of the erosion and sediment control assessment scope for the above project it was determined that understanding sediment yield from the proposed earthworks is necessary to allow for determination of effects (particularly on freshwater ecology) and to provide for a robust assessment of the need for open area limitations and staging requirements.

With recent project experience, NZTA have utilised a sediment yield model referred to as GLEAMS[1] however, due to reasons outside of the control of NZTA this model is not an option at this time. Universal Soil Loss Equations also provide an option for sediment yield analysis, however, this approach is acknowledged as having limitations as it only provides an annual average sediment yield, does not provide for any TSS concentrations, and has the primary purpose of identifying comparative sediment yield risk throughout a project.

Consideration was given to various approaches, with the preferred approach being to rely on existing monitoring data from recent projects and professional judgement. This memorandum provides a summary of the approach adopted.

The NZTA Puhoi to Warkworth Project and the Long Bay Project were both assessed as representative of the nature of earthworks sediment yields for sites with similar soils and contours and with similar methodologies and approaches. The NZTA Puhoi to Warkworth Project in particular, also represents a recent NZTA project.

[1] *Groundwater Loading Effects of Agricultural Management Systems administered by NIWA*

2.0 PUHOI TO WARKWORTH BACKGROUND AND MONITORING

The NZTA Puhoi to Warkworth Project Construction Water Assessment Report (CWAR) was prepared during the consenting phase of that project and provides an assessment of the construction water effects of the NZTA Puhoi to Warkworth Project. The CWAR provided a comprehensive assessment of anticipated sediment yields for the two primary catchments across the site, being, Mahurangi catchment and Puhoi catchment. Separate sediment yields were established[2] for the Mahurangi Hill country and Mahurangi Flat country. These sediment yields were used to inform the open area restrictions prescribed in consent conditions for that project. The sediment yields were expressed in t/ha/year and are shown in the following table.

Area	Construction sediment yield t/ha/year
Mahurangi flat country	22.9
Mahurangi hill country	49.1
Puhoi hill country	49.1

The NZTA Puhoi to Warkworth Project also had an adaptive monitoring plan in place with this requiring pre and post trigger rain event inspections for each forecast rain trigger event. These inspections were to ensure maintenance of environmental controls and additional measures such as cut off drains and bunds were installed prior to rain.

Consent conditions also required manual grab sampling (to determine Total Suspended Solid (TSS) concentrations) at the outlet of all sediment retention ponds (SRPs) and selected decanting earth bunds (DEBs) during, or immediately after, rainfall events which exceeded 25mm/24-hour and/or 15mm/hour.

In addition, 4 automated flow and sediment sampling units were established (setup in May and June 2018). The automated flow and sediment sampling units triggered a sample when the water level in the pond weir rose above a pre-determined level and sampling stopped when the levels fell below this level. The samplers were setup in the inlet and outlet of each of the 4 selected sediment control devices. A maximum of 96 samples were taken by each automated flow and sediment sampling unit during an event, with 4 samples taken per sample bottle (24 sample bottles).

2.1 Puhoi to Warkworth Manual Grab Sampling

The summary and findings of the manual grab samples are as set out below. Quarterly reports were produced for the NZTA Puhoi to Warkworth Project during implementation and these provided a comprehensive overview of all samples taken. These manual grab sample outcomes are summarised

[2] *Utilising GLEAMS modelling*

below, and as part of the development of this memorandum Quarterly periods where higher rainfall or higher TSS concentrations were observed are summarised as follows.

Quarterly Period to June 2018

During this quarter there are some instances where water continues to discharge from the SRP beyond the sampling period of the automated samplers. Due to health and safety reasons, some samples can not be collected from sediment retention devices – particularly in hill country areas, where access tracks became slippery after high rainfall events.

The average TSS grab samples for the quarter are as below, and are shown between hill country and flat country. These results are slightly skewed due to a few samples where TSS levels over 500 g/m^3 were recorded.

Average for 6 Events for Quarter - Flat	**40.7**	**260.3**	**3579.4**
Average for 6 Events for Quarter - Hill	**82.3**	**505.9**	**392.3**
	Rainfall (mm)	**SRP TSS**	**DEB TSS**

Importantly the grab samples illustrated some periods of high TSS concentrations at the outlet samples, but these were not subject to automated sampling devices which were installed on other SRPs and DEBs. The individual outlet grab samples were however analysed and assessed and a sediment yield for each of these devices estimated.

Quarterly Period to June 2019

Average for 5 Events for Quarter - Flat	**21.5**	**109.8**	**224.8**
Average for 5 Events for Quarter - Hill	**25.3**	**4885.1**	**270.7**
	Rainfall (mm)	**SRP TSS**	**DEB TSS**

Three very high TSS concentrations were recorded within this quarter due to failure of items such as catchments area diverted to the incorrect device and pipe failures. The results from this quarter illustrate the importance of as built plans and pre rain inspections.

Quarterly Period to September 2022

	Average for 7 Events for Quarter - Flat	50.1	NA	NA	
	Average for 7 Events for Quarter - Hill	44.7	181.6	239.5	
		Rainfall (mm)	SRP TSS	DEB TSS	

As a general rule 4 key conclusions can be drawn from this monitoring data:

- Hill country sediment yields are typically higher than flat country. There is a direct relationship between slope of the earthwork area and sediment generation and yield with steeper areas generating and yielding more sediment;
- Typically, SRPs performed better than DEBs representing a more efficient and robust sediment control device;
- There are times when very high TSS concentrations are recorded. These are typically short duration periods and are not always reflective of a high sediment yield; and
- The issues identified as part of the manual grab sampling programme confirm the importance of effective implementation, as built certification plans that are updated on a regular basis and maintenance of all erosion and sediment control devices.

2.2 Puhoi to Warkworth Automated Sampling

For the NZTA Puhoi to Warkworth Project, the validity of a sediment yield (t/ha/yr) derived from manual grab samples is limited as manual grab samples do not capture fluctuations in outlet TSS concentrations over the duration of a rain event. To address this, the automated monitoring data from the 4 automated flow and sediment sampling units was analysed at the time to determine the difference between the outlet TSS concentration at the time manual grab samples were taken, and the peak outlet TSS concentration measured during the rain event. The NZTA Puhoi to Warkworth Project expressed this as a ratio for each of the 4 automated flow and sediment sampling units and re-calculated sediment yields accordingly.

The results from the automated flow and sediment sampling units are confirmed within the table as follows. This illustrates the sediment yield based on grab sampling only, the sediment yield based on a worst-case mean multiplier , and the sediment yield based on a worst-case median multiplier.

Quarter End	Grab Sample Yield from NX2 Report (t/ha/yr Extrap) - Mah Flat	Grab Sample Yield from NX2 Report (t/ha/yr Extrap) - Puhoi Flat	Grab Sample Yield from NX2 Report (t/ha/yr Extrap) - Mah Hill	Extrapoltaed Yield Worst Case Mean Multiplier Applied (t/ha/yr) - Mah Flat	Extrapoltaed Yield Worst Case Mean Multiplier Applied (t/ha/yr) - Puhoi Flat	Extrapoltaed Yield Worst Case Mean Multiplier Applied (t/ha/yr) - Mah Hill	Extrapoltaed Yield Worst Case Median Multiplier Applied (t/ha/yr) - Mah Flat	Extrapoltaed Yield Worst Case Median Multiplier Applied (t/ha/yr) - Puhoi Flat	Extrapoltaed Yield Worst Case Median Multiplier Applied (t/ha/yr) - Mah Hill
Mar-18	0.168	0.426	0.326	NA	NA	NA	NA	NA	NA
Jun-18	1.72	6.92	7.12	NA	NA	NA	NA	NA	NA
Sept-18	0.48	3.2	0.72	NA	NA	NA	NA	NA	NA
Dec-18	0.92	0.44	1.72	NA	NA	NA	NA	NA	NA
Mar-19	0.00002	0.001	0.016	NA	NA	NA	NA	NA	NA
Jun-19	0.24	0.54	28.4	2.15	5.5	40.4	1.45	3.71	27.22
Sept-19	1.48	1.4	2.48	NA	NA	NA	NA	NA	NA
Dec-19	0.76	0.6	1.48	NA	NA	NA	NA	NA	NA
Mar-20	0	0	0	NA	NA	NA	NA	NA	NA
Jun-20	0.24	0.96	0.216	5.31	4.1	5.54	4.72	3.65	4.93
Sept-20	1	1.12	3.04	3.64	9.81	8.61	3.44	9.29	8.15
Dec-20	4.08	1.84	1.42	8.39	6.18	7.37	8.19	6.04	7.19
Mar-21	0.16	0.76	0.92	0.44	2.12	2.57	0.24	1.17	1.41
Jun-21	2.48	0.52	0.72	20.3	11.15	15.9	10.24	5.62	8.07
Sept-21	5.12	2.99	1.04	31.1	16.06	10.7	15.7	8.1	5.43
Dec-21	2.19	1	0.65	26.173	13.85	8.763	13.211	6.99	4.423
Mar-22	0.08	0.16	0.48	25.96	12.27	7.6	13.1	6.19	3.83
Jun-22	0	0.28	1.28	19.46	11.68	9.05	9.82	5.89	4.57
Sept-22	0	2.8	11.48	18.9	18.9	38.9	9.5	9.5	19.6
Dec-22	0	1.16	2.84	0.21	11.62	42.29	0.11	6.41	21.35
Mar-23	0	7.36	7.92	NA	19.36	20.83	NA	9.77	10.51
Avergae	**1.01**	**1.64**	**3.54**	**13.50**	**10.97**	**16.81**	**7.48**	**6.33**	**9.74**

Summary Table	Overall Flat Average (exclud just grab samples)	Overall Hill Average (exclud just grab samples)	Highest Flat Yield	Highest Hill Yield
t/ha/year from EW	9.57	13.28	26.173	42.29

Table 1. NZTA Puhoi to Warkworth Project Sediment Yield Analysis

This sediment yield analysis confirms that with the multiplier applied to take account of grab sampling and the automated flow and sediment sampling units, an average of 9.6 tonnes per ha per year represents the yield for the flat country and an average of 13.3 tonnes per ha per year represents the yield for the hill country. The highest quarterly yield for flat country equates to 26.2 tonnes per ha per year and for hill country equates to 42.3 tonnes per ha per year.

These results represent a “typical” earthworks site where due to a number of reasons such as diversion channels breaching, maintenance of forebays and incorrect set up of flocculation systems, sediment generation and yield can be higher. This highlights the necessity to have good erosion and sediment control structural measures in place, however this needs to be supported by a robust non-structural measure approach including an active monitoring and review programme for devices and their catchments, as well as ongoing maintenance programmes.

3.0 LONG BAY EARTHWORK SAMPLING OUTCOMES

For this assessment we have focused on the bulk earthworks undertaken in the period 2011 to 2017. These earthworks were for the purpose of the residential development and were subject to open area restrictions as illustrated below in Table 2.

Long Bay Earthworks Season	**Open Area During Season (ha)**
2011/2012	21
2012/2013	21
2013/2014	24
2014/2015	25
2015/2016	25.5

Table 2. Long Bay Open Area Restrictions

These open area limitations represented the maximum earthworks areas open over that specific season. It is noted that the typical pattern of earthworks on the site commenced with minimal open ground and increased over a 2-to-3-month period to maximum levels, as expressed in Table 2, at the peak of the earthworks season. At the close of the season the reverse trend applied whereby the site was subject to progressive stabilisation over a period of time until full stabilisation occurred prior to the winter period.

For the purposes of assessing full site sediment yield from the Long Bay development earthworks it is assumed that the maximum open area limitations apply throughout and this therefore represents a conservative scenario.

The Long Bay earthworks were subject to automated sampling with both flow rates and TSS concentrations. The resultant sediment yield per ha was then determined. These sediment yield results were presented to Auckland Council at the time, in a series of quarterly and annual reporting processes.

Table 3 below sets out the summary of sediment yields per ha per earthworks season (approx. a 7-month period).

Earthworks Season	**Total Yield from Automated Devices (tonnes)**	**Number of ha of Earthworks**	**Sediment Yield (tonnes) per ha for season**
2011/2012	3.57	12	0.3
2012/2013	4.74	12	0.4
2013/2014	0.35	12	0.03
2014/2015	1.343	12	0.11
2015/2016	1.407	12	0.12
2016/2017	93.424	12	7.79
Average			1.48

Table 3. Long Bay Sediment Yield Analysis

These sediment yields for Long Bay were skewed by the 2016/2017 earthworks season where over 98% of this period yield came from the March and April 2017 period. During that time there were 7 separate rain events and sediment yields recorded at the automated samplers were higher than typical due to the extreme wet conditions and the higher flows leaving the SRPs. Maintenance was recorded at the time as focusing on the sediment retention ponds, cleaning out forebays and the main body of the devices, use of drop out pits, lined channels, contour drains and flat graded delivery drains, plus the ongoing checking of the flocculation systems.

In addition, it was recorded and reported at the time that for the event of the 10th March 2017 it was confirmed that geotextile cloth in the SRP outlet drain had become dislodged and was wrapped around the monitoring weir, which caused an artificial water level and flow volume. This also caused an exposed channel base which may have created higher TSS concentrations overall.

If these Long Bay results are conservatively extrapolated for a full 12-month period, the average sediment yield of 1.4 tonnes per ha per season equates to 2.4 tonnes per ha per year.

In addition to these automated sampling results the site was subject to manual grab sampling. Unlike the NZTA Puhoi to Warkworth Project these manual sample results have not been extrapolated to provide for a site wide sediment yield. The results have however been viewed and assessed against the automated sample results with the 2 sets of data assessed as consistent. This provides for further confidence in the automated sample collection process and outcomes, and that this represents an accurate approach to sediment yield per ha per year.

It is clear that the majority of sediment yield for Long Bay came from earthworks that experienced single large rain events and within these events sediment generation and yield risk is increased.

4.0 SUMMARY AND APPROACH FOR NZTA'S ALTERNATIVE TO THE BRYNDERWYN HILLS – BRYNDERWYN HILLS SECTION

The data collected for both the NZTA Puhoi to Warkworth Project and Long Bay is comprehensive and has been through a robust review process at the time, including Auckland Council compliance overview. It is assessed that this data is representative of the nature of earthworks sediment yields for sites with similar soils and contours and with similar methodologies and approaches. The NZTA Puhoi to Warkworth Project in particular, also represents a recent NZTA project.

It is determined that for the purpose of the Project there is no need for detailed statistical analysis of the data outlined within this memorandum. A separate, and unrelated, Auckland Council project is undertaking this detailed analysis task which will provide further confidence moving forward. Nevertheless, the water quality trends and existing data analysis undertaken by the previous projects is assessed as robust and clearly demonstrates the sediment yield estimates that can be expected throughout.

Both projects also helpfully identify a series of issues for erosion and sediment control that were experienced during implementation. In addition to the wider site experience of the expert team in erosion and sediment control implementation, these documented issues allow for a focus on key areas and risk items which can assist in identifying where lessons can be learnt and where effort can be applied to further reduce sediment generation and yield throughout.

In the context of the sediment yield analysis as above, it is recommended that the Project utilise the full knowledge gained from these other projects, and with respect to sediment yields, utilise the worst-case scenario from the NZTA Puhoi to Warkworth Project. That equates to:

- For Chainage 9200 to 17700 (8.5km) a sediment yield of 9.6 tonnes per ha per year is to be utilised. This chainage represents the easier flat contour on the northern side of the Brynderwyn Hills.

- For Chainage 17700 to 26200 (8.5km) a sediment yield of 13.3 tonnes per ha per year is to be utilised. This chainage represents the steeper parts of the alignment and also incorporates the rolling contour to the south of the Brynderwyn Hills which is conservatively incorporated into the steeper contour category for the purpose of sediment yield assessments.

For the purpose of evaluation, the TSS concentrations that will be assessed through the Project earthworks programme will also draw on the experience and monitoring data from previous projects.

As a general principle the Project will implement an approach that will further reduce the overall sediment loads and will achieve this through applying effort in the individual high intensity rain events. In particular this will be addressed through strategies such as:

- Winter work restrictions;

- Staging areas and having a robust stabilisation strategy;

- Rainfall forecasting and a focused and dedicated monitoring team; and

- Risk management – knowing where the risks are and addressing those accordingly.

The primary reasons recorded for this increased risk (assessed based on site experience and recorded from Long Bay and the NZTA Puhoi to Warkworth Project) is based on maintenance items, and a lack of consideration to changing design, catchment areas and associated erosion and sediment control devices, and chemical treatment systems. In addition, the importance of progressive stabilisation has been emphasised throughout and is a primary consideration for earthworks design.

5.0 APPLICABILITY

This memorandum has been prepared for the sole benefit of NZTA as Ridley Dunphy Environmental Limited's client with respect to the brief. It is not to be relied upon or used out of context by any other person without reference to NZTA. The reliance by other parties on the information or opinions contained in the memorandum shall, without prior review and agreement in writing, be at such party's sole risk.

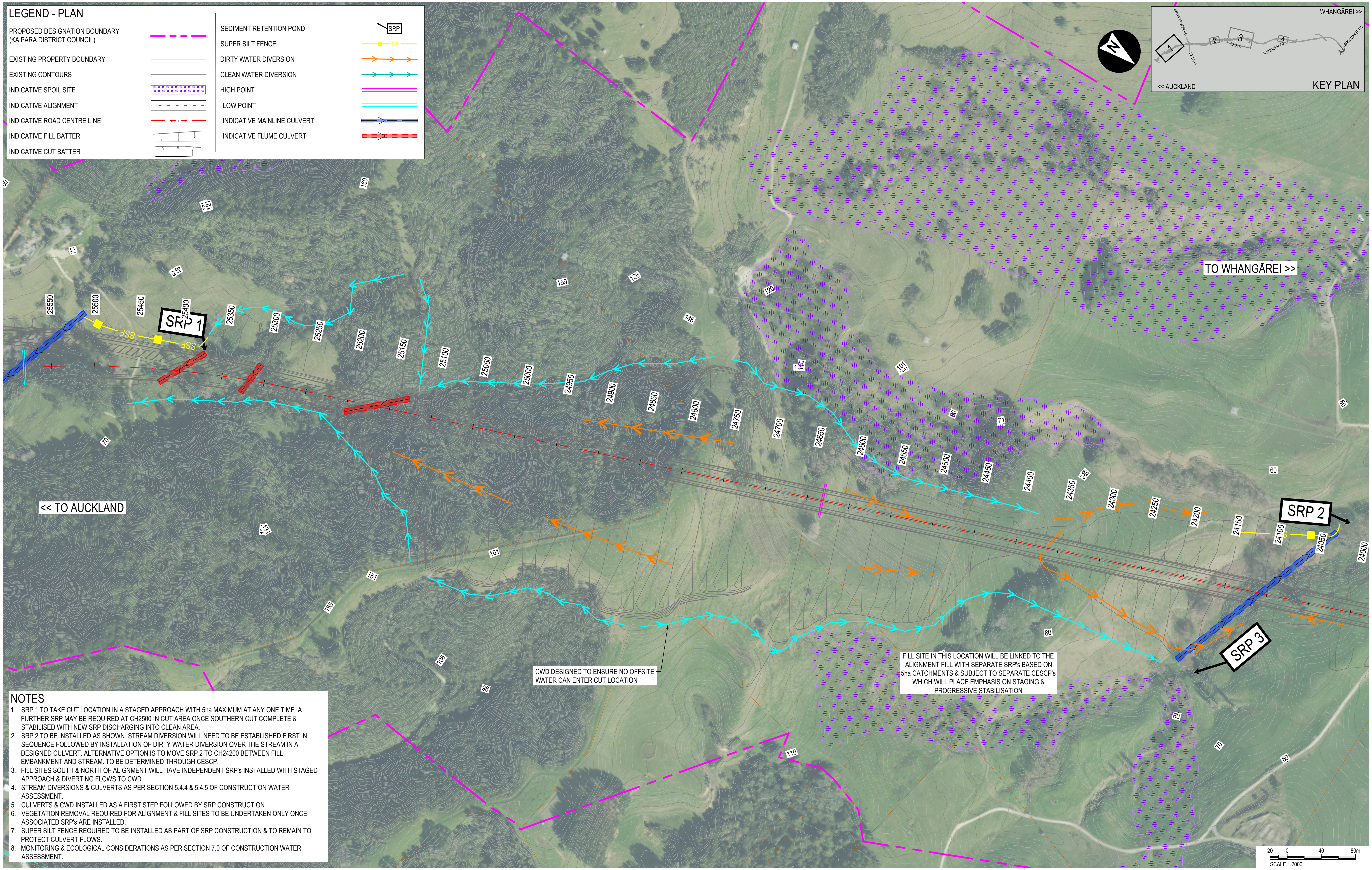
G.S. Ridley

Graeme Ridley
Ridley Dunphy Environmental Limited

Appendix B
ESCP Conceptual Plans

LEGEND - PLAN

- PROPOSED DESIGNATION BOUNDARY (KAIPARA DISTRICT COUNCIL)
- EXISTING PROPERTY BOUNDARY
- EXISTING CONTOURS
- INDICATIVE SPOIL SITE
- INDICATIVE ALIGNMENT
- INDICATIVE ROAD CENTRE LINE
- INDICATIVE FILL BATTER
- INDICATIVE CUT BATTER
- SEDIMENT RETENTION POND
- SUPER SILT FENCE
- DIRTY WATER DIVERSION
- CLEAN WATER DIVERSION
- HIGH POINT
- LOW POINT
- INDICATIVE MAINLINE CULVERT
- INDICATIVE FLUME CULVERT



NOTES

1. SRP 1 TO TAKE CUT LOCATION IN A STAGED APPROACH WITH 5ha MAXIMUM AT ANY ONE TIME. A FURTHER SRP MAY BE REQUIRED AT CH2500 IN CUT AREA ONCE SOUTHERN CUT COMPLETE & STABILISED WITH NEW SRP DISCHARGING INTO CLEAN AREA.
2. SRP 2 TO BE INSTALLED AS SHOWN. STREAM DIVERSION WILL NEED TO BE ESTABLISHED FIRST IN SEQUENCE FOLLOWED BY INSTALLATION OF DIRTY WATER DIVERSION OVER THE STREAM IN A DESIGNED CULVERT. ALTERNATIVE OPTION IS TO MOVE SRP 2 TO CH24200 BETWEEN FILL EMBANKMENT AND STREAM. TO BE DETERMINED THROUGH CESCP.
3. FILL SITES SOUTH & NORTH OF ALIGNMENT WILL HAVE INDEPENDENT SRP's INSTALLED WITH STAGED APPROACH & DIVERTING FLOWS TO CWD.
4. STREAM DIVERSIONS & CULVERTS AS PER SECTION 5.4.4 & 5.4.5 OF CONSTRUCTION WATER ASSESSMENT.
5. CULVERTS & CWD INSTALLED AS A FIRST STEP FOLLOWED BY SRP CONSTRUCTION.
6. VEGETATION REMOVAL REQUIRED FOR ALIGNMENT & FILL SITES TO BE UNDERTAKEN ONLY ONCE ASSOCIATED SRP's ARE INSTALLED.
7. SUPER SILT FENCE REQUIRED TO BE INSTALLED AS PART OF SRP CONSTRUCTION & TO REMAIN TO PROTECT CULVERT FLOWS.
8. MONITORING & ECOLOGICAL CONSIDERATIONS AS PER SECTION 7.0 OF CONSTRUCTION WATER ASSESSMENT.

PROJECT

ALL INFORMATION SHOWN IS SUBJECT TO FINAL DESIGN AND THE DETAILS MAY CHANGE. AREAS AND MEASUREMENTS ARE SUBJECT TO SURVEY

NZ TRANSPORT AGENCY WAKA KOTAHI — Northland Corridor — Roads of National Significance

COORDINATE SYSTEM: NZTM 2000, VERTICAL DATUM: NZVD2016

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REV	DATE	REVISION DETAILS	APPROVED
A	27.03.26	DESIGN ISSUE FOR LODGEMENT	R.D

DRAWN	V.HOOKER	27.03.26
DRG CHECK	G.RIDLEY	27.03.26
DESIGN	G.RIDLEY	27.03.26
VERIFIED	G.POPE	27.03.26
PROJECT LEAD	T.IRELAND	27.03.26

STATUS: CONSENT DESIGN

APPROVED: R.DUPLOOY

APPROVED BY	DATE
R.DUPLOOY	27.03.26

TITLE: INDICATIVE WATER MANAGEMENT PLAN SHEET 1

PROJECT INFORMATION: NORTHLAND CORRIDOR

DOCUMENT CODE: 10722-PTA-2B0-PE-DRG-1601

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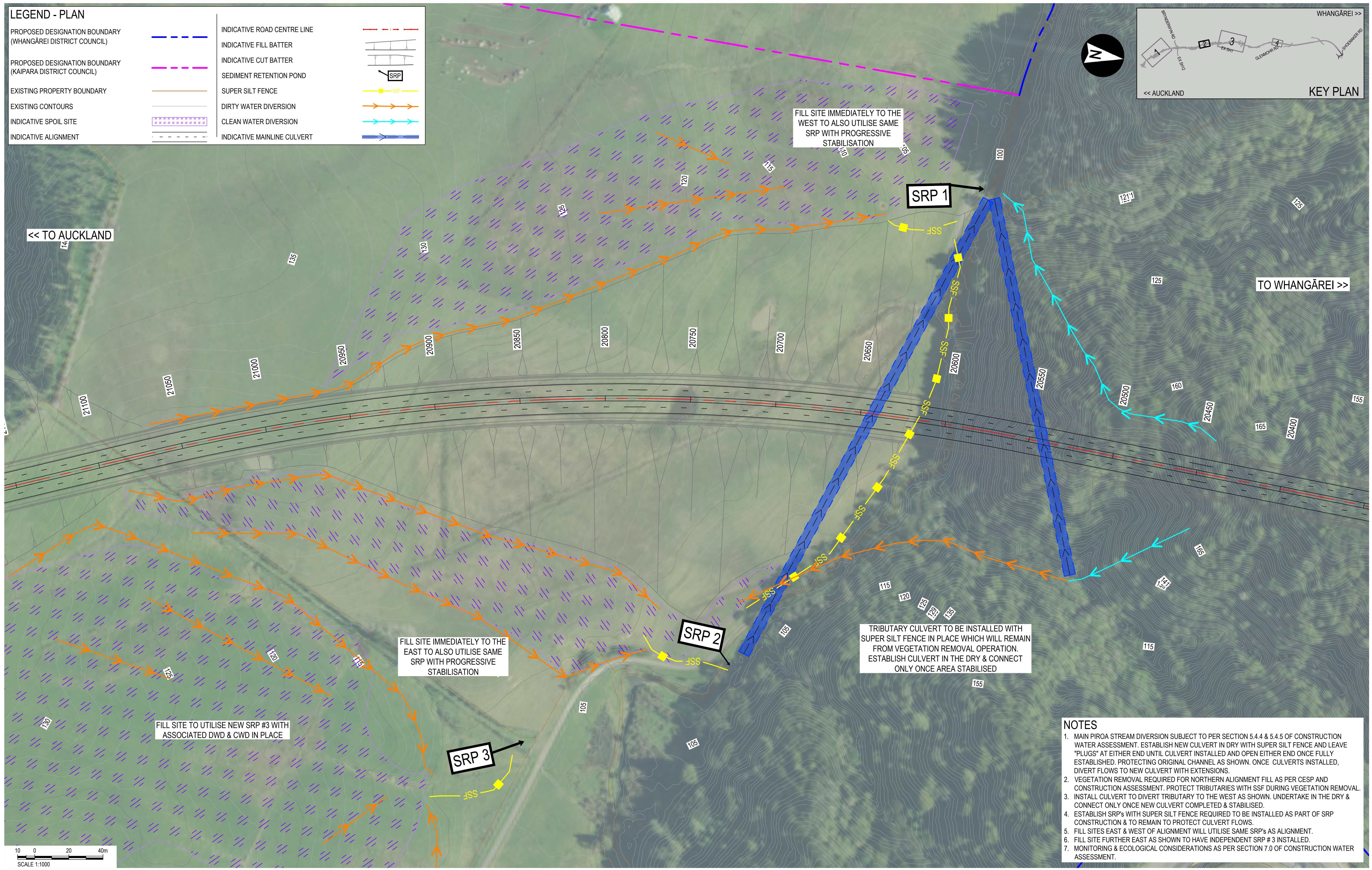

LEGEND - PLAN

PROPOSED DESIGNATION BOUNDARY (WHANGĀREI DISTRICT COUNCIL)	INDICATIVE ROAD CENTRE LINE
PROPOSED DESIGNATION BOUNDARY (KAIPARA DISTRICT COUNCIL)	INDICATIVE FILL BATTER
EXISTING PROPERTY BOUNDARY	INDICATIVE CUT BATTER
EXISTING CONTOURS	SEDIMENT RETENTION POND
INDICATIVE SPOIL SITE	SUPER SILT FENCE
INDICATIVE ALIGNMENT	DIRTY WATER DIVERSION
	CLEAN WATER DIVERSION
	INDICATIVE MAINLINE CULVERT

NOTES

1. MAIN PIROA STREAM DIVERSION SUBJECT TO PER SECTION 5.4.4 & 5.4.5 OF CONSTRUCTION WATER ASSESSMENT. ESTABLISH NEW CULVERT IN DRY WITH SUPER SILT FENCE AND LEAVE "PLUGS" AT EITHER END UNTIL CULVERT INSTALLED AND OPEN EITHER END ONCE FULLY ESTABLISHED. PROTECTING ORIGINAL CHANNEL AS SHOWN. ONCE CULVERTS INSTALLED, DIVERT FLOWS TO NEW CULVERT WITH EXTENSIONS.
2. VEGETATION REMOVAL REQUIRED FOR NORTHERN ALIGNMENT FILL AS PER CESP AND CONSTRUCTION ASSESSMENT. PROTECT TRIBUTARIES WITH SSF DURING VEGETATION REMOVAL.
3. INSTALL CULVERT TO DIVERT TRIBUTARY TO THE WEST AS SHOWN. UNDERTAKE IN THE DRY & CONNECT ONLY ONCE NEW CULVERT COMPLETED & STABILISED.
4. ESTABLISH SRP's WITH SUPER SILT FENCE REQUIRED TO BE INSTALLED AS PART OF SRP CONSTRUCTION & TO REMAIN TO PROTECT CULVERT FLOWS.
5. FILL SITES EAST & WEST OF ALIGNMENT WILL UTILISE SAME SRP's AS ALIGNMENT.
6. FILL SITE FURTHER EAST AS SHOWN TO HAVE INDEPENDENT SRP # 3 INSTALLED.
7. MONITORING & ECOLOGICAL CONSIDERATIONS AS PER SECTION 7.0 OF CONSTRUCTION WATER ASSESSMENT.

PROJECT	REV	DATE	REVISION DETAILS	APPROVED
ALL INFORMATION SHOWN IS SUBJECT TO FINAL DESIGN AND THE DETAILS MAY CHANGE. AREAS AND MEASUREMENTS ARE SUBJECT TO SURVEY	A	27.03.26	DESIGN ISSUE FOR LODGEMENT	R.D

NZ TRANSPORT AGENCY WAKA KOTAHI — Northland Corridor — Roads of National Significance

DRAWN	V.HOOKER	27.03.26
DRG CHECK	G.RIDLEY	27.03.26
DESIGN	G.RIDLEY	27.03.26
VERIFIED	G.POPE	27.03.26
PROJECT LEAD	T.IRELAND	27.03.26

STATUS: CONSENT DESIGN

APPROVED: R.DUPLOOY

APPROVED BY	DATE
R.DUPLOOY	27.03.26

TITLE: INDICATIVE WATER MANAGEMENT PLAN SHEET 2

PROJECT INFORMATION: NORTHLAND CORRIDOR

DOCUMENT CODE: 10722-PTA-2B0-PE-DGR-1602

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COORDINATE SYSTEM: NZTM 2000, VERTICAL DATUM: NZVD2016

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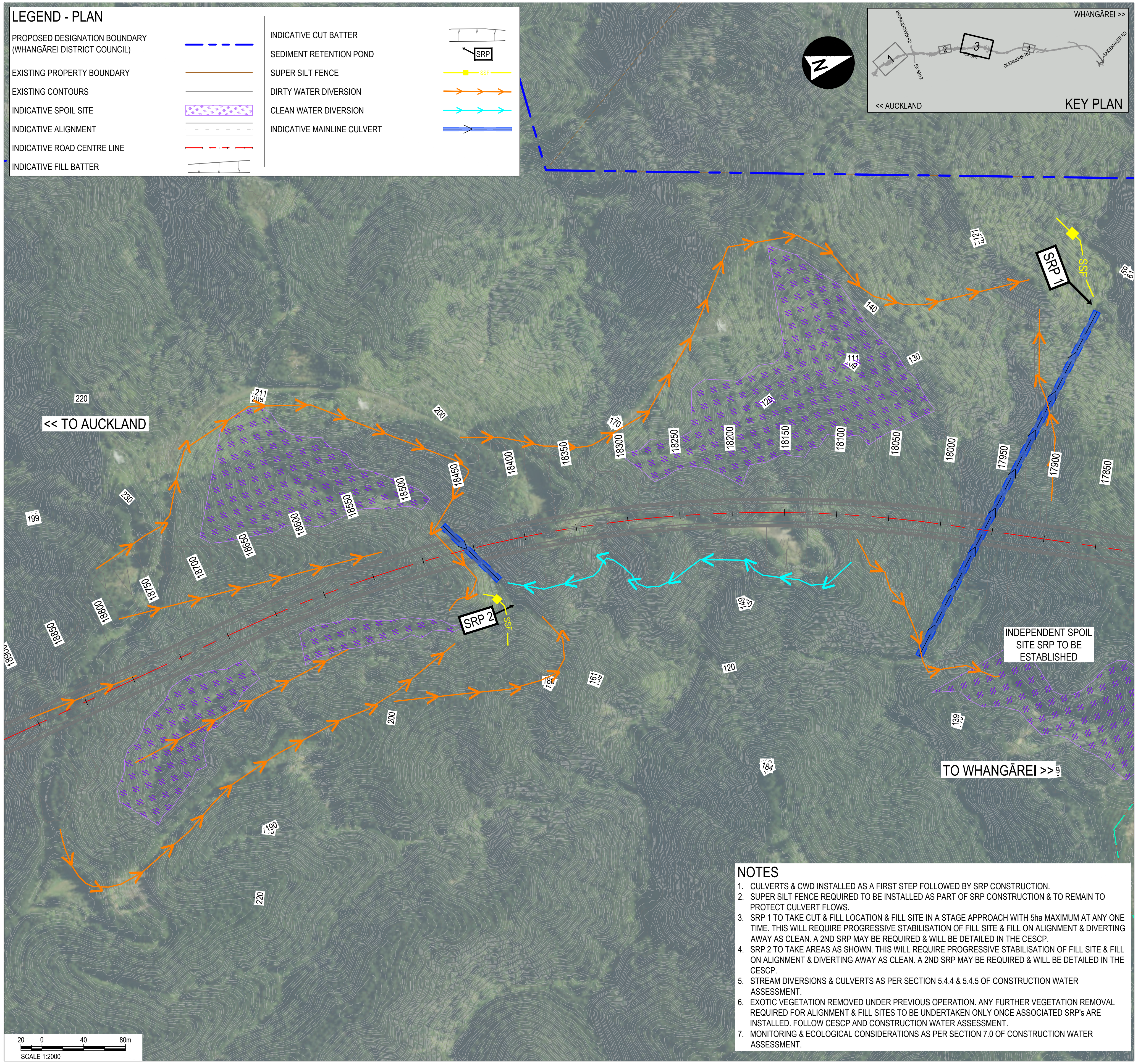

NOTES

1. CULVERTS & CWD INSTALLED AS A FIRST STEP FOLLOWED BY SRP CONSTRUCTION.
2. SUPER SILT FENCE REQUIRED TO BE INSTALLED AS PART OF SRP CONSTRUCTION & TO REMAIN TO PROTECT CULVERT FLOWS.
3. SRP 1 TO TAKE CUT & FILL LOCATION & FILL SITE IN A STAGE APPROACH WITH 5ha MAXIMUM AT ANY ONE TIME. THIS WILL REQUIRE PROGRESSIVE STABILISATION OF FILL SITE & FILL ON ALIGNMENT & DIVERTING AWAY AS CLEAN. A 2ND SRP MAY BE REQUIRED & WILL BE DETAILED IN THE CESCP.
4. SRP 2 TO TAKE AREAS AS SHOWN. THIS WILL REQUIRE PROGRESSIVE STABILISATION OF FILL SITE & FILL ON ALIGNMENT & DIVERTING AWAY AS CLEAN. A 2ND SRP MAY BE REQUIRED & WILL BE DETAILED IN THE CESCP.
5. STREAM DIVERSIONS & CULVERTS AS PER SECTION 5.4.4 & 5.4.5 OF CONSTRUCTION WATER ASSESSMENT.
6. EXOTIC VEGETATION REMOVED UNDER PREVIOUS OPERATION. ANY FURTHER VEGETATION REMOVAL REQUIRED FOR ALIGNMENT & FILL SITES TO BE UNDERTAKEN ONLY ONCE ASSOCIATED SRP's ARE INSTALLED. FOLLOW CESCP AND CONSTRUCTION WATER ASSESSMENT.
7. MONITORING & ECOLOGICAL CONSIDERATIONS AS PER SECTION 7.0 OF CONSTRUCTION WATER ASSESSMENT.

PROJECT

ALL INFORMATION SHOWN IS SUBJECT TO FINAL DESIGN AND THE DETAILS MAY CHANGE. AREAS AND MEASUREMENTS ARE SUBJECT TO SURVEY

NZ TRANSPORT AGENCY WAKA KOTAHI — Northland Corridor — Roads of National Significance

REV	DATE	REVISION DETAILS	APPROVED
A	27.03.26	DESIGN ISSUE FOR LODGEMENT	R.D

DRAWN	V.HOOKER	27.03.26
DRG CHECK	G.RIDLEY	27.03.26
DESIGN	G.RIDLEY	27.03.26
VERIFIED	G.POPE	27.03.26
PROJECT LEAD	T.IRELAND	27.03.26

STATUS: CONSENT DESIGN

APPROVED: R.DUPLOOY

APPROVED BY	DATE
R.DUPLOOY	27.03.26

TITLE: INDICATIVE WATER MANAGEMENT PLAN SHEET 3

PROJECT INFORMATION: NORTHLAND CORRIDOR

DOCUMENT CODE: 10722-PTA-2B0-PE-DRG-1603

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COORDINATE SYSTEM: NZTM 2000, VERTICAL DATUM: NZVD2016 -

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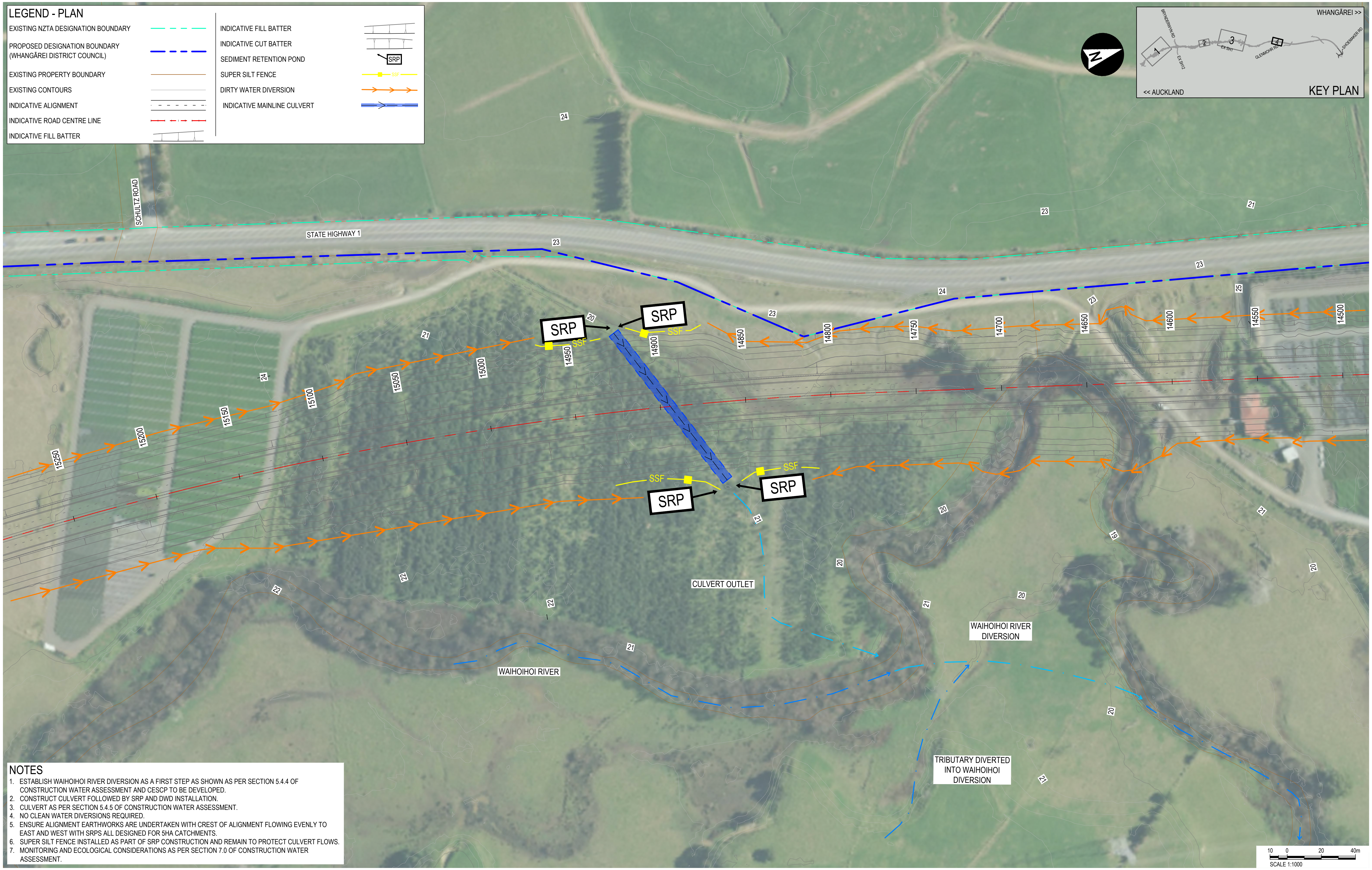

LEGEND - PLAN

- EXISTING NZTA DESIGNATION BOUNDARY
- PROPOSED DESIGNATION BOUNDARY (WHANGĀREI DISTRICT COUNCIL)
- EXISTING PROPERTY BOUNDARY
- EXISTING CONTOURS
- INDICATIVE ALIGNMENT
- INDICATIVE ROAD CENTRE LINE
- INDICATIVE FILL BATTER
- INDICATIVE FILL BATTER
- INDICATIVE CUT BATTER
- SEDIMENT RETENTION POND
- SUPER SILT FENCE
- DIRTY WATER DIVERSION
- INDICATIVE MAINLINE CULVERT

NOTES

1. ESTABLISH WAIHOIHOI RIVER DIVERSION AS A FIRST STEP AS SHOWN AS PER SECTION 5.4.4 OF CONSTRUCTION WATER ASSESSMENT AND CESCP TO BE DEVELOPED.
2. CONSTRUCT CULVERT FOLLOWED BY SRP AND DWD INSTALLATION.
3. CULVERT AS PER SECTION 5.4.5 OF CONSTRUCTION WATER ASSESSMENT.
4. NO CLEAN WATER DIVERSIONS REQUIRED.
5. ENSURE ALIGNMENT EARTHWORKS ARE UNDERTAKEN WITH CREST OF ALIGNMENT FLOWING EVENLY TO EAST AND WEST WITH SRPS ALL DESIGNED FOR 5HA CATCHMENTS.
6. SUPER SILT FENCE INSTALLED AS PART OF SRP CONSTRUCTION AND REMAIN TO PROTECT CULVERT FLOWS.
7. MONITORING AND ECOLOGICAL CONSIDERATIONS AS PER SECTION 7.0 OF CONSTRUCTION WATER ASSESSMENT.

PROJECT	REV	DATE	REVISION DETAILS	APPROVED
ALL INFORMATION SHOWN IS SUBJECT TO FINAL DESIGN AND THE DETAILS MAY CHANGE. AREAS AND MEASUREMENTS ARE SUBJECT TO SURVEY	A	27.03.26	DESIGN ISSUE FOR LODGEMENT	R.D

NZ TRANSPORT AGENCY WAKA KOTAHI — Northland Corridor — Roads of National Significance

DRAWN	V.HOOKER	27.03.26
DRG CHECK	G.RIDLEY	27.03.26
DESIGN	G.RIDLEY	27.03.26
VERIFIED	G.POPE	27.03.26
PROJECT LEAD	T.IRELAND	27.03.26

STATUS: CONSENT DESIGN

APPROVED: R.DUPLOOY

APPROVED BY	DATE
R.DUPLOOY	27.03.26

TITLE: INDICATIVE WATER MANAGEMENT PLAN SHEET 4

PROJECT INFORMATION: NORTHLAND CORRIDOR

DOCUMENT CODE: 10722-PTA-2B0-PE-DRG-1604

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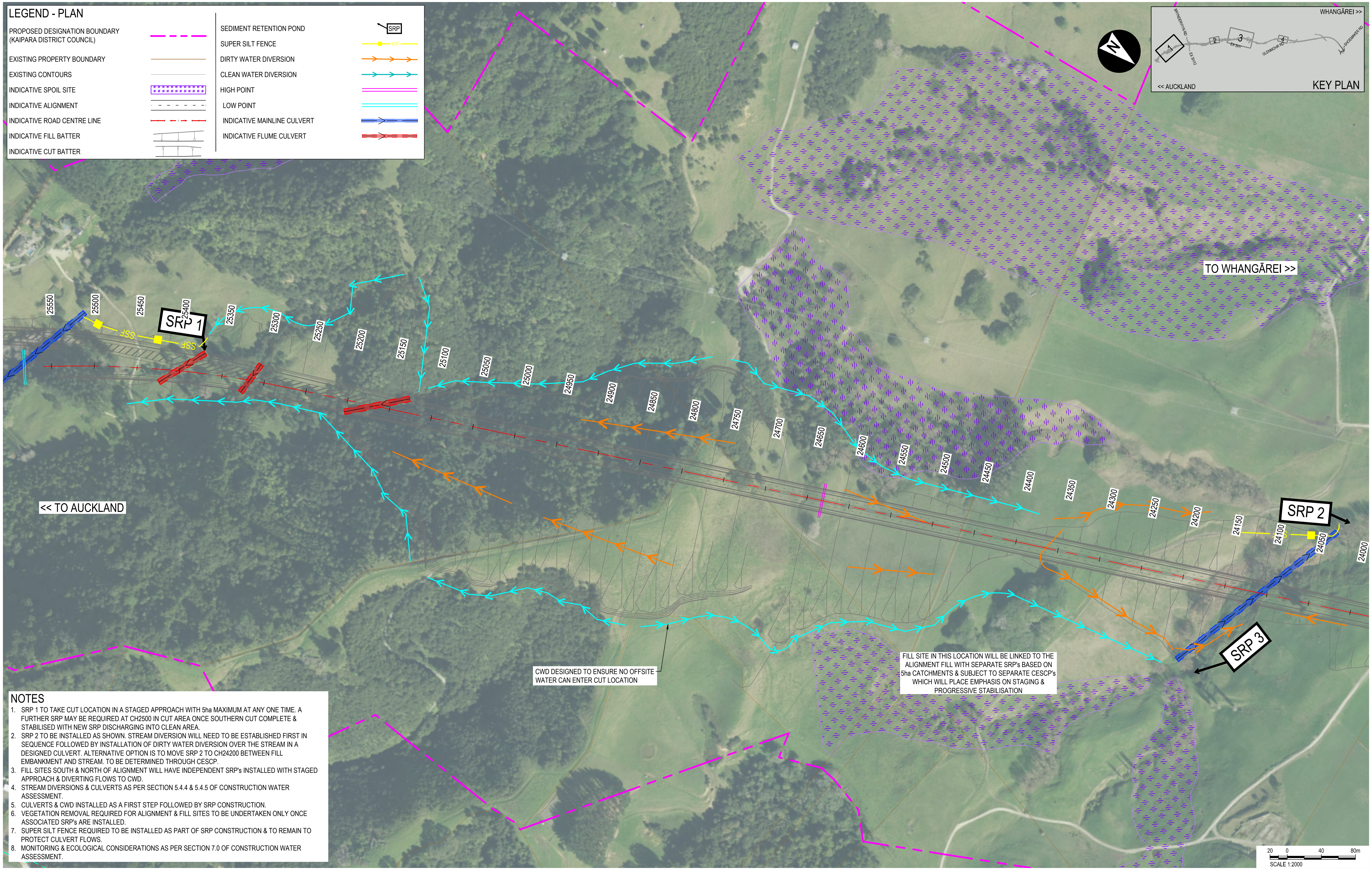

NOTES

1. SRP 1 TO TAKE CUT LOCATION IN A STAGED APPROACH WITH 5ha MAXIMUM AT ANY ONE TIME. A FURTHER SRP MAY BE REQUIRED AT CH2500 IN CUT AREA ONCE SOUTHERN CUT COMPLETE & STABILISED WITH NEW SRP DISCHARGING INTO CLEAN AREA.
2. SRP 2 TO BE INSTALLED AS SHOWN. STREAM DIVERSION WILL NEED TO BE ESTABLISHED FIRST IN SEQUENCE FOLLOWED BY INSTALLATION OF DIRTY WATER DIVERSION OVER THE STREAM IN A DESIGNED CULVERT. ALTERNATIVE OPTION IS TO MOVE SRP 2 TO CH24200 BETWEEN FILL EMBANKMENT AND STREAM. TO BE DETERMINED THROUGH CESCP.
3. FILL SITES SOUTH & NORTH OF ALIGNMENT WILL HAVE INDEPENDENT SRP's INSTALLED WITH STAGED APPROACH & DIVERTING FLOWS TO CWD.
4. STREAM DIVERSIONS & CULVERTS AS PER SECTION 5.4.4 & 5.4.5 OF CONSTRUCTION WATER ASSESSMENT.
5. CULVERTS & CWD INSTALLED AS A FIRST STEP FOLLOWED BY SRP CONSTRUCTION.
6. VEGETATION REMOVAL REQUIRED FOR ALIGNMENT & FILL SITES TO BE UNDERTAKEN ONLY ONCE ASSOCIATED SRP's ARE INSTALLED.
7. SUPER SILT FENCE REQUIRED TO BE INSTALLED AS PART OF SRP CONSTRUCTION & TO REMAIN TO PROTECT CULVERT FLOWS.
8. MONITORING & ECOLOGICAL CONSIDERATIONS AS PER SECTION 7.0 OF CONSTRUCTION WATER ASSESSMENT.

PROJECT	REV	DATE	REVISION DETAILS	APPROVED
ALL INFORMATION SHOWN IS SUBJECT TO FINAL DESIGN AND THE DETAILS MAY CHANGE. AREAS AND MEASUREMENTS ARE SUBJECT TO SURVEY	A	27.03.26	DESIGN ISSUE FOR LODGEMENT	R.D

NZ TRANSPORT AGENCY WAKA KOTAHI — Northland Corridor — Roads of National Significance

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DESIGN	G.RIDLEY	27.03.26
VERIFIED	G.POPE	27.03.26
PROJECT LEAD	T.IRELAND	27.03.26

STATUS: CONSENT DESIGN

APPROVED: R.DUPLOOY

APPROVED BY	DATE
R.DUPLOOY	27.03.26

TITLE: INDICATIVE WATER MANAGEMENT PLAN (NO CONTOURS) SHEET 1

PROJECT INFORMATION: NORTHLAND CORRIDOR

DOCUMENT CODE: 10722-PTA-2B0-PE-DRG-1611

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COORDINATE SYSTEM: NZTM 2000, VERTICAL DATUM: NZVD2016

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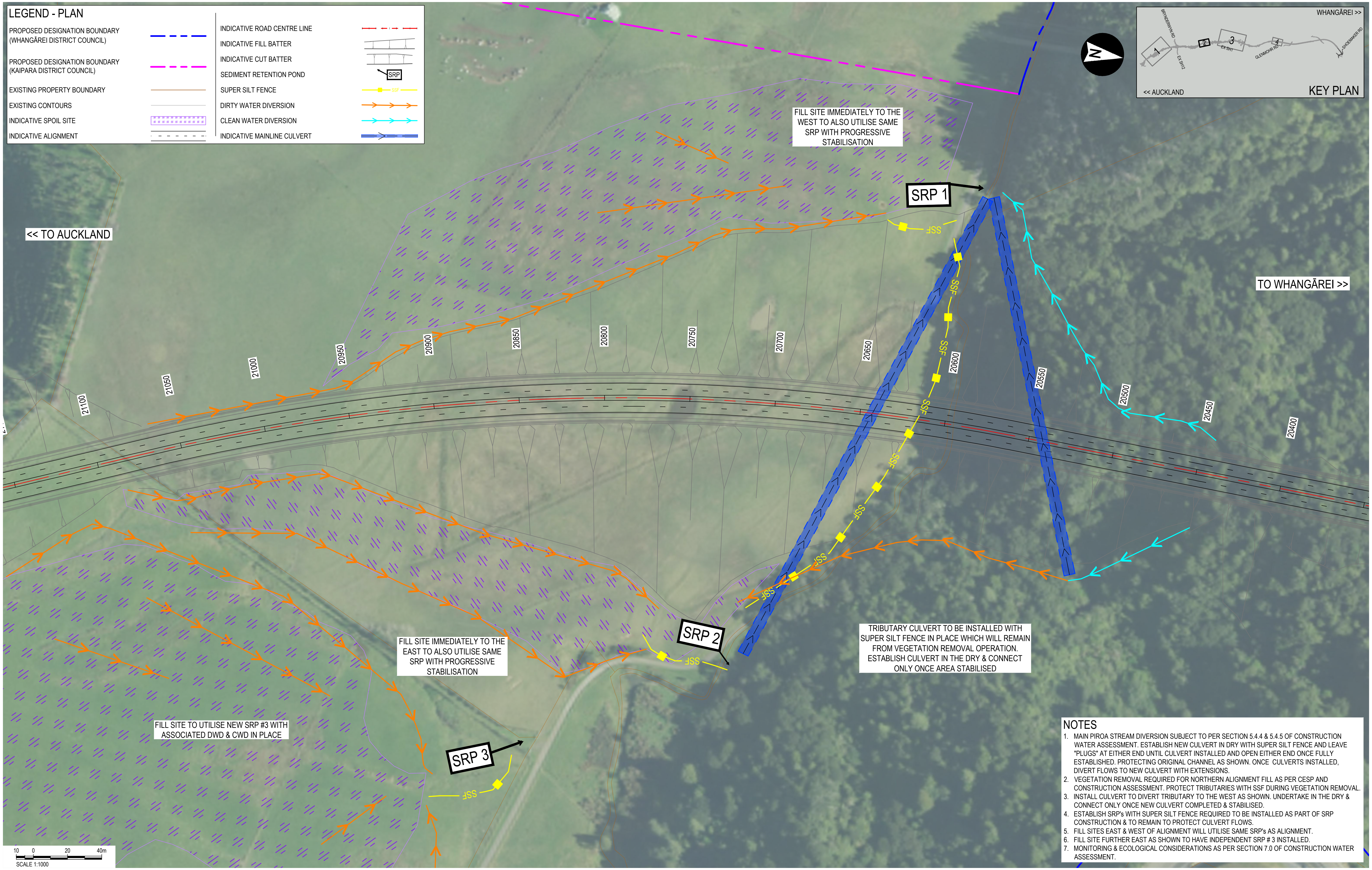
LEGEND - PLAN

PROPOSED DESIGNATION BOUNDARY (WHANGĀREI DISTRICT COUNCIL)	INDICATIVE ROAD CENTRE LINE
PROPOSED DESIGNATION BOUNDARY (KAIPARA DISTRICT COUNCIL)	INDICATIVE FILL BATTER
EXISTING PROPERTY BOUNDARY	INDICATIVE CUT BATTER
EXISTING CONTOURS	SEDIMENT RETENTION POND (SRP)
INDICATIVE SPOIL SITE	SUPER SILT FENCE
INDICATIVE ALIGNMENT	DIRTY WATER DIVERSION
	CLEAN WATER DIVERSION
	INDICATIVE MAINLINE CULVERT



NOTES

1. MAIN PIROA STREAM DIVERSION SUBJECT TO PER SECTION 5.4.4 & 5.4.5 OF CONSTRUCTION WATER ASSESSMENT. ESTABLISH NEW CULVERT IN DRY WITH SUPER SILT FENCE AND LEAVE "PLUGS" AT EITHER END UNTIL CULVERT INSTALLED AND OPEN EITHER END ONCE FULLY ESTABLISHED. PROTECTING ORIGINAL CHANNEL AS SHOWN. ONCE CULVERTS INSTALLED, DIVERT FLOWS TO NEW CULVERT WITH EXTENSIONS.
2. VEGETATION REMOVAL REQUIRED FOR NORTHERN ALIGNMENT FILL AS PER CESP AND CONSTRUCTION ASSESSMENT. PROTECT TRIBUTARIES WITH SSF DURING VEGETATION REMOVAL.
3. INSTALL CULVERT TO DIVERT TRIBUTARY TO THE WEST AS SHOWN. UNDERTAKE IN THE DRY & CONNECT ONLY ONCE NEW CULVERT COMPLETED & STABILISED.
4. ESTABLISH SRP's WITH SUPER SILT FENCE REQUIRED TO BE INSTALLED AS PART OF SRP CONSTRUCTION & TO REMAIN TO PROTECT CULVERT FLOWS.
5. FILL SITES EAST & WEST OF ALIGNMENT WILL UTILISE SAME SRP's AS ALIGNMENT.
6. FILL SITE FURTHER EAST AS SHOWN TO HAVE INDEPENDENT SRP # 3 INSTALLED.
7. MONITORING & ECOLOGICAL CONSIDERATIONS AS PER SECTION 7.0 OF CONSTRUCTION WATER ASSESSMENT.

PROJECT

ALL INFORMATION SHOWN IS SUBJECT TO FINAL DESIGN AND THE DETAILS MAY CHANGE. AREAS AND MEASUREMENTS ARE SUBJECT TO SURVEY

NZ TRANSPORT AGENCY WAKA KOTAHI — Northland Corridor — Roads of National Significance

REV	DATE	REVISION DETAILS	APPROVED
A	27.03.26	DESIGN ISSUE FOR LODGEMENT	R.D

DRAWN	V.HOOKER	27.03.26
DRG CHECK	G.RIDLEY	27.03.26
DESIGN	G.RIDLEY	27.03.26
VERIFIED	G.POPE	27.03.26
PROJECT LEAD	T.IRELAND	27.03.26

STATUS: CONSENT DESIGN

APPROVED: R.DUPLOOY

APPROVED BY	DATE
R.DUPLOOY	27.03.26

TITLE: INDICATIVE WATER MANAGEMENT PLAN (NO CONTOURS) SHEET 2

PROJECT INFORMATION: NORTHLAND CORRIDOR

DOCUMENT CODE: 10722-PTA-2B0-PE-DRG-1612

SCALE	SIZE	REFERENCE No.	REV
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COORDINATE SYSTEM: NZTM 2000, VERTICAL DATUM: NZVD2016

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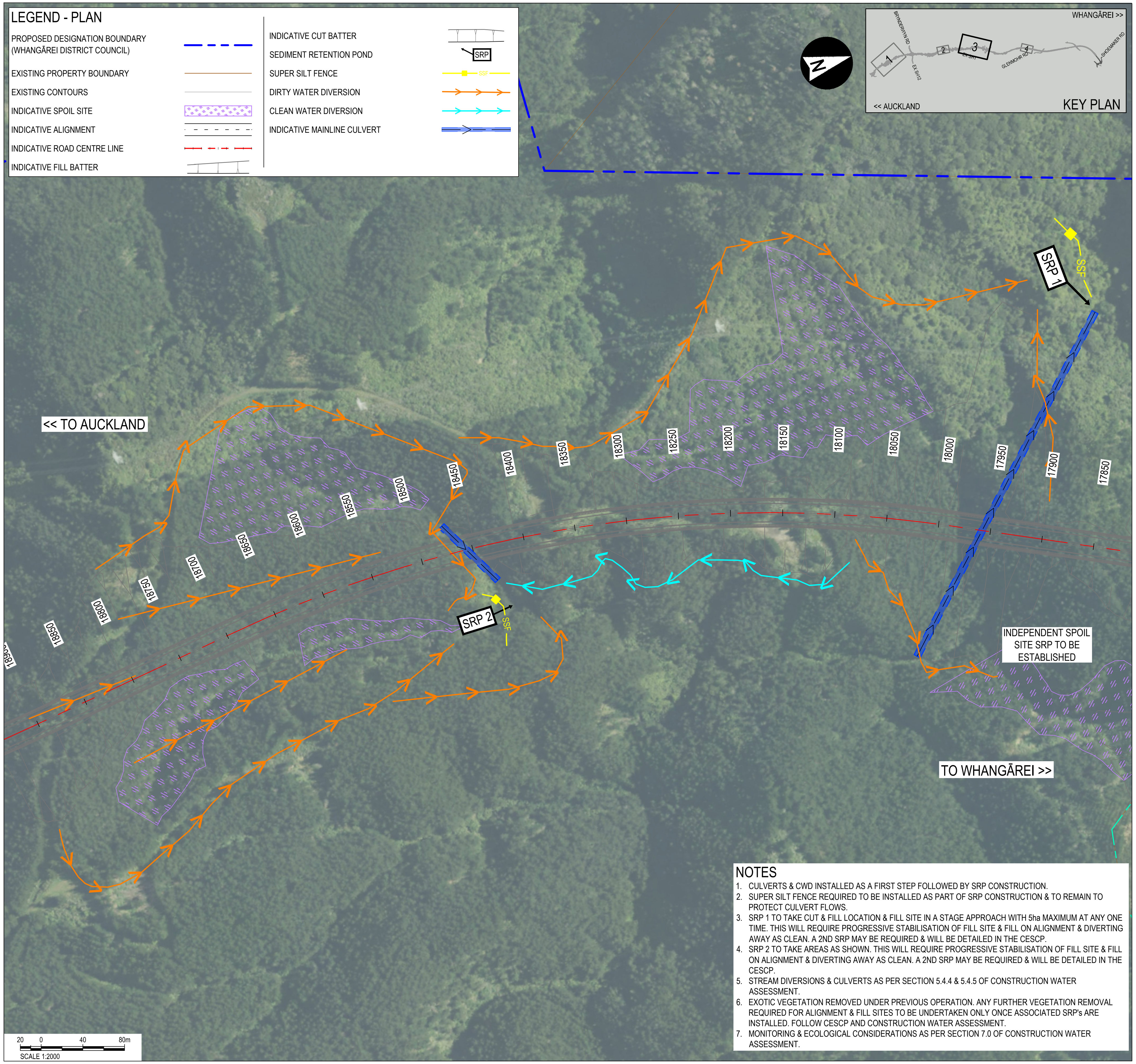
LEGEND - PLAN

- PROPOSED DESIGNATION BOUNDARY (WHANGĀREI DISTRICT COUNCIL)
- EXISTING PROPERTY BOUNDARY
- EXISTING CONTOURS
- INDICATIVE SPOIL SITE
- INDICATIVE ALIGNMENT
- INDICATIVE ROAD CENTRE LINE
- INDICATIVE FILL BATTER
- INDICATIVE CUT BATTER
- SEDIMENT RETENTION POND (SRP)
- SUPER SILT FENCE
- DIRTY WATER DIVERSION
- CLEAN WATER DIVERSION
- INDICATIVE MAINLINE CULVERT



NOTES

1. CULVERTS & CWD INSTALLED AS A FIRST STEP FOLLOWED BY SRP CONSTRUCTION.
2. SUPER SILT FENCE REQUIRED TO BE INSTALLED AS PART OF SRP CONSTRUCTION & TO REMAIN TO PROTECT CULVERT FLOWS.
3. SRP 1 TO TAKE CUT & FILL LOCATION & FILL SITE IN A STAGE APPROACH WITH 5ha MAXIMUM AT ANY ONE TIME. THIS WILL REQUIRE PROGRESSIVE STABILISATION OF FILL SITE & FILL ON ALIGNMENT & DIVERTING AWAY AS CLEAN. A 2ND SRP MAY BE REQUIRED & WILL BE DETAILED IN THE CESCP.
4. SRP 2 TO TAKE AREAS AS SHOWN. THIS WILL REQUIRE PROGRESSIVE STABILISATION OF FILL SITE & FILL ON ALIGNMENT & DIVERTING AWAY AS CLEAN. A 2ND SRP MAY BE REQUIRED & WILL BE DETAILED IN THE CESCP.
5. STREAM DIVERSIONS & CULVERTS AS PER SECTION 5.4.4 & 5.4.5 OF CONSTRUCTION WATER ASSESSMENT.
6. EXOTIC VEGETATION REMOVED UNDER PREVIOUS OPERATION. ANY FURTHER VEGETATION REMOVAL REQUIRED FOR ALIGNMENT & FILL SITES TO BE UNDERTAKEN ONLY ONCE ASSOCIATED SRP's ARE INSTALLED. FOLLOW CESCP AND CONSTRUCTION WATER ASSESSMENT.
7. MONITORING & ECOLOGICAL CONSIDERATIONS AS PER SECTION 7.0 OF CONSTRUCTION WATER ASSESSMENT.

PROJECT	REV	DATE	REVISION DETAILS	APPROVED
ALL INFORMATION SHOWN IS SUBJECT TO FINAL DESIGN AND THE DETAILS MAY CHANGE. AREAS AND MEASUREMENTS ARE SUBJECT TO SURVEY	A	27.03.26	DESIGN ISSUE FOR LODGEMENT	R.D

NZ TRANSPORT AGENCY WAKA KOTAHI — Northland Corridor — Roads of National Significance

DRAWN	V.HOOKER	27.03.26
DRG CHECK	G.RIDLEY	27.03.26
DESIGN	G.RIDLEY	27.03.26
VERIFIED	G.POPE	27.03.26
PROJECT LEAD	T.IRELAND	27.03.26

STATUS: CONSENT DESIGN

APPROVED: R.DUPLOOY

APPROVED BY	DATE
R.DUPLOOY	27.03.26

TITLE: INDICATIVE WATER MANAGEMENT PLAN (NO CONTOURS) SHEET 3

PROJECT INFORMATION: NORTHLAND CORRIDOR

DOCUMENT CODE: 10722-PTA-2B0-PE-DRG-1613

SCALE	SIZE	REFERENCE No.	REV
1:2000	A1	PE-1613	A

COORDINATE SYSTEM: NZTM 2000, VERTICAL DATUM: NZVD2016 -

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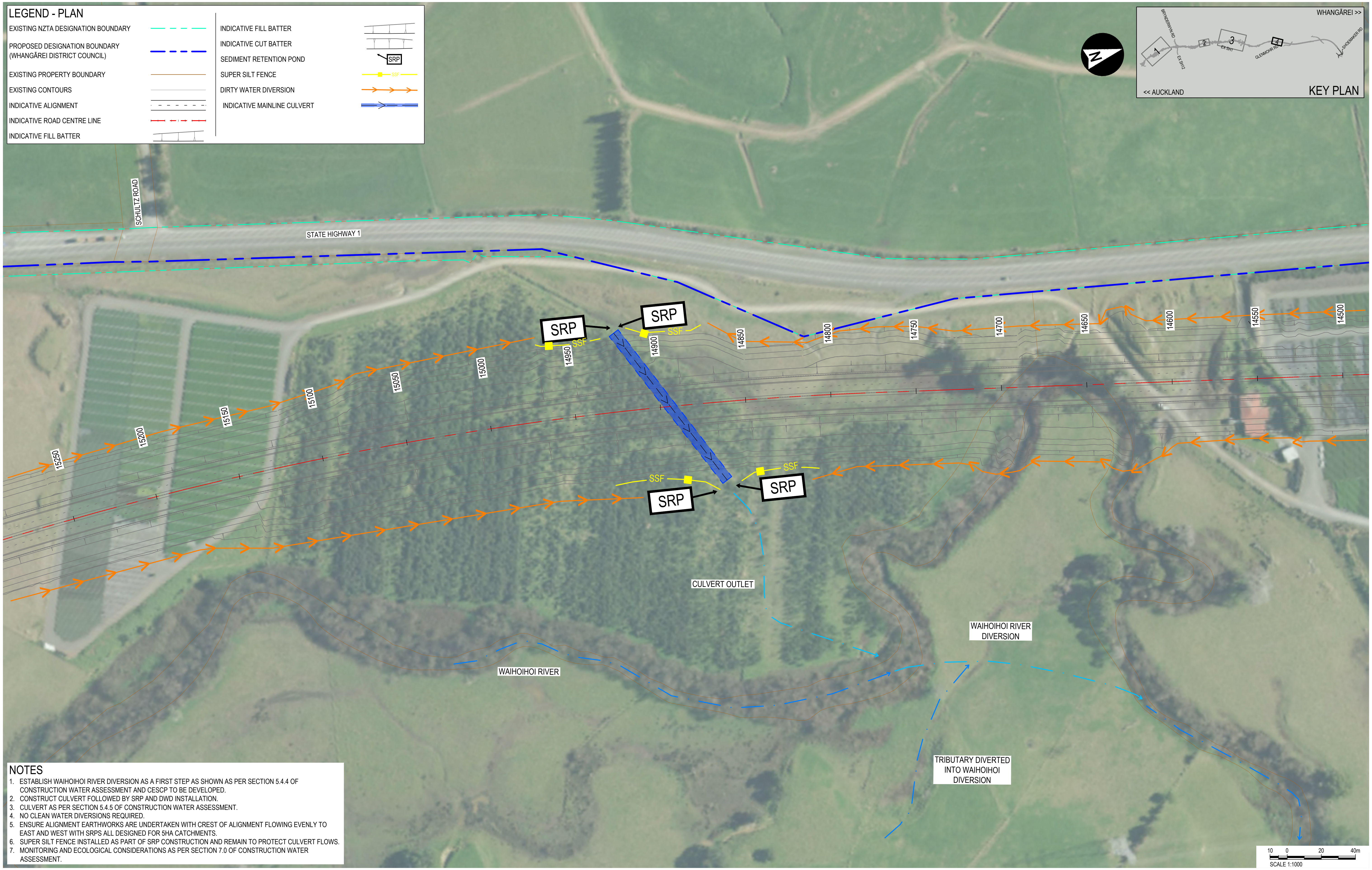
Plot Date: 3/29/2026 12:05 pm | Plotted By: Vicci Hooker | Original File: C:\PW\WSP-AUS-19\D0453449\10722-PTA-2B0-PE-DRG-1613.DWG | Tab: [A]



LEGEND - PLAN

EXISTING NZTA DESIGNATION BOUNDARY	INDICATIVE FILL BATTER
PROPOSED DESIGNATION BOUNDARY (WHANGĀREI DISTRICT COUNCIL)	INDICATIVE CUT BATTER
	SEDIMENT RETENTION POND (SRP)
EXISTING PROPERTY BOUNDARY	SUPER SILT FENCE
EXISTING CONTOURS	DIRTY WATER DIVERSION
INDICATIVE ALIGNMENT	INDICATIVE MAINLINE CULVERT
INDICATIVE ROAD CENTRE LINE	
INDICATIVE FILL BATTER	

NOTES

1. ESTABLISH WAIHOIHOI RIVER DIVERSION AS A FIRST STEP AS SHOWN AS PER SECTION 5.4.4 OF CONSTRUCTION WATER ASSESSMENT AND CESCP TO BE DEVELOPED.
2. CONSTRUCT CULVERT FOLLOWED BY SRP AND DWD INSTALLATION.
3. CULVERT AS PER SECTION 5.4.5 OF CONSTRUCTION WATER ASSESSMENT.
4. NO CLEAN WATER DIVERSIONS REQUIRED.
5. ENSURE ALIGNMENT EARTHWORKS ARE UNDERTAKEN WITH CREST OF ALIGNMENT FLOWING EVENLY TO EAST AND WEST WITH SRPS ALL DESIGNED FOR 5HA CATCHMENTS.
6. SUPER SILT FENCE INSTALLED AS PART OF SRP CONSTRUCTION AND REMAIN TO PROTECT CULVERT FLOWS.
7. MONITORING AND ECOLOGICAL CONSIDERATIONS AS PER SECTION 7.0 OF CONSTRUCTION WATER ASSESSMENT.

PROJECT	REV	DATE	REVISION DETAILS	APPROVED
ALL INFORMATION SHOWN IS SUBJECT TO FINAL DESIGN AND THE DETAILS MAY CHANGE. AREAS AND MEASUREMENTS ARE SUBJECT TO SURVEY	A	27.03.26	DESIGN ISSUE FOR LODGEMENT	R.D

NZ TRANSPORT AGENCY WAKA KOTAHI — Northland Corridor — Roads of National Significance

COORDINATE SYSTEM: NZTM 2000, VERTICAL DATUM: NZVD2016

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DRG CHECK	G.RIDLEY	27.03.26
DESIGN	G.RIDLEY	27.03.26
VERIFIED	G.POPE	27.03.26
PROJECT LEAD	T.IRELAND	27.03.26

STATUS: CONSENT DESIGN

APPROVED: R.DUPLOOY

APPROVED BY	DATE
R.DUPLOOY	27.03.26

TITLE: INDICATIVE WATER MANAGEMENT PLAN (NO CONTOURS) SHEET 4

PROJECT INFORMATION: NORTHLAND CORRIDOR

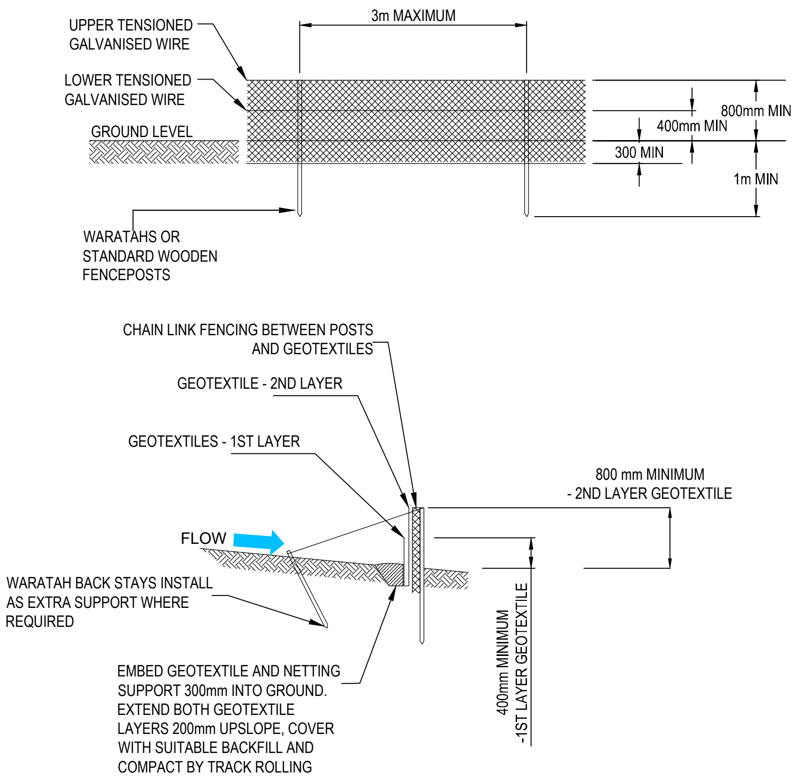
DOCUMENT CODE: 10722-PTA-2B0-PE-DRG-1614

SCALE	SIZE	REFERENCE No.	REV
1:1000	A1	PE-1614	A

Plot Date: 3/29/2026 12:05 pm | Plotted By: Vicci Hooker | Original File: C:\PWWSP-AUS-19\D0453449\10722-PTA-2B0-PE-DRG-1614.DWG | Tab: [A]

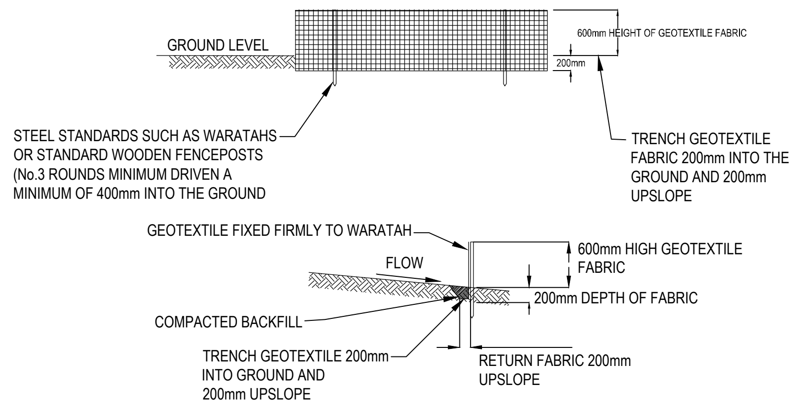
Appendix C

ESCP Design Plans



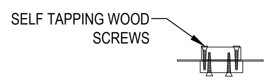
SUPER SILT FENCE DETAIL

1:50



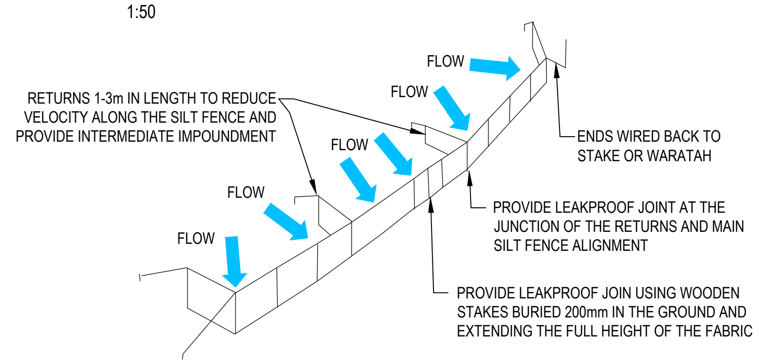
SILT FENCE CROSS SECTION

1:50



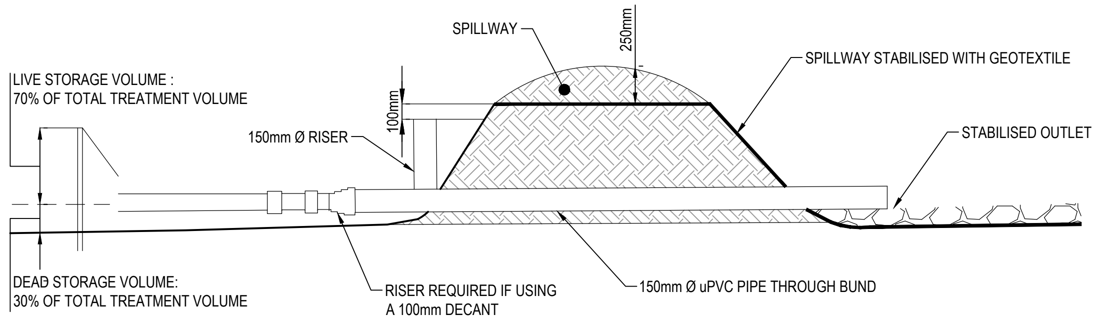
STANDARD DETAIL FOR FABRIC JOIN

1:50



SILT FENCE RETURNS AND WIRE

1:50



DECANTING EARTH BUND

1:25

250 0 500 1000mm SCALE 1:25

500 0 1000 2000mm SCALE 1:50

PROJECT	REV	DATE	REVISION DETAILS	APPROVED
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NZ TRANSPORT AGENCY WAKA KOTAHI — Northland Corridor — Roads of National Significance

COORDINATE SYSTEM: NZTM 2000, VERTICAL DATUM: NZVD2016

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PROJECT LEAD	T.IRELAND	27.03.26

STATUS	
CONSENT DESIGN	
APPROVED	
R.DUPLOOY	
APPROVED BY	DATE
R.DUPLOOY	27.03.26

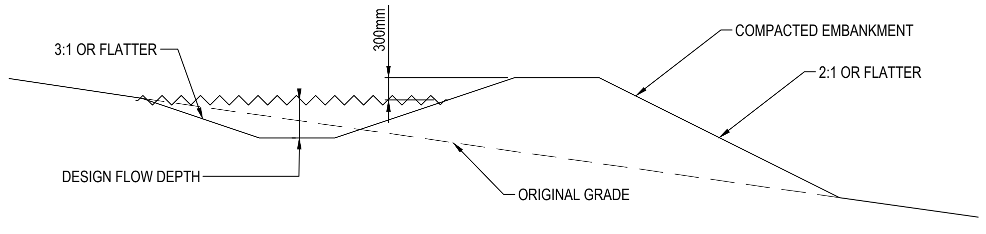
TITLE: EROSION & SEDIMENT CONTROL DETAILS SHEET 1

PROJECT INFORMATION: NORTHLAND CORRIDOR

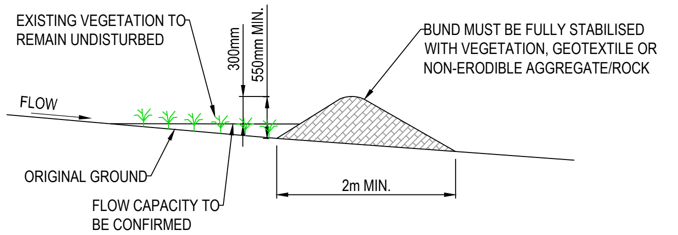
DOCUMENT CODE: 10722-PTA-2B0-PE-DRG-1651

SCALE	SIZE	REFERENCE No.	REV
AS SHOWN	A1	PE-1651	A

Plot Date: 3/27/2026 3:23 pm | Plotted By: Vicci Hooker | Original File: C:\PW\WSP-AUS-19\D0453449\10722-PTA-2B0-PE-DRG-1651.DWG | Tab: [A]



DIRTY WATER DIVERSION CHANNEL DETAIL
1:50



CLEAN WATER DIVERSION DETAIL
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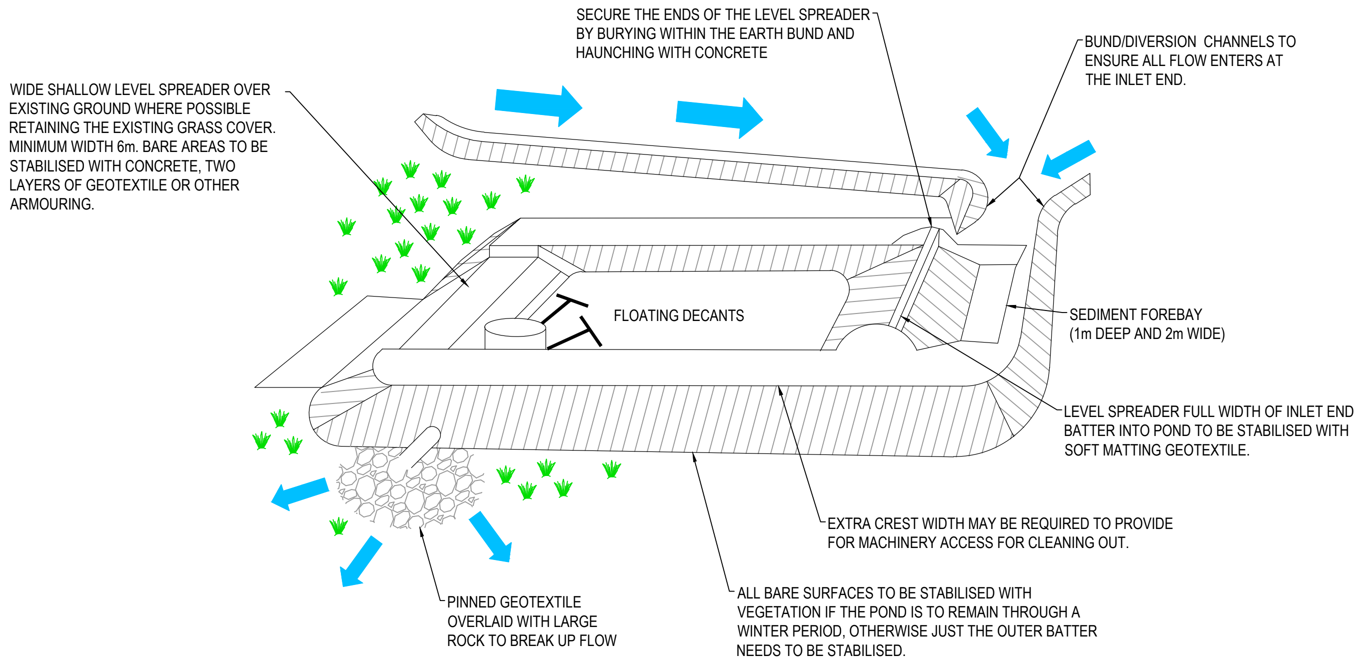
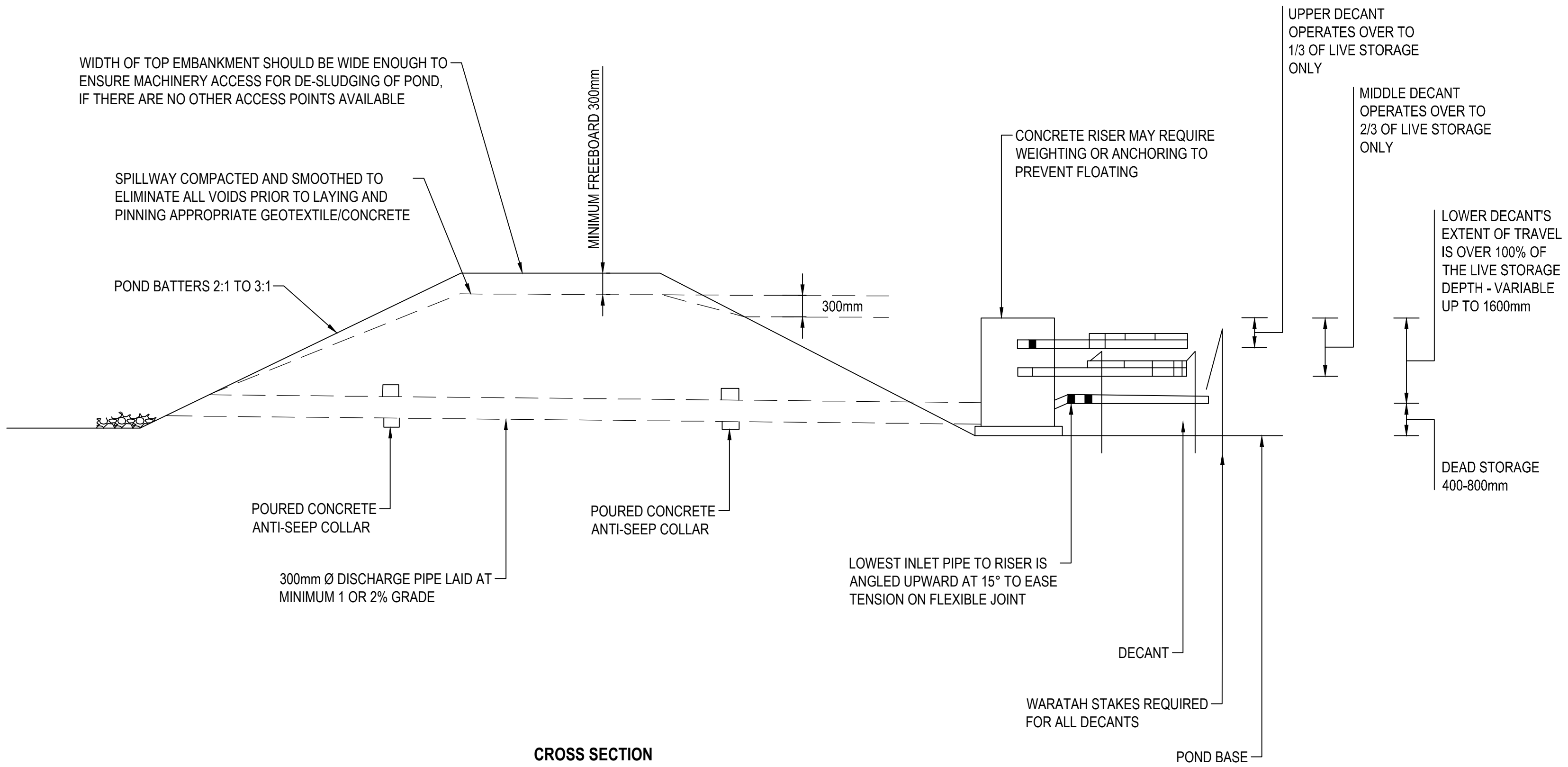
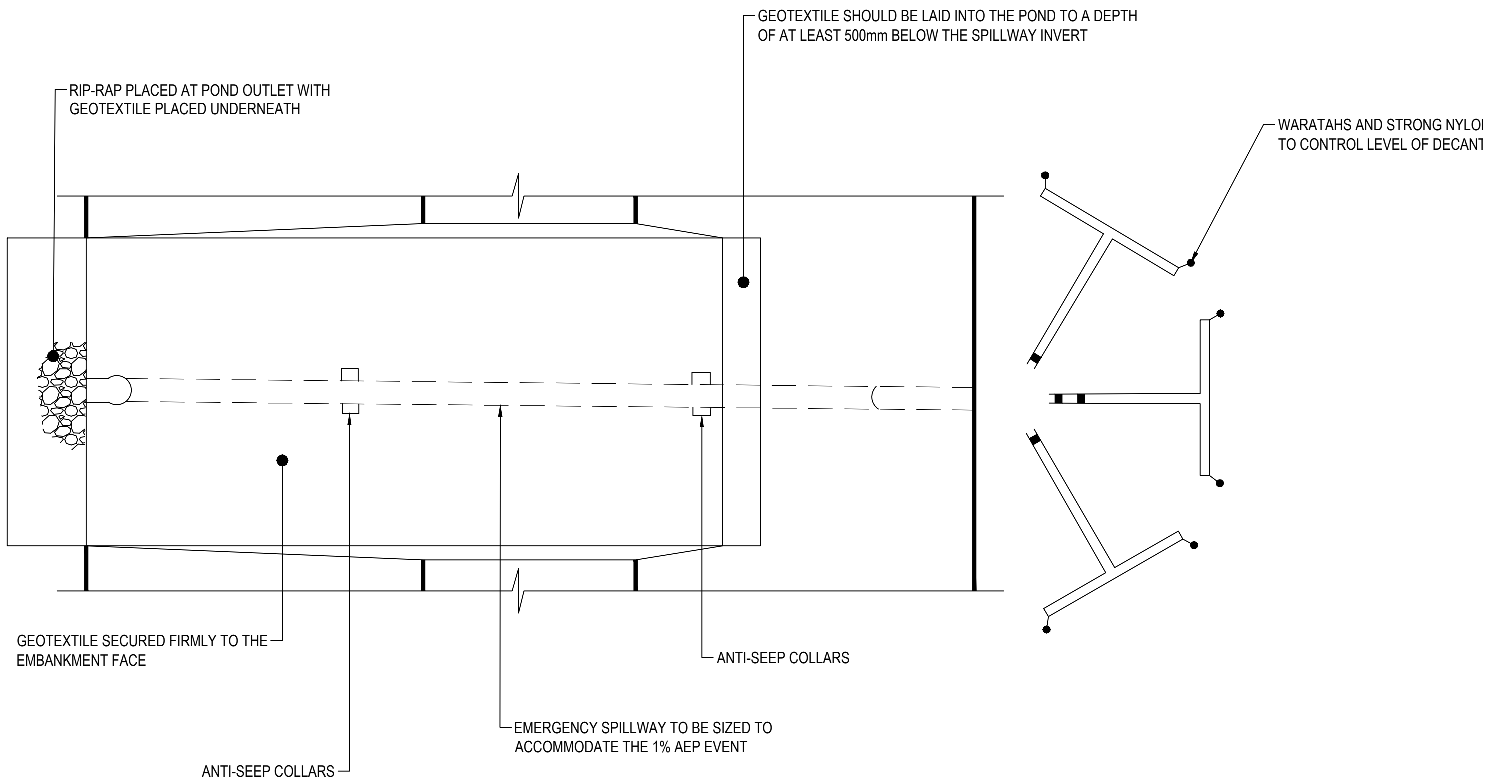


CONCEPTUAL SEDIMENT RETENTION POND
1:200



CROSS SECTION



PLAN VIEW

SEDIMENT RETENTION POND
1:50

2 0 4 8m
SCALE 1:200

500 0 1000 2000mm
SCALE 1:50

PROJECT	REV	DATE	REVISION DETAILS	APPROVED
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NZ TRANSPORT AGENCY WAKA KOTAHI — Northland Corridor — Roads of National Significance

COORDINATE SYSTEM: NZTM 2000, VERTICAL DATUM: NZVD2016

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PROJECT LEAD	T.IRELAND	27.03.26

STATUS: CONSENT DESIGN

APPROVED: *R.DUPLOOY*

APPROVED BY	DATE
R.DUPLOOY	*27.03.26*

TITLE: EROSION & SEDIMENT CONTROL DETAILS SHEET 2

PROJECT INFORMATION: NORTHLAND CORRIDOR

DOCUMENT CODE: 10722-PTA-2B0-PE-DRG-1652

SCALE	SIZE	REFERENCE No.	REV
AS SHOWN	A1	PE-1652	A