Meridian Energy Mt Munro Wind Farm Construction Water Management Plan and Effects Assessment Report

Final May 2023

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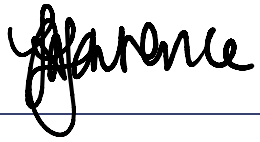
Reviewed by:		Leanne Lawrence	Ridley Dunphy Environmental
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Glossary of key terms

Report relevant terms	Definition
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 sediment generation, 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. Flocculation can be used to promote rapid settling in sediment retention ponds by the addition of flocculating chemicals (flocculants).
Land disturbing activity	Any disturbance to the ground surface that may result in soil erosion through the action of wind or water.
Sediment control	Capturing sediment that has been eroded and entrained in overland flow before it enters the receiving environment.
Sediment delivery ratio	The proportion of the sediment eroded from within a catchment area that actually reaches sediment treatment controls.
Sediment generation	That sediment that is generated on the site of earthwork activity prior to treatment through any sediment retention device.
Sediment load	Mass of sediment carried in suspension within rivers and marine waters.
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 can be expressed in many ways including suspended sediment concentration or a mass load on a time basis or an aerial basis.
Stabilisation	An area inherently resistant to erosion such as rock, or rendered resistant by the application of aggregate, geotextile, vegetation, mulch or an approved alternative. Where vegetation is to be used on a surface that is not otherwise resistant to erosion, the surface is considered stabilised once an 80% vegetation cover has been established.

Glossary of key abbreviations

Report relevant abbreviations	Definition
AEE	Assessment of environmental effects
AEP	Annual exceedance probability
ARI	Average recurrence interval
BPO	Best practicable option
CWD	Clean water diversions
DEB	Decanting earth bund
DWD	Dirty water diversions
ESC	Erosion and sediment control
ESCP	Erosion and sediment control plan
HDEB	Hybrid decanting earth bund
PSD	Particle size distribution
RMA	Resource Management Act 1991
SEMP	Specific environmental management plan
SF	Silt fence
SRP	Sediment retention pond
SSF	Super silt fence
USLE	Universal soil loss equation

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1. Introduction

1.1 Purpose and scope of this report

This Construction Water Management Plan and Effects Assessment Report (the "Report") provides an assessment of the construction water management measures (including erosion and sediment control) in support of a resource consent application by Meridian Energy Limited for the Mt Munro Wind Farm (the "Project"). Our assessment of the construction water management measures and practices likely to be required for the Project is based on the detail within this Report. This Report outlines the principles that will need to be applied throughout and the approach to be adopted for all construction activities and associated water management.

The scope of this Report is as follows:

- Identify the construction-related erosion and sediment management issues for the Project;
- Identify the construction erosion and sediment control principles for the Project;
- Describe the environmental management issues and solutions, including erosion and sediment control (ESC) measures for the construction process;
- Develop indicative erosion and sediment control management methodologies for key construction activities including some specific "Focus Area" ESCPs;
- Assess environmental risks associated with the key construction activities; and
- Identify monitoring procedures.

Assuming that resource consents are granted, the Project would then move into a detailed design phase with more specific details and plans being developed. It is also envisaged that through the detailed design phase the contents of this Report will also be refined and amended to include specific Project construction and earthworks analysis. This will occur prior to earthworks (or any stream works) commencing at a given location and will be produced in the form of a Specific Environmental Management Plan (SEMP). These SEMP's will be submitted to Manawatū-Whanganui Regional Council (Horizons) and Greater Wellington Regional Council (GWRC) for certification against the consent conditions, this Report and best practice ESC. The SEMPs will be informed by the principles of this Report and will enable specific construction constraints and opportunities to be incorporated into the final design for the works at that location. The SEMPs further will allow for flexibility, for enhanced outcomes and the opportunity for implementing improved practices based on any new knowledge and Project outcomes.

The SEMPs will be developed prior to works commencing in the specific locations or for specific activities. They will consider the specific environmental and ecological values and will then determine the most effective and appropriate form of construction water management practices required to manage on a site-by-site basis, during the construction period. The number of SEMPs to be developed will be directly linked to the construction sequence and timing and this will be determined prior to implementation. For ease of implementation however, the project will minimise the number of SEMPs as much as practicable throughout the construction period.

1.2 Project description and background

The Project is proposed within an overall site area of 900 hectares located on hill tops approximately halfway between Mauriceville and Eketāhuna in the northern Wairarapa. The site area is approximately 2 km southeast of State Highway 2 and straddles the regional boundary between the Wellington and Manawatū-Whanganui Regions. It is characterised by steep hills and relatively flat plateau areas on the top. The hillslopes are generally quite steep and high within the Project area, with more gentle lower hillslopes to the east. The Project is located on an active farm, which is used primarily for sheep and cattle grazing.

The Project extends across the boundary between the Masterton and Tararua District Councils.

Meridian had previously sought resource consent for a wind farm and associated facilities at the Project site in 2011. This previous consent application was withdrawn in 2013 due to a lack of electricity demand and a new consent is now sought associated with a new wind farm layout. Figure 1 below confirms the location.

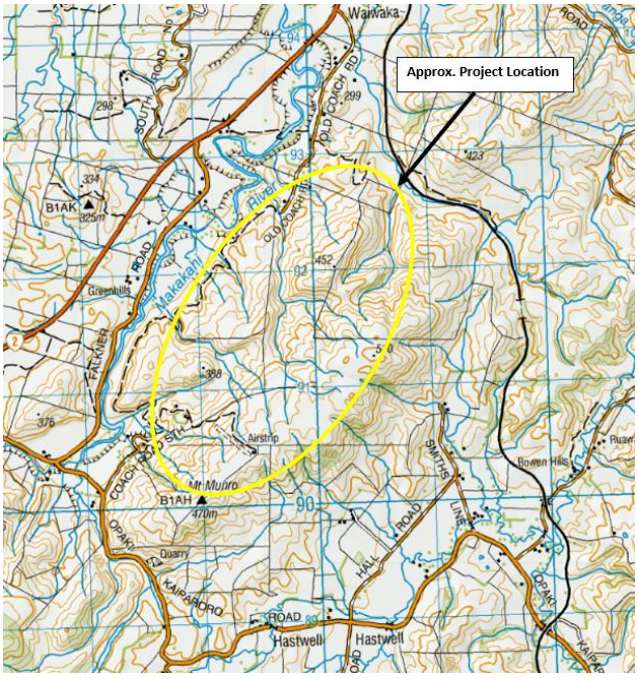


Figure 1 – Project Location

Rather than the traditional assessment approach, which specifies wind turbine locations with micro-siting allowances, Meridian is seeking consent for a design envelope on which all turbines and any infrastructure will be located referred to as a Turbine Envelope Zone. In addition, a Turbine Exclusion Zone will apply where any infrastructure, but no turbines will be located.

These zones are illustrated below in Figure 2.

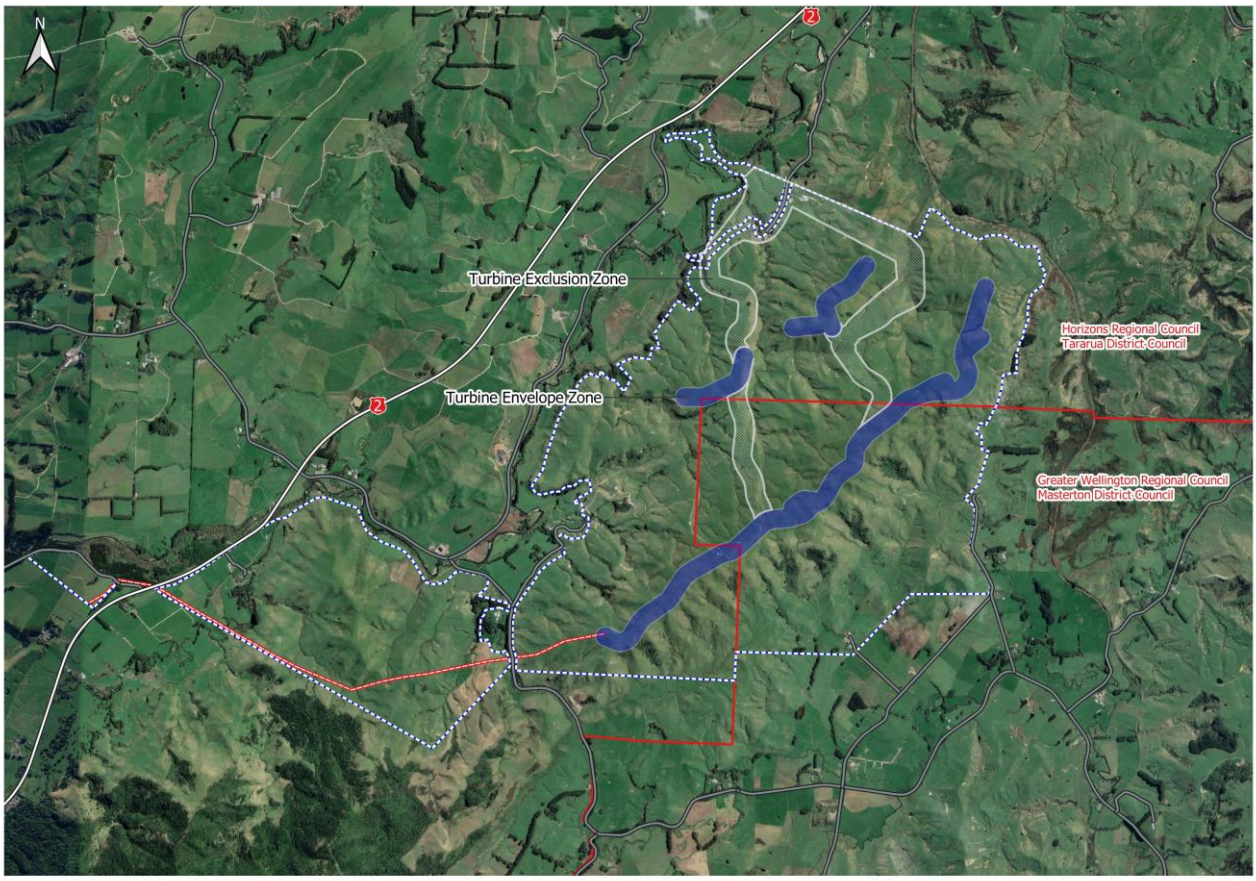


Figure 2 – Project Zones

1.3 Project parameters

This Report does not repeat the details of the Project description itself or the existing environment within which it is to be located. These aspects are clearly identified within the other supporting information for the Project. The following however summarises the key Project parameters that are considered to be of relevance to the earthworks and associated ESCs implemented.

Appendix A of this Report illustrates the proposed Project layout and the associated locations and cut and fill quantities.

Key Project Parameter	2DArea / Volumes / Discussion
Number of Turbine Foundationss	20
Earthwork Areas	
Area of Earthworks for Road Corridor	Approximately 2ha
Area of Earthworks for Turbine Foundations	Approximately 8ha
Area of Earthworks for Fill Sites	Approximately 25ha
Area of Earthworks for Laydown area, Substation and Batching Plants	Approximately 2.3ha
Topsoil Volumes	
Total Topsoil Cut Volume (topsoil thickness assumed to be 250mm)	87,900 m^3
Road Corridor Bulk Earthwork Volumes	
Total Cut Volume of Earthworks (excluding topsoil) for Corridors	935,100 m^3 (includes 10% contingency)
Total Fill Volume of Earthworks for Corridors	335,700 m^3 (includes 10% contingency)
Turbine Platforms Bulk Earthwork Volumes	
Total Cut Volume of Earthworks (excluding topsoil) for Turbine Platforms including foundation excavations. (Excludes batching plant, substation and laydown)	758,600 m^3 (includes 10% contingency)
Total Fill Volume of Earthworks for Turbine Platforms including foundation excavations (Excludes batching plant, substation and laydown)	141,300 m^3 (includes 10% contingency)
Fill Disposal Sites	
Total Fill Volume of Topsoil for Fill Disposal Sites or Export	76,300 m^3 (includes 10% contingency)
Total Fill Volume of Bulk Earthworks for Fill Disposal Sites	1,090,000 m^3 (includes 10% contingency)

Table 1 – Key Project Parameters

1.4 Best practice guidelines

Both Horizons and GWRC have developed/adopted the *Erosion and Sediment Control Guide for Land Disturbing Activities in the Wellington Region dated February 2021* (the "GWRC Guideline") as a best practice ESC guide for land disturbing activities. This GWRC Guideline provides a minimum standard for designing ESC measures and development of an associated ESCP as part of resource consent and permitted activities for earthwork activities.

As part of the construction water management assessment for this Project, the GWRC Guideline has been assessed and incorporated with best practice experience. This reflects the current state of knowledge (as per the GWRC Guideline), the specific physical conditions to be encountered with the Project and the previous knowledge of the team (from other similar projects) which will be reflected in the measures adopted. Where there is any uncertainty as to the specific design to be implemented, the GWRC Guideline will take precedence.

1.5 Roles and responsibilities

As the consent holder, Meridian will have the overall responsibility for meeting the requirements of this Report. For the bulk earthworks the contractor engaged will include an environmental manager (or equivalent) that will implement the SEMPs including all required monitoring, management and necessary communication to the regulatory agencies.

The project will also include specific environmental training for all relevant personnel for the purpose of consent awareness, environmental risks and opportunities and erosion and sediment control management. This will occur prior to works commencing and will also include refresher training opportunities.

This SEMPs will be implemented for the duration of the construction works and a copy of the SEMPs will be kept in an accessible location for the duration of the consent.

Specific roles and responsibilities including contact details for key staff with environmental responsibilities will be identified within the SEMPs as necessary. This will likely include supervisors with responsibility for SEMP compliance and daily inspections, contractor environmental managers with responsibility for weekly audits and rain related responses, independent audits of SEMPs on site on a monthly basis and consent holder inspections with a focus on high-risk locations.

2. Statutory and non-statutory context and technical framework

2.1 Statutory framework

2.1.1 Resource Management Act 1991

The Resource Management Act 1991 (RMA) regulates activities that may affect the environment, including stormwater discharges. Sections 14 and 15 are the governing sections of the RMA in relation to use of and discharges to water.

The purpose and principles of the RMA are set out in sections 5 to 8 of that Act. Of particular relevance to this assessment of effects of discharges to water are sections 5(1) and 5(2).

Section 7 of the RMA requires consent authorities to have particular regard to those matters listed in the section. In the case of discharges to water from this Project, we consider the following matters to be relevant:

- Maintenance and enhancement of amenity values (Section 7(c)); and
- Maintenance and enhancement of the quality of the environment (Section 7(f)).

In the context of this assessment, amenity values may be affected by discharges of sediment-laden water during construction. The quality of the water environment is primarily defined by effects on the life supporting capacity of the water and its ability to provide for uses of the water.

Section 107 of the RMA places restrictions on the grant of certain discharge permits.

Section 107 requires that except as provided in subsection (2), a consent authority shall not grant a discharge permit that would otherwise contravene Section 15 or Section 15A allowing the discharge of a contaminant or water into water.

Further Section 107 notes a consent authority shall not grant a discharge permit if, after reasonable mixing, the contaminant or water discharged (either by itself or in combination with the same, similar, or other contaminants or water), is likely to give rise to all or any of the following effects in the receiving waters:

- the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
- any conspicuous change in the colour or visual clarity;
- any emission of objectionable odour;

- the rendering of fresh water unsuitable for consumption by farm animals; and/or
- any significant adverse effects on aquatic life.

Subsection 2 requires that a consent authority may grant a discharge permit that would otherwise contravene section 15 or section 15A that may allow any of the effects described in subsection (1) if it is satisfied that the discharge is of a temporary nature.

2.1.2 Horizons Regional Plan – One Plan

The Project site is within the Mangatainoka Surface Water Management Zone, and sub zone Makakahi (Mana_8d). It is valued for Life Supporting Capacity – Hill Mixed, Aesthetics, Contact Recreation, Mauri, Industrial Abstraction, Irrigation, Stock water, Existing Infrastructure, Capacity to Assimilate Pollution, Natural State, Sites of Significance - Aquatic, Regionally Significant Trout Fishery, Trout Spawning, Water Supply, and Flood Control and Drainage.

The Project site is also within a Hill Country Erosion Management Area as parts of the site have slopes which are 20^{o} or greater.

Relevant rules, matters of discretion and assessment criteria:

Rule 13-6 Specified…land disturbance…in a Hill Country Erosion Management Area

Pursuant to s9(2) RMA, except as regulated by Rule 13-8 and 13-9, any:

a. land disturbance of more than 100 m^2 per property per 12-month period, or

b. vegetation clearance of 1 ha or greater per property per 12-month period where the age of the vegetation in the area to be cleared is greater than seven years, or

c. cultivation,

undertaken within a Hill Country Erosion Management Area and any ancillary:

a. diversion of water pursuant to s14(2) RMA on the land where the vegetation clearance, land disturbance or cultivation is undertaken, or

b. discharge of sediment into water pursuant to s15(1) RMA resulting from the vegetation clearance, land disturbance or cultivation

Is a Restricted Discretionary Activity.

Conditions/Standards/Terms

a. The activity must not take place on land that is within a coastal foredune

b. The activity must not occur on land that is in, or within 10 m of:

i. the bed of a river that is permanently flowing,

ii. the bed of a river that is not permanently flowing and has an active bed width greater than 1 m,

iii. the bed of a lake,

iv. a wetland as identified in Schedule F[1],

v. sites valued for Trout Spawning as identified in Schedule B,

vi. Sites of Significance - Aquatic as identified in Schedule B.

Matters of Discretion

a. the location, nature, scale, timing and duration of the activity

b. effects of the activity and associated sediment run-off on soil conservation, surface water quality and aquatic ecology and the methods to be taken to avoid, remedy or mitigate them

c. the requirement to provide an Erosion and Sediment Control Plan, the content of and standard to which the plan must be prepared, the implementation of the plan, and the timing of when it must be prepared and submitted

d. the provision of greater setback distances from water bodies than those specified under condition (b) to provide greater protection to a water body if required

e. the extent of non-compliance with the water quality target for visual clarity set out in Schedule E[2],

f. duration of consent

g. review of consent conditions

h. compliance monitoring

i. the matters in Policy 14-9.

[1] To be confirmed by ecologist, as *seepage and spring wetlands* are identified in Schedule F

[2] The visual clarity targets for the Makakahi subzone are 3m <50th %tile and 20m%Δ

Advice Note: Examples of alternative methods to avoid, remedy or mitigate sediment run-off can be found in Chapters 3, -9 of the "Erosion and Sediment Control Guidelines for the Wellington Region" (September 2002).

For completeness, the matters in Policy 14-9 are as follows:

Policy 14-9: Consent decision making requirements from the National Policy Statement for Freshwater Management

a. This policy applies to any application for the following discharges^ (including a diffuse discharge by any person or animal):

i. a new discharge; or

ii. a change or increase in any discharge of any contaminant into fresh water, or onto or into land in circumstances that may result in that contaminant (or, as a result of any natural process from the discharge of that contaminant, any other contaminant) entering fresh water.

b. When considering any application for a discharge the Regional Council must have regard to the following matters:

i. the extent to which the discharge would avoid contamination that will have an adverse effect on the life-supporting capacity of fresh water including on any ecosystem associated with fresh water; and

ii. the extent to which it is feasible and dependable that any more than minor adverse effect on fresh water, and on any ecosystem associated with fresh water, resulting from the discharge would be avoided.

c. When considering any application for a discharge the Regional Council must have regard to the following matters:

i. the extent to which the discharge would avoid contamination that will have an adverse effect on the health of people and communities as affected by their secondary contact with fresh water; and

ii. the extent to which it is feasible and dependable that any more than minor adverse effect on the health of people and communities as affected by their secondary contact with fresh water resulting from the discharge would be avoided.

Note, if the above rule cannot be complied with (in terms of setback distances), then resource consent would be required as a Discretionary Activity under Rule 13-7, with the focus from an

earthworks management perspective continuing to be on those matters of discretion identified in Rule 13-6 above.

2.1.3 Greater Wellington Natural Resources Plan

The Kopuaranga River, which flows south and east of the site is identified in Schedule B of the NRP as Nga Taonga Nui a Kiwa. It is also identified in Schedule I as an important trout fishery river and spawning water. It is a Class 3 river, as are its tributaries which flow from the site (although there is an instance of a Class 1 river, and two instances of a class 6 river. On the western side of the hill, flowing towards the Tararua District/Horizons Region is a small stem of River Class 2.

Relevant rules, matters of discretion and assessment criteria:

Rule 102: Earthworks and vegetation clearance for renewable energy generation – restricted discretionary activity

The use of land, and the associated discharge of sediment into water or onto or into land where it may enter water from earthworks not permitted by Rule R99 or vegetation clearance on erosion prone land that is not permitted by Rule R100 associated with the use, development, operation, maintenance and upgrade of renewable energy generation is a restricted discretionary activity, provided the following conditions are met:

a. the earthworks or vegetation clearance and associated discharge are associated with the following construction activities:

i. the formation of access tracks,

ii. the formation of laydown areas and stockpile areas,

iii. the formation of wind turbine platforms, including foundation formation,

iv. foundations for any operations building or transmission line,

v. placement of any excess fill associated with any of the activities listed in (i) to (iv) above,

vi. ancillary works necessary to construct or maintain any erosion and sediment control measures associated with (i) to (v) above, and

b. the activity does not occur within the coast marine area, and

c. any soil or debris from the vegetation clearance is not placed where it can enter a surface water body or the coastal marine area, and

d. the earthworks or vegetation clearance will not create or contribute to instability or subsidence of a slope or another land surface at or beyond the boundary of the property where the earthworks or vegetation clearance occurs, and

e. work areas are stabilised within six months after the completion of the earthworks, and

f. any earthworks shall not, after the zone of reasonable mixing, result in any of the following effects in receiving waters:

i. the production of conspicuous oil or grease films, scums of foams, or floatable or suspended materials, or

ii. any conspicuous change in colour or visual clarity, or

iii. any emission of objectionable odour, or

iv. the rendering of fresh water unsuitable for consumption by animals, or

v. any significant effect on aquatic life, and

g. the earthworks or vegetation clearance shall not, occur within 10m of a surface water body or coastal marine area.

Matters for discretion

1. The location, area, scale, volume, duration and timing of the works

2. The design and suitability of erosion and sediment control measures including consideration of hazard mitigation and the risk of accelerated soil erosion associated with

3. Staging of works and progressive stabilisation:

4. Adverse effects on:

i. groundwater, surface water bodies and their margins, particularly surface water bodies within sites identified in Schedule A (outstanding water bodies), Schedule B (Ngā Taonga Nui a Kiwa), Schedule C (mana whenua), Schedule F (ecosystems and habitats with indigenous biodiversity), Schedule H (contact recreation and Māori customary use) or Schedule I (important trout fishery rivers and spawning waters)

ii. group and community drinking water supplies

iii. mauri, water quality (including water quality in the coastal marine area), aquatic and marine ecosystem health, aquatic and riparian habitat quality, indigenous

biodiversity values, mahinga kai and critical life cycle periods for indigenous aquatic species

iv. *the natural character of lakes, rivers, natural wetlands and their margins and the coastal environment*

v. *natural hazards, land stability, soil erosion, sedimentation and flood hazard management including the use of natural buffers*

5. *The placement and treatment of stockpiled materials on the site, including requirements to remove material if it is not to be reused on the site*

6. *The benefits to be derived from the use and development of renewable energy generation*

7. *Monitoring and reporting requirements.*

2.2 Assessment criteria for the Project

Generally, the planning provisions as detailed above direct the Project to avoid sediment loss and increased sedimentation and minimise adverse effects in all other instances. Discharges, including sediment discharges from earthworks, are expected to meet water quality criteria.

We have outlined the key assessment criteria as set out below in Table 2.

Matter of Discretion
Effects of the activity and associated sediment run-off on soil conservation, surface water quality and aquatic ecology and the methods to be taken to avoid, remedy or mitigate them.
The provision of an Erosion and Sediment Control Plan, prepared to a standard that satisfies each Council. In the Greater Wellington Region, the erosion and sediment control measures must include consideration of hazard mitigation and the risk of any associated accelerated soil erosion.
Compliance with visual clarity water quality targets in receiving waters.
Staging of works and progressive stabilisation.
The placement and treatment of stockpiled materials on the site, including requirements to remove material if it is not to be reused on the site.

Table 2 – Earthwork Key Matters of Discretion

3. Existing environment

3.1 Rainfall

Masterton experiences approximately 1310mm rainfall per year, with the months of June through to October typically a wetter period of the year. Figure 3 below illustrates this rainfall pattern which is assessed to be similar for the Project site. Bulk earthworks will be programmed to be undertaken during the summer period however as detailed below some winter activities may also occur.

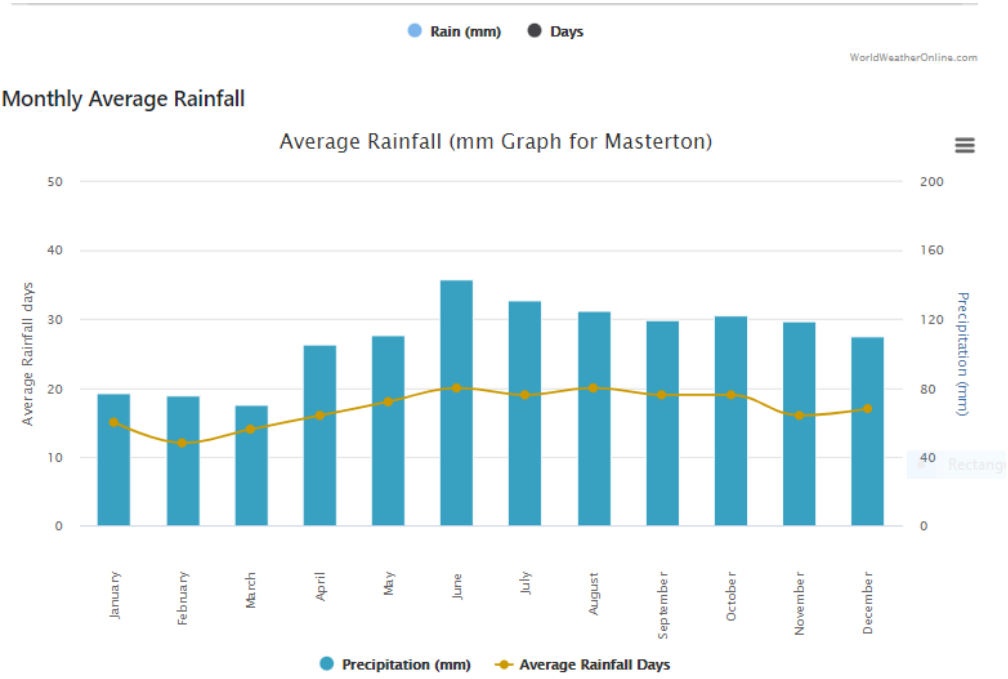


Figure 3: Masterton Annual Rainfall Patterns

3.2 Catchment description and topography

3.2.1 Catchment description

The area that will be subject to earthworks is pastoral farmland originally part of the "Wairarapa Bush". The Project site still contains some signs of major burn-offs, with large log remains present in the paddocks. The site is relatively flat along most of the top plateau, but access to these ridgelines is steep from the valley floor.

The area is drained by two river systems, with the area in the northern, western and southern part of the site containing tributaries of the Makakahi River system which eventually flows into the Manawatu River. The eastern area of the site contains tributaries that flow into the Kopuranga River, a tributary of the Ruamahanga River.

3.3 Geology

The geotechnical factual report that supports the Project confirms that the area is generally underlain by older, stronger volcaniclastic greywacke sandstones and mudstones of the Waioeka Terrane. The river terrace adjacent to State Highway 2 comprises Quaternary-age alluvial deposits whilst the lower lying hillslopes to the east are underlain by much younger, weaker Miocene-age conglomerates and Pleistocene-mudstones.

Geotechnical investigations were carried out at the Project site on 14th and 15th December 2021. The investigations comprised the excavation of test pits to determine geological features. Soil samples from these same test pits were collected and tested for soil settlibility as detailed within Section 5.2.6 of this Report.

3.4 Water quality

The site contains many areas of streams and wetland areas with these identified within the ecological reporting that supports the Project. As mentioned above the Project area, and the proposed earthworks, will eventually drain to the Manawatu River with the eastern area of the site draining to the Ruamahanga River.

These river systems, and the various tributaries, have recognised values from both a recreational and ecological perspective.

3.5 Overall sensitivity of the receiving environment

Based on the knowledge of the receiving environment and the extent of the Project works, while the Project earthworks are not significant in terms of aerial extent, it is important that the minimisation of discharges from construction activity occurs at all times. Best practice measures will need to be designed, implemented and maintained with a BPO approach to ensure this can be achieved overall.

4. Overview of erosion and sediment control

4.1 Erosion and sedimentation process

Erosion occurs when the surface of the land is worn away (eroded) by the action of water, wind, ice or geological processes. Through the erosion process, soil particles are dislodged, generally by rainfall, surface water flow and wind. As rain falls, water droplets concentrate and as this flow moves down a slope, the combined energy of the rain droplets and the concentration and velocity of flows has the potential to dislodge soil particles from the surface of the land.

Sedimentation occurs when these soil particles are deposited. The amount of sediment generated depends on the erodibility of the soil, the energy created by the intensity of the rain event, the site conditions (for example the slope and the slope length) and the area of bare earth or unstabilised ground open to rainfall.

The following terms represent the key aspects of ESC:

- **Sediment generation** – this highlights the generation potential of the area in question and is based on slope, slope length, soils, rainfall and erosion control factors.
- **Sediment delivery** – this relates to the amount of eroded material that is not retained onsite in depressions and within the site's natural contours prior to it entering any sediment treatment devices.
- **Sediment yield** – the amount of sediment that actually leaves the site and enters the receiving environment (stream system).
- **Sediment load** – the mass of sediment carried in suspension within rivers and marine waters.

Erosion control is based on the practical prevention of sediment generation in the first instance. If erosion control measures and practices are effective, then sediment generation will be minimised and the primary reliance on the sediment control measures is reduced.

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, earthworks, even with best practice erosion control measures in place. Sediment control measures are designed to capture this sediment and to minimise any resultant sediment-laden discharges (sediment yield) to stream systems.

Rather than primarily relying on sediment control measures, reducing erosion will have the direct effect of reducing sediment generation and therefore less sediment laden runoff will need to be intercepted, treated and discharged from the sediment control measures.

ESC measures can be considered as both structural and non-structural measures. Structural measures are physical control measures that are put in place on an earthworks site while non-structural measures are those that are based around methodologies and sequencing of works. Both categories have benefits in the minimisation of sediment yields and both of them must be considered to allow for successful implementation. When both structural and non – structural measures are implemented on a site, best practice is in place.

Example of structural and non-structural ESC measures are outlined below:

- **Structural measures**
  - Mulching for stabilisation;
  - Sediment retention ponds;
  - Silt fences; and
  - Rainfall activated chemical treatment devices.
- **Non-Structural**
  - Methodologies for work activities;
  - Pre, during and post rain inspections;
  - Appropriate sequencing of works;
  - Weather forecasting;
  - Implementation of an adaptive monitoring programme; and
  - Appropriate resource skills and quantity to achieve the outcomes required.

With the above in mind, the ESC measures for the Project are designed to minimise the extent of soil erosion and manage any resultant sediment yield. Erosion control will be the highest priority in the design of measures, and we also consider non-structural measures to be crucial in avoiding significant environmental effects.

4.2 Erosion and sediment control principles

This section outlines the general principles for construction water management control on the Project and sets the context for our assessment.

It is essential that construction water management measures and practices implemented during the construction phase of the Project recognise these values and manage any discharge, particularly sediment, accordingly. As detailed within the ecological assessment reporting, this applies during lower baseline turbidity periods when further sediment inputs are recognised as having more significant impacts. Higher risk areas are also identified as those locations within, adjacent to, or connected to, freshwater environments in addition to those areas of steeper contour.

This Report provides the background and assesses the erosion and sedimentation effects that will result from Project construction activity.

The development of the ESC measures discussed in this Report is based on:

- Viewing the construction of the Project in a holistic manner. The combined effects of the construction activity on the receiving environment, are considered as a whole and not in isolation from each other;
- Minimising the potential adverse effects on the receiving environment, by using measures, both structural and non-structural that meet or exceed industry best practice and GWRC Guidelines;
- Developing SEMPs and undertaking pre-construction meetings for specific stages of construction and having regular 'toolbox' meetings onsite with relevant personnel in attendance as part of the construction phase;
- Ensuring that all construction water discharges are considered and assessed as part of the Project implementation;
- Maintaining a register of control measures and 'As Built' information of key ESC controls to allow for quick and efficient referencing, identification and understanding of function and location of the various measures installed onsite;
- Ensuring that all measures utilised are structurally sound and have appropriate geotechnical approval where necessary;
- Including both structural measures and non-structural measures within the methodologies; and

- The development of an adaptive monitoring (continuous improvement) programme, to inform the extent and environmental performance of construction activity onsite and directing the work activity to influence and reduce the discharge of sediment into the receiving environment

Within the GWRC Guidelines there are a series of key principles that apply to all earthworks. These underpin this Report and the earthworks/construction methodology that applies. These are included in Appendix B of this Report and are summarised as relevant for this Project as detailed below:

Minimise disturbance

A minimum earthworks strategy with a low impact design will be implemented, avoiding watercourses, wetlands and springs where possible.

Stage construction

The extent of exposed soil and length of time that area is exposed has a direct influence on the sediment yield leaving a particular area of the site. Earthworks and construction activities will be staged and sequenced in order to limit the area of exposed soil required to complete an element of the work. Open earthworks areas will be progressively stabilised to reduce the potential for erosion to occur with a 14-day period recommended.

The specific sequencing and staging for this Project will evolve and be refined as the construction methodology is confirmed through the detailed design phase.

Protect steep slopes

Where possible, earthworks on steep slopes will be avoided. The bulk of the earthworks will occur largely on top of ridgelines. Runoff from the exposed working areas will be diverted where possible from steep slopes to minimise the risk of erosion. Where steep slopes require earthworks then progressive and rapid stabilisation will occur to protect these areas from erosion. A cut and cover methodology will apply to a large percentage of the roading corridor activity.

Protect watercourses

Existing watercourses and proposed drainage patterns are indicated on the plans supporting the Project. Existing watercourses will be protected from works and sedimentation by the proposed controls included in this Report and the SEMPs.

Stabilise exposed areas rapidly

Progressive and rapid stabilisation methods (e.g. hay/straw mulching, hydroseeding, aggregate placement) will be implemented to minimise the length of time areas of works are exposed, thus minimising the potential for erosion and sedimentation. Additionally, areas of completed works will be protected from stock until fully rehabilitated. As mentioned above exposed earthworks areas will be progressively stabilised to reduce the potential for erosion to occur with a 14-day period recommended.

Install perimeter controls

Where there is an upstream catchment to working areas, perimeter controls (e.g. clean water diversion bunds/channels) will be implemented. These are designed for the key purpose of keeping clean water away from earthwork locations and also for diverting dirty water flows to sediment control devices where installed.

Employ detention devices

Sediment laden water will be treated by detention devices prior to discharging into the receiving environment.

Experience and training

As detailed in Section 1.5 of this Report, all earthworks will be managed by an appropriately qualified person experienced in erosion and sediment control and associated environmental issues. These people will have clearly defined roles and responsibilities including monitoring compliance with the imposed consent conditions and meeting with consent authorities as required. As detailed above in Section 1.5 the Project will also include specific environmental training for all relevant personnel for the purpose of consent awareness, environmental risks and opportunities and erosion and sediment control management. This will occur prior to works commencing and will also include refresher training opportunities.

Ensuring the plan evolves

The SEMPs will be evolving documents and will be reviewed routinely and updated during the course of the Project to reflect material changes associated with construction techniques, communication, monitoring results, mitigation, compliance or the natural environment.

Assess and adjust

As detailed in Section 8 of this Report, a monitoring and maintenance programme of the ESCs will be established. Based on the results of this monitoring, the ESC measures will be maintained and adjusted accordingly to ensure these controls are operating efficiently and effectively and in accordance with this Report, the SEMP and best practice.

To expand on these overarching principles further the following will apply to all earthworks associated with the Project.

1. Erosion and sediment control will, where practicable, be undertaken and implemented with a hierarchy and priority order as follows:

    - Erosion control will be provided for in all circumstances by minimising sediment generation through a range of structural (physical measures) and non-structural (methodologies and construction sequencing) erosion control measures.

    - Sediment control will be implemented for all sediment laden discharges.

2. Construction water management measures will be outlined in detail in the SEMPs. All ESCs will, where practicable, meet the minimum criteria as detailed in this Report and will incorporate innovative ideas and procedures to ensure best practice applies and to match the local challenges and opportunities.

3. All ESCs will, where practicable, meet the minimum criteria of the GWRC Guidelines and will incorporate innovative ideas and procedures to match the local challenges and opportunities.

4. The development of SEMPs, in accordance with the direction and principles of this Report, will allow for future innovation, flexibility and practicality of approach to erosion and sediment control and shall allow the ability to adapt appropriately to changing conditions.

5. Progressive and rapid stabilisation of disturbed areas using mulch, 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 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 of earthworks not actively worked for more than a 14-day period.

6. All Sediment Retention Ponds (SRPs), Hybrid Decanting Earth Bunds (HDEBs) and Decanting Earth Bunds (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.

7. All Project SRPs, HDEBs and higher risk DEBs (as identified in the SEMPs) will be chemically treated with a flocculant appropriate for the soil type and discharge location unless the SEMP for that location confirms that there are no benefits from such use.

8. 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 with active stream channels, and any associated works with 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.

9. 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 SEMPs 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 and also upstream and downstream sampling to assess against baseline water quality parameters.

9. 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.

5. Erosion and sediment control measures

5.1 Key erosion control measures

In general, the erosion control measures to be applied to the Project are as follows:

5.1.1 Construction staging and sequencing

The extent of exposed soil and length of time that area is exposed has a direct influence on the sediment generation (erosion) and sediment yield. The Project will minimise this soil exposure and provide the detail within the SEMP to ensure areas are subject to progressive stabilisation and are not "exposed" and unworked at any time. Staging and sequencing will be a key non-structural element and includes progressive stabilisation as works advance.

5.1.2 Clean and dirty water diversions (CWD and DWD)

CWDs provide for the controlled conveyance of upslope runoff away from works areas and will be used on the Project to prevent run on water from the undisturbed catchment above the works from entering the construction area.

CWDs will be designed to cater for the 20-year ARI rain event with a 1-hour duration (plus a 300mm freeboard). This design is consistent with best practice and will ensure that the works are sufficiently protected from flows from the natural catchment outside of the works.

DWDs transfer sediment laden water to sediment retention devices for treatment. They are effectively a conveyance device and are designed to cater for the 20-year ARI rain event with a 1-hour duration (plus a 300mm freeboard). The DWD design criteria for the Project will ensure that all construction runoff from rain events up to the 20-year ARI event will be transferred to treatment devices. This design (including the freeboard provision) effectively has the same capacity as a 100-year rainfall event and therefore is assessed as providing a robust and best practice approach.

CWDs will be stabilised with either vegetation or geotextile cloth or using turf from adjacent grass areas and layering this on exposed soil surfaces. DWDs will be stabilised dependent upon soil type and slope for the specific area of works and will have this detail outlined within the SEMP.

Both CWDs and DWDs are confirmed as locations where failure or breaches can occur when design is not achieved or when compaction of these devices is not sufficient and leads to saturation and failure. All CWDs and DWDs must be constructed of well compacted cohesive material that minimises this potential.

A maintenance programme will be implemented during Project construction activity to remove any resultant sediment deposited within the DWD. The DWD will also have drop out pits with a

$2m^3$ volume capacity established at 50m intervals along the channel itself to assist with the capture of the heavier particle size sediments that are generated.

5.1.3 Contour drains

Contour drains are temporary berms or excavated channels or a combination of the two that are constructed to convey water across a slope at a gradient of maximum 2% slope. They are installed prior to rainfall events to reduce the slope length and therefore the velocity of water flowing down disturbed slopes and hence reduce sediment generation.

5.1.4 Rock check dams

Check dams are small dams made of rock, or other non-erodible material, constructed across a swale or channel to act as a control structure. The purpose of a check dam is to reduce the velocity of flow within the channel and prevent scour of the channel surface. Check dams also allow for some settlement of suspended solids within the channel.

5.1.5 Stabilisation for erosion and dust management purposes

Stabilisation is a key element of the Project and will include mulching, vegetative cover, geotextile and the use of hard fill material. Stabilised is defined as:

> *An area inherently resistant to erosion such as rock, or rendered resistant by the application of aggregate, geotextile, vegetation, mulch or an approved alternative. Where vegetation is to be used on a surface that is not otherwise resistant to erosion, the surface is considered stabilised once an 80% vegetation cover has been established.*

Progressive and rapid stabilisation of disturbed areas will be ongoing throughout the Project to achieve the necessary staging and sequencing process. Where mulch is utilised it will include hay/straw and wood bark generated onsite through the removal and mulching of any existing vegetation as appropriate.

Mulching will typically apply to slopes of less than 15 degrees (27%), above which alternatives will need to be considered. In addition, mulch is prone to wind blow during application and if these circumstances arise then alternatives such as hydroseeding may be applied.

Stabilisation options include traditional grass sowing methodologies, however this is not considered stabilised until such a time as 80% vegetative cover is established on site. Hardfill with clean aggregate also creates a stabilised surface. If other alternatives, such as polymer/soil binder products, are to be utilised they will need to be verified as stabilised, demonstrated to have no residual impacts and will need to be trialled on site to demonstrate appropriateness prior to use.

The development of the SEMPs will determine the specifics of this stabilisation technique and timing.

Stabilisation will be undertaken with three key purposes:

- To achieve the staging and sequencing provisions to reduce sediment generation (erosion potential) of the Project;
- To reduce the open area of higher risk locations to assist with a reduction in sediment generation including wind borne sediment; and
- In response to the adaptive monitoring programme to address any potential effects or undesirable monitoring (water quality) trends.

5.1.6 Pipe drop structure / flume

Temporary pipe drop structures or flumes are constructed to convey construction runoff down a slope face without causing erosion of the slope and will be used to ensure no scour of these batters occurs. GWRC Guidelines will provide the design criteria.

5.1.7 Stabilised construction entrance way

Stabilised construction entranceways are a stabilised pad of aggregate placed on a filter base and are located where construction traffic will exit or enter a construction site. They help to prevent site entry and exit points from becoming a source of sediment and also help to reduce dust generation and disturbance along public roads. In many circumstances on this Project existing stabilised entrances will be utilised. GWRC Guidelines will provide the design criteria.

No vehicles will be allowed to leave the Project site unless tyres are clean and vehicles will not contribute to sediment deposition on public road surfaces.

5.2 Key sediment control measures

Sediment control on the Project will involve the treatment of sediment-laden runoff from the various construction areas along the Project. Sediment control will be established through the use of recognised sediment control measures and site management practices.

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 only small catchment areas to reduce risk and will be subject to an increased inspection and maintenance regime, in particular the removal of any accumulated sediment.

The sediment control measures to be applied to the Project are as follows:

5.2.1 Sediment retention pond (SRP)

Treatment of construction runoff will be carried out to ensure that sediment is removed to the maximum extent possible from the construction runoff before being discharged to the receiving environment. SRPs provide the most robust and effective measure in achieving sediment removal from construction runoff however are only appropriate for larger areas of earthworks.

SRPs will be designed to receive the flows from the upstream catchment during a 100-year ARI rain event through the established DWD as detailed above. The GWRC Guideline has a 5ha maximum contributing catchment area that can be treated through a single SRP. The Project will, where practicable, maximise catchment areas to this 5ha limit however there may be circumstances where slightly larger catchments may be appropriate and reflect best practice and this will be detailed within the SEMP.

SRPs will be designed with a minimum 3% volume criterion applied in relationship to catchment size (i.e. 300m^3 SRP volume per 10000 m^2 or 1ha of contributing catchment). This criterion exceeds GWRC Guidelines which also allows for the provision of a 2% volume criterion to be applied for some lesser slope sites. The 3% volume criteria provides for a more robust and effective measure. Where SRPs are to be installed and the 3% criteria cannot be achieved this will be detailed within the SEMP with best practice still applying.

SRP spillways will be designed and constructed to ensure that they safely pass the 100-year ARI rain event with low velocity, which will reduce the risk of scour on the downstream side of the spillway. Forebays of SRPs will be established that are designed to capture the majority of the sediment entering the SRP.

We note that as part of the SRP construction, it will be necessary to do the following:

- Check ground conditions, including in some circumstances through the use of bore holes to undertake a geotechnical assessment, of the proposed SRP site; and
- Remove any unsuitable material and confirm ground conditions as appropriate for SRP establishment.

This specific detail will be provided within a SEMP.

SRPs will typically be subject to chemical treatment with this detail confirmed within the SEMP and largely based on soil types for that SEMP activity.

5.2.2 Decanting earth bund (DEB)

DEBs are impoundment areas where ponding of sediment-laden runoff can occur and which provide time for suspended solids to settle out before the runoff is discharged to the receiving environment. They are formed like a miniature SRP and have a maximum contributing catchment area of 0.3ha.

DEBs will be designed based on a volume of 2% of the contributing catchment area with an ideal length to width ratio of 3:1, but not exceeding 5:1. All spillways from the DEBs will be constructed to safely pass the 100-year ARI rain event with low velocity and therefore minimal scour potential. All DEBs will have floating decants installed.

DEBs will typically not be subject to chemical treatment unless the SEMP confirms this requirement for higher risk locations.

5.2.3 Hybrid decanting earth bund (HDEB)

In some circumstances there are catchments that exceed the design criteria for DEBs however are not large enough, or the duration of works is of a short period, to justify the installation of a fully designed SRP. These circumstances are for catchments between 0.3 and 0.5ha and for works that are of less than 4 months duration. These HDEBs, while not featuring in the GWRC Guidelines, have been successfully utilised on other projects including the Turitea Windfarm in the Manawatu.

Similar to DEBs, the HDEB will be designed based on a volume of 2% of the contributing catchment area with an ideal length to width ratio of 3:1, but not exceeding 5:1. All spillways from the HDEBs will be constructed to safely pass the 100-year ARI rain event with low velocity and therefore minimal scour potential. HDEBs will have floating decants.

The key design difference from a DEB is that the HDEBs will have a sump established at the inlet end with a geotextile lined bund between this sump and the main body of the HDEB. The volume of this sump is based on 10% volume of the main body volume.

All HDEBs will typically be subject to chemical treatment with this detail confirmed within the SEMP and largely based on soil types for that SEMP activity.

5.2.4 Pumping activities

All SRPs, HDEBs and DEBs will be fitted with floating decants and with a mechanism to control outflow such as a manual decant pulley system or a stop valve to be used during pumping activities to these structures. The pumping rates and volumes to SRPs, HDEBs and DEBs will be designed for the total pump volume to be fully captured within the retention structure and the decants only allowed to discharge once an acceptable standard of discharge quality can be

achieved. This acceptable discharge is assessed as 100mm visibility which will be further assessed through monitoring as per Section 8 of this Report.

5.2.5 Silt fence (SF) and Super silt fence (SSF)

SF and SSF are fabric fences reinforced with stakes and a chain-link backing (SSF only) to allow a physical barrier to sediment laden flows leaving the area of earthworks. This barrier acts as a detention and filter for these flows to ensure sediment yield is minimised. Their design and placement will be based upon the criteria contained within the GWRC Guidelines. SSFs will be used, instead of SFs, in those areas of work adjacent to, or in the immediate vicinity of watercourses.

As a risk management tool for SSFs, the fabric will be installed with a minimum 200mm of fabric placed upslope at the base of the trench to represent best practice.

The use of SF and SSF may be limited on site due to wind conditions, however smaller areas will benefit from such devices and they remain as a tool in the “sediment control tool box”.

5.2.6 Flocculation

Flocculation is a chemical treatment method for increasing the retention of suspended solids from construction earthworks runoff in SRPs and HDEBs. Flocculant is added to the construction runoff flowing into a SRP or HDEB via a rainfall activated or flow activated system (flocculant shed) or via manual batch dosing.

The use of flocculation chemicals increases the efficiency of SRPs and HDEBs and reduces the amount of sediment discharged to the receiving environment.

All Project SRPs, HDEBs and higher risk DEBs (as identified in the SEMPs) will be chemically treated with a flocculant appropriate for the soil type and discharge location unless the SEMP for that location confirms such treatment will not benefit environmental outcomes.

Appendix D of this Report provides the results of bench testing undertaken on a representative selection of soil types from within the Project. While it is assessed as appropriate that specific bench testing of soil types still occur prior to earthworks in each SEMP, the results of the bench testing already undertaken confirms the benefits of chemical treatment and that low dose rates of Polyaluminium chloride will achieve an effective reduction in turbidity (from those tests with no chemical treatment) and also has minimal effect on final pH levels. In particular, it was noted that within the clay silt soils a significant reduction in turbidity from 377 NTU to 15.78 NTU was achieved.

With confidence we can confirm that chemical treatment will achieve positive and effective results with the onsite soils. Any use of chemical for flocculation will be subject to a Chemical Treatment Management Plan.

5.3 ESC measure design criteria summary

Table 3 below summarises the principles and key ESC design criteria that have been developed for the Project:

Device / methodology	Criteria
Erosion control measures	
Clean water diversions (CWD)	Clean water diversion channels and bunds will be designed to cater for the 20-yr ARI 1 hour duration rain event plus 300mm freeboard.
Construction staging and sequencing	Staging and sequencing are both important non-structural measures and will be implemented and details of the staging and sequencing of works will be within the SEMP.
Contour drains	Contour drains will be designed and implemented in accordance with the GWRC Guidelines.
Device location	All ESC devices should be located outside the 20-year ARI flood level unless no other viable alternative exists.
Dirty water diversions (DWD)	Dirty water runoff diversion channels will be sized to cater for the 20-year ARI 1 hour duration rain event plus 300mm freeboard. Sediment sumps of $2m^3$ minimum capacity per sump will be installed in all DWD at 50m intervals.
Pipe drop structures / Flumes	Flumes will be used in accordance with the GWRC Guidelines to safely transfer runoff from the top to the bottom of the batter slopes.
Rock check dams	Rock check dams will be designed and implemented in accordance with the GWRC Guidelines.
Stabilisation for erosion and dust management purposes	Progressive and rapid stabilisation of disturbed areas using top soil (where necessary) and seed, mulch, hydroseed, turfing and geotextiles will be ongoing throughout the Project. Alternative stabilisation measures will need to be detailed and confirmed within the SEMPs.
Stabilised entrance ways	Stabilised entrance ways will be established at all ingress and egress points of the site from a public road network in accordance with the GWRC Guidelines.

Device / methodology	Criteria
Sediment control measures	
Sediment retention ponds	All SRPs will be implemented based a 3% volume criterion applied in relationship to catchment size (i.e. 300m^3 SRP volume per 10,000 m^2 of contributing catchment).
Hybrid Decanting earth Bunds	All HDEB will be designed based on a volume of 2% of the contributing catchment area and will have floating decants. HDEBs will have a sump established at the inlet end with a geotextile lined bund between this sump and the main body of the HDEB. The volume of this sump is based on 10% volume of the main body volume.
Decanting earth bunds	All DEBs established will be based on a volume of 2% of the contributing catchment area. All DEBs will be fitted with floating decants. Decants have a mechanism to control (or cease) outflow during pumping activities to these structures.
Flocculation	Flocculation will be applied on all SRPs, HDEBs and high risk (as defined in the SEMP) DEBs based on an approved chemical treatment management plan unless otherwise outlined within the SEMP for that location. Manual batch dosing will be carried out as required. Flocculant socks will be used as alternative and/or additional measures as required.
Super silt fences and silt fences and filter socks	All super silt fences, silt fences and filter socks will be based upon the design criteria within the GWRC Guideline. SSF fabric will be installed with 200mm of fabric upslope at the base of the trench.

Other measures / methodologies	
Specific Environmental Management Plans (SEMPs)	SEMPs will be submitted prior to commencement of work. SEMPs will include: • Work / activity details; • Location of the work; • Contour information; • Risk level and management; • Erosion and sediment controls; • Chemical treatment requirements (if any), design and details; • Catchment boundaries; • Details of construction methods; • Contingency measures; • Design details; • A programme for managing non-stabilised areas; • The identification staff who will manage all controls; • The identification of staff who monitor compliance with conditions; • A chain of responsibility for managing environmental issues; • Methods and procedures for decommissioning measures; and • Design details for managing the discharge of contaminants.
Decommissioning of devices	Removal of devices will be in accordance with the SEMP and is based on removal only after stabilisation.
Pumping activities	Pumping of sediment laden runoff and groundwater during construction will be to SRPs, HDEBs, DEBs to existing grass buffer zones or to temporary sediment retention devices.
Streamworks	At all practical times these activities, and any associated works within these environments will be undertaken in an offline 'dry' environment. Fish spawning and migration periods will be avoided and managed accordingly.

Table 3 – Erosion and sediment control design criteria

5.4 Decommissioning of devices

All erosion and sediment control measures will remain in place until such a time as the catchment contributing to that device is stabilised. Once the contributing catchment is considered stabilised, or other measures are in place as agreed through the SEMP process, the measure will be decommissioned in consultation with Horizons and GWRC. The decision process and procedure for this will be outlined within the SEMPs.

5.5 Non-sediment contaminants

Non-sediment contaminants generally consist of products and materials that may directly or indirectly discharge into the receiving environment from based site activity.

Potential non-sediment contaminants used in construction activity on the Project are listed in Table 4 below:

Product / work activity	Potential contaminants	Indicator	Non-visible potential contaminants
Adhesives	• Adhesives • Glues • Resins • Epoxy • PVC Cement	Oily sheen or discoloration from some products	• Phenols • Formaldehydes • Asbestos • Benzene and • Naphthalene
Asphalt paving	Hot and cold mix asphalt	Oil sheen	Oil, petroleum distillates, Polyaromatic hydrocarbons
Cleaning products	Cleaners, ammonia, lye, caustic sodas, bleaching agents, chromate salts	Discolouration	Acidity / alkalinity
Concrete	Cement	Discolouration	Alkalinity (high pH)
Flocculants	Specific to flocculant used but can include pH and aluminium	Very high clarity	• Aluminium toxicity • pH
Sanitary waste	Portable toilets, disturbance of sewer lines	Discolouration, sanitary waste	Bacteria, biological oxygen demand, pathogens
Vehicle and equipment use	Equipment operation, maintenance, washing, refuelling	Oil sheen, sediment	Total petroleum, hydrocarbons, coolants, benzene and derivatives

Table 4 – Potential Project non-sediment contaminants

The management of these non-sediment contaminants will be subject to specific best management practice and industry guidelines. It is currently unclear as to the specific non-sediment contaminants that will be used or the associated volumes; however, Table 5 below provides some generic guidance as to the expected management approach of these contaminants for the Project.

Product / work activity	**Management approach**
Adhesives	• Store materials in an area that is not subject to rainfall contact. • Use adhesives carefully and clean up any spilled material. • Follow MSDS as necessary. • Properly dispose of containers once they are empty.
Asphalt paving	• Any runoff during application should discharge to a treatment system designed to capture hydrocarbons.
Cleaning products	• Store materials in an area that is not subject to rainfall contact. • Follow MSDS as necessary. • Use products carefully and clean up any spilled material. • Properly dispose of containers once they are empty.
Concrete	• Concrete truck chutes, pumps and internals should only be washed out into formed concrete wash facilities (impoundment for that purpose), other locations where concrete pours are yet to occur or returned to the batching plant / concrete supply yard where washing facilities will be established. • Unused concrete remaining in trucks shall be returned to the concrete batching plant. • Hand tools should only be washed out into the formed areas.
Flocculants	• Ensure the use of flocculants follows an approved chemical treatment management plan and industry best practice. • Follow MSDS as necessary • Regularly measure pH of the discharge from sediment retention devices.
Sanitary waste	• Avoid knocking over portable toilets. • Place portable toilets away from site vehicle movement areas. • Service portable toilets regularly and empty portable toilets before they are moved. • Avoid breaking sanitary sewer lines that may exist onsite.

Product / work activity	Management approach
Vehicle and equipment use	• Fuel storage tanks shall be bunded to store a minimum of 100% of the tank's capacity. Note that for this Project no bulk fuel storage is expected and mobile refuelling will occur. • Procedures and practices shall be put in place to minimise or eliminate the discharge of lubricants, coolants or hydraulic fluids to the receiving environment. • Have spill prevention and control measures (spill kits) and procedures in place.

Table 5 – Potential Project non-sediment contaminants management approach

5.6 Innovation

The design criteria for ESC measures incorporate some procedures and measures that exceed the guidance provided in the GWRC Guideline. Through the design and construction phases of the Project, we recognise that there will be scope for innovation and alternative means of achieving the same environmental outcome as specified in consent conditions. The implementation of SEMPs will allow for this 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.

6. Management of construction activities

6.1 Construction activity specific methodologies

This section includes the details of ESC measures and methodologies required to manage erosion and sediment runoff from the various construction activities associated with the Project. The activities include:

- Roading and corridor access establishment;
- Wind turbine foundations;
- Ancillary structures and site compound;
- Underground cable network construction;
- Fill placement; and
- Streamworks and culverts.

The works methodologies discussed below are conceptual and general in nature based on current knowledge of the activities and site visit assessment undertaken. The methodologies have however been subject to ground truthing to ensure that they are practicable and feasible. The ESC approach has also built on the knowledge of a number of similar wind farm projects completed within New Zealand providing further confidence of implementation. The ESC measures and methodologies have been established based on the above principles and have a clear objective of ensuring that effects are managed to an acceptable level.

Appendix C of this Report provides some ESC plans of the proposed measures to be implemented on identified focus areas. These have been undertaken to demonstrate the feasibility of the approach and to ensure that the key construction activities have been considered in full.

As detailed in Section 1.2 above, it is important to again recognise that rather than the traditional approach, which specifies turbine locations with micro-siting allowances, Meridian is seeking consent for:

- A Turbine Envelope Zone within which all turbines and any infrastructure will be located.
- A Turbine Exclusion Zone where any infrastructure but no turbines will be located.
- A transmission corridor and substation to electrically connect the wind farm to the national electrical grid.

This approach and the associated design envelope and exclusion zone are assessed within the context of the various activities to be undertaken.

Detailed and site or activity specific descriptions of the methods required to manage erosion and sediment during the construction phase for the various construction activities will be further developed and detailed within the SEMPs.

6.2 Roading and corridor access establishment

The Project will include a total of approximately 11km of roading and access tracks which typically follow existing farm access tracks and ridgelines.

The width of the wind farm ridge roads within the Turbine Envelope Zone will be between 8 and 11 m in width. These roads will have relatively gentle slopes, resulting in relatively low levels of earthwork requirements. The combined length of these roads will be approximately 6.0 km.

The "access roads" that run from the bottom of the hill to the wind farm ridges via relatively steep slopes will be between 6 m and 8 m in width. These roads are within the Turbine Exclusion Zone, and have a combined length of approximately 5.5 km. Two main access roads may be built for safety and practicality reasons, one for the heavy components and one for light traffic/service vehicles. The road will be as steep as 16% in some sections, requiring suitable surfacing to enable heavy components to be safely transported to the ridge top, likely being towed/pushed by one or more support vehicle(s). The surface water drainage will be managed by cross-fall gradients, roadside collection channels and culverts.

Generally, the roading and access tracks can be constructed with cut and fill operations of no greater than 2m depth, however there are localised sections where excavation will exceed this and filling will also be of a greater volume as part of the deposition of surplus fill from the site.

The general road construction methodology is as follows:

1. Strip topsoil from the alignment of the road and access tracks and temporarily stockpile in designated stockpile locations for future re-establishment use. The condition of the existing road alignment is good and where such roads are in place the activity will be more of a widening operation rather than new formation. Plate 1 below illustrates the nature of these existing road alignments.

Plate 1: Existing access track formation

2. All temporary stockpiles will be located on flat contour with topsoil transported to these locations as necessary. Erosion and sediment control for the stockpiles will be "independent" for that specific stockpile only and will be based on a silt fence or filter sock around the stockpile location. No stockpiles will be placed within 20m of stream systems.

3. Excavation for site tracks, crane pads, and laydown areas will closely follow the topsoil strip and will be taken down to suitable soil formation or bedrock. Where traverse sloping ground is encountered a cut and fill construction will be adopted with aggregate generated from the cutting of the uphill batters and drainage channels being used to form the road embankments to the downhill side of the track.

4. Each layer will be compacted and shaped in order to provide a road profile and finish suitable to accommodate the turbine construction, delivery, and service vehicles.

5. A drainage channel will be formed between the toe of the uphill batter and the edge of the road. This will intercept any rainwater runoff, which will then be directed under the road via appropriate sized pipes or culverts into existing drains where available. Where necessary, additional culverts will be installed to maintain the site hydrology.

6. The road formation will be staged such that as the road is formed, a cover of aggregate can be placed over the track surface to achieve a stabilised area. This is referred to as a "cut and cover" methodology and earthworks themselves will progress no more than 24 hours in advance of the stabilised surface. This has the effect of reducing sediment generation and also associated risk.

7. The source of the surface aggregate will be confirmed through the SEMP. Some of the road cuts are expected to enable aggregate to be won and therefore this will simply be placed as stabilised material close the same location.

8. The methodology also provides for the ability to avoid concentrating flows to a point where scour and sediment generation can result.

9. Any cut or fill batter slopes will be fenced from stock access and will be revegetated on completion.

10. Filter socks will also be installed at the base of fill batters where other alternatives are not practicable.

The establishment of some roading locations requires a more substantial cut and fill activity. These areas have been viewed as part of site visits and will require the installation of CWD, DWD and DEBs, HDEBs or SRPs along the access as works proceed. These will operate more similar to a cut and fill earthworks operation. Within Appendix C of this Report is a plan showing the ESC measures that will apply to a specific access track formation activity.

6.3 Wind turbine foundations

The Project consists of 20 wind turbines, which all require earthworks to form a level foundation for the construction of the turbine. Each turbine will require a foundation, crane pad, and blade laydown area onto which the turbine can be erected.

The wind turbines are generally located close to or on top of ridgelines, or on the upper side of slopes, therefore minimising the contributing water catchment to these foundation locations. The foundations will all be formed solely on original cut ground (as opposed to fill) and therefore the likelihood of subsidence is greatly diminished.

The turbine foundations are constructed below ground surface and approximately a 25m by 25m hexangular shape. Typical turbine foundation arrangements are shown in Figure 4 below.

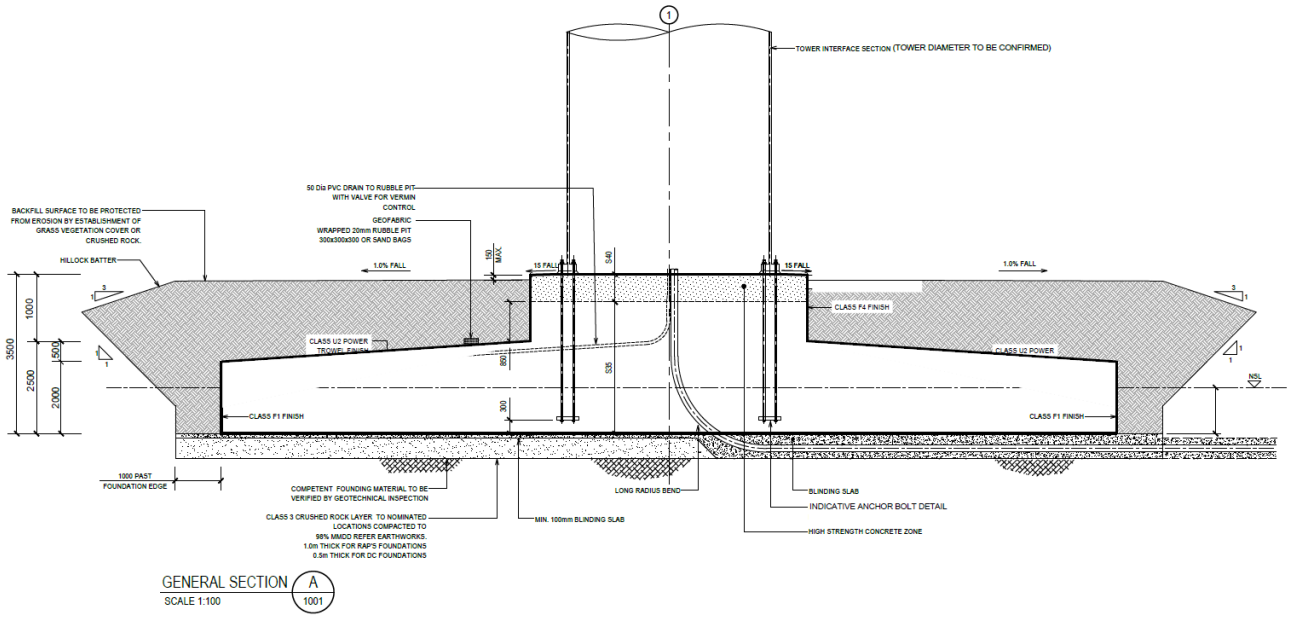


Figure 4 – Typical wind turbine foundation design

In terms of ESC these turbine foundation works can be treated as isolated areas of work. These foundations are all isolated from stream systems and effectively are cut activities on grass paddock environments. The overall earthworks footprint for the turbine foundation itself and any laydown area is typically less than 0.5ha in surface area. The works will be completed as a single operation and once completed, will be stabilised with aggregate for all weather access. As with corridor access track formation any surplus material (in particular that from the turbine foundation excavation) will be stockpiled on flat contour with material transported to fill locations as necessary. ESC for the stockpiles will be "independent" for that specific stockpile only and will be based on a silt fence or filter sock around the stockpile location. No stockpiles will be placed within 20m of stream systems.

While an immediate cover of stabilised aggregate will be applied to the earthworks surface, a formal DEB or HDEB (and in some cases a SRP for combined turbines) will also be established on site. In all cases, and as confirmed via site visits, the associated earthworks will all discharge over grass paddock environments which provides a polishing effect prior to entry to any stream systems. Stock exclusion is also important, and all earthworks will be fenced in this regard.

Within Appendix C of this Report is a plan showing the ESC measures that will apply to turbine foundations.

6.4 Ancillary structures and site compound

The connecting substation (Terminal Substation) for the wind farm will be located near the existing 110kV Transpower line, on the western side of the corner of Kaiparoro Road and SH2. It will take the internal transmission line from the windfarm and house all the electrical protection equipment to enable connection into the National Grid via Transpowers 110 kV transmission lines. The main transformer (33 kV to 110 kV) will be housed here or at the internal substation. The Services/O&M building may also be housed on Meridian's half of this substation.

The internal wind farm 33kV network will be underground from the turbines to a point near the southwest most turbine on the main ridge. Here the cables will be collected into a small internal substation/switching station (internal substation). The internal network between turbines will be buried under access roads wherever possible. It is expected that four strings of cables will be required. Section 6.5 of this Report provides the ESC approach to this cable construction.

The majority of these activities are very small in terms of surface area and are assessed as able to be managed with silt fences, super silt fences in some locations and progressive stabilisation.

From an erosion control perspective, the two key aspects will be stock exclusion from all earthwork areas, diversion of cleanwater away from the earthworks locations and progressive stabilisation. As part of this progressive stabilisation the substation batter slopes will be revegetated and planted with longer term species to provide a longer-term protection of this area.

The Project site will include one concrete batching plant to be located within the Turbine Envelope Zone or the Turbine Exclusion Zone. These will be fully bunded and fully contained systems to ensure that not only sediment discharges are minimised but that pH levels in any discharge, should they eventuate, are maintained below 8.5 at all times from the concrete activity.

The site compound area was assessed in full during site visits and is located on a flat paddock environment at the site entrance. During construction this compound will house the construction village, including temporary site offices, amenities, security, parking, and a laydown area (for deliveries of turbine components and for holding these until delivery up to final turbine locations. Once construction begins it is expected that the personnel numbers onsite will range between 100 to 150 people depending on the specific activities that are being undertaken. These figures may vary depending on the final development and construction programme.

After commissioning, the entrance area could be used for operations, and could house the Services/O&M building, and/or continue to function as a storage area for spares and large components required for repairs.

ESC measures for this site compound will include a super silt fence and as soon as possible stabilising the area with aggregate as part of the site compound formation. At all times the stream system that is directly below this site compound area will be protected, including the super silt fence and am existing grass buffer zone. Within Appendix C of this Report is a plan showing the ESC measures that will apply to the site compound area. This confirms that the stream adjacent to the site compound will have a culvert installed for access provisions.

6.5 Underground cable network construction

The preferred method of cable installation is by specialised cable laying machines which will operate once the road access is complete for that specific location. These machines are easily able to cut through coherent rock to form a neat and stable trench, while laying the cable in the trench simultaneously. In addition, there is the ability to also install any necessary subsoil drainage and other utilities at the same time. The cable will be brought to site in drums to be loaded into the cable laying machinery. The cable trench is then backfilled automatically with the necessary material (aggregate material for heat dissipation) a part of the laying process. Once completed the surface will be fully stabilised with either the aggregate cover or a vegetated surface established.

The primary erosion and sediment control is therefore based on a progressive stabilisation with the trench area open able to be stabilised quickly if a forecast rain event occurs. In addition, filter socks will be utilised around all drainage systems and stream channels to ensure there is no direct discharge to these environments.

If dewatering of these trenches is required, this will be undertaken via a pump methodology with all pumping to a turkeys nest arrangement prior to an existing grass buffer zone environment which is also prior to any discharge into the stream system.

6.6 Fill placement

Approximately 1,090,000m^3 of material will be placed within designated fill sites within the Turbine Envelope Zone or the Turbine Exclusion Zone. This surplus material will be used to primarily fill natural depressions.

From a construction perspective, prior to the placement of fill, the sites will be stripped of topsoil and the area benched. The fill is then nominally track rolled into place. Following the completion of filling, topsoil will be spread and the area re-vegetated. The final grade of the clean fill will be site specific depending on site topography, depth of fill and extent of filling however all batter slopes will be kept to less than 20 degrees to maintain a lower erosion risk overall. This 20-degree slope will also allow for future landuse as a pastoral farming activity.

From an ESC perspective the topsoil stripped from the sites will be stored in areas of flat topography and will be managed in an “independent” manner for that specific stockpile only and

will be based on a silt fence or filter sock around the stockpile location. No stockpiles will be placed within 20m of stream systems.

The only fill to be placed in these designated fill sites is that associated with the wind farm construction.

For the fill sites themselves the first step that will be undertaken is the confirmation that the fill site is appropriately sited, avoids direct filling over stream systems and where practicable avoids vegetated areas. This exercise has already occurred as part of the advancement of the Project design, however will be able to be fine-tuned prior to filling activity. The SEMPs will confirm this process and the criteria with which fill sites are to be finalised and selected are as follows:

1. Fill site must be within the Turbine Envelope Zone or the Turbine Exclusion Zone;
2. Avoid wetlands and streams;
3. Avoid vegetation;
4. Geotechnical assessment;
5. Visual landscape assessment;
6. Catchment area above fill site is minimised (5ha maximum) and where this exists it can be practically diverted around the fill area; and
7. There is sufficient room that allows for placement of ESC measures.

An example of an identified fill site is as below in Plate 2. I have assessed the availability of fill sites within the Project based on the worst-case scenario fill volumes as indicated above. Working with the criteria 1 to 7 above I am comfortable that there is adequate room if required for this volume and that the fill sites themselves can be appropriately managed from an erosion and sediment control perspective.

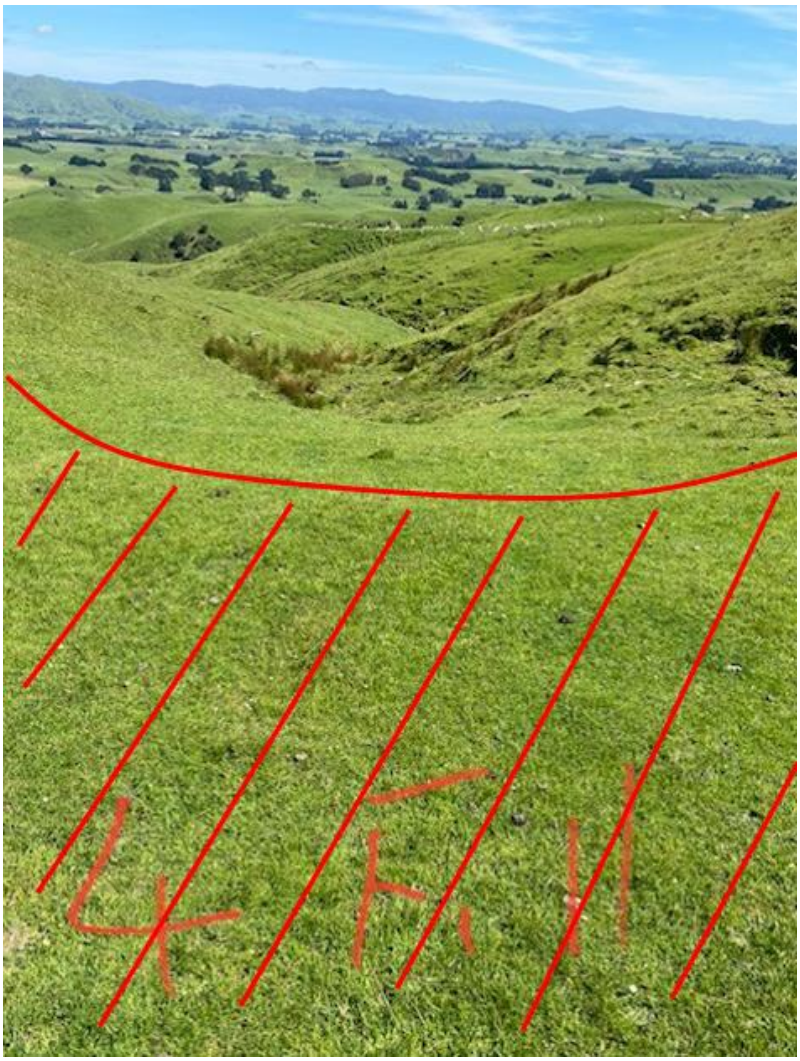


Plate 2: Identified fill site Turbine 4

Once the extent of the fill is confirmed then a specific sediment control device will be installed which will likely be in the form of a DEB or SRP. The fill sites will operate based on a tip head and therefore there is the ability to manage open areas to minimise the exposed surface. This progressive stabilisation continues as a key element with this activity. The fill sites will however be constantly added to over time and will remain open in this manner until such a time as the fill source for that site is complete.

These fill sites are identified as a potentially higher risk activity due to the ongoing nature of their operation the contour of the ground within which they are located. This specific risk identification, and risk management will be further addressed within the SEMPs that are developed.

Within Appendix C of this Report is a plan showing the ESC measures that will apply to a filling activity.

6.7 Streamworks, culverts and bridges

The methodologies for the construction of any culvert structure will be determined on a site-by-site basis and confirmed within a SEMP. With respect to this Report however, potential culvert locations have been viewed and assessed as to the appropriateness of the methodologies that follow. The locations of the culverts are identified within the Project Civil Engineering Report.

This above assessment process has confirmed the suitability of the methodologies within the final design details to be included within the SEMPs.

A key consideration when assessing the appropriate methodology for culvert construction is that there is limited room availability on all the culverts for the installation of a formal diversion around the works location. This will be further investigated as an option within the SEMPs however it is assessed that the key methodology to be employed will be based on a dam and pump process.

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 5m 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;
- Sand bags 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;
- Sandbags, as a coffer dam, will also be installed downstream from the culvert works to effectively create a works area where any runoff and water captured can be treated prior to discharge;
- The pump flow rate will be equal to the expected dry weather flow for the particular stream;
- The Ecology Report provides for fish management measures however with the controls in place, any fish observed in any of the pools within the work area will be recovered and released downstream;
- Works can commence and will involve the culvert removal, upgrade or extension as required. Any excavated material will be removed from the work area and disposed of within one of the identified fill 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 any 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 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; and

- The pump and coffer dams will be removed and the stream flows can then be passed through the new culvert structure.

This methodology will apply to all stream systems where flow is recorded.

An alternative methodology can apply whereby if an existing culvert is to be extended, a plywood bulkhead, or equivalent, with a flexible bypass pipe can be fixed into the bulkhead of the culvert. 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 while the works continue.

Where flow is not recorded within ephemeral dry gullies, a similar methodology will occur however pumping will not be required. These works will be completed in a short duration and stabilised as quickly as practicable. Downstream of works in such dry gullies a coffer dam will still be established which will capture any discharges for treatment.

All culvert works

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

- Prior to any works commencing on the construction of a particular culvert a period forecast of dry weather sufficient to construct the culvert will be confirmed through appropriate weather monitoring system;

- Culverts are expected to be installed in stages and each stage 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 turkeys nest and then to an existing grass environment which will be located a minimum distance of 20m from, and discharge away from, the stream environment; and

- On completion of the culvert works, all plant, materials and labour will be demobilised and the site will be permanently stabilised in accordance with the SEMP for that work area.

In the event of high rainfall during the course of construction of the culvert, or prior to leaving the site for more than a 24-hour period, the following will occur:

- That any loose material that could enter a watercourse is to be removed from the flood plain of the stream;
- Any downstream sandbag barriers will be checked and, if required, removed;
- All existing sediment control measures will be inspected and secured and maintained where required should a significant rain event be forecast. The streambed in the location of the culvert will be fully stabilised to ensure no flows overtopping the upstream dams or bunds can create scour issues. It is expected that this will be achieved through geotextile membrane being appropriately trenched in at the head and toe of the work area; and,
- Extend the working hours subject to compliance with relevant consent conditions, if it is believed to have significant benefit with regard to programme, forecast weather events and environmental impacts.

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

Bridge structure

A permanent bridge crossing is proposed on an un-named tributary of the Makahahi River to provide access from the laydown compound area to the western part of the site.

The proposed bridge is likely to consist of driven steel piles, steel girders and a concrete deck. Concrete abutments will be placed well back from the stream bank so that no excavation will take place within the stream itself and no earthworks or retaining will be undertaken within the stream.

From an erosion and sediment control perspective these works can be managed through the use of isolating the activity from the stream flow through the provision of super silt fences and also ensuring that all machinery and storage of equipment is within the adjacent site compound location.

7. Risk Assessment

7.1 Overall risk

The Project will largely involve works occurring along ridge tops on several fronts. The earthworks areas will be subject to ongoing stabilisation as works progress to minimise the open areas of earthworks and the potential for sediment generation (erosion) and subsequent sediment yield from the Project.

The key elements of construction related environmental risk for this Project are the exposure of bare land, the steep nature of the topography in sections of the Project and works within or adjacent to watercourses.

Key risk locations for this Project are therefore assessed as:

- Works adjacent to wetlands and stream systems;
- Cut and fill operations in steep high-risk erosion areas; and
- Fill site establishment and placement.

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

Those areas with slopes exceeding 20-degrees, and other identified high-risk locations, will be subject to a higher level of detailed design and ongoing contractor monitoring, as outlined in Section 8 of this Report. These monitoring and maintenance procedures will be defined further and confirmed through the SEMPs. In summary, the monitoring and maintenance will, in particular, focus on pre-forecast rainfall monitoring and post rainfall monitoring to ensure all ESCs are in place, are working as intended and are achieving the required outcomes and will also include a water quality monitoring programme of the receiving environment.

Overall sediment yield risk is assessed for the proposed earthworks within the Project area, in the context of both event probability and associated consequence. The area of Project earthworks is not significant and 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 as part of this, progressively stabilising as works proceed. The erosion control practice of cut and cover methodologies will therefore have a significant impact on reducing overall sediment generation and yield.

To assist in this process, it is recommended that a 14-day maximum period of leaving exposed areas with no works occurring is assessed as a critical risk reduction element, and will in itself, encourage progressive stabilisation.

Within all earthworks, including the higher risk locations, ESCs will be installed to minimise generation, capture and treat sediment laden runoff that may enter the receiving environments. Additionally, for the higher risk locations the duration and timing of works will be minimised as far as practical to minimise disturbed soils exposed to heavy rainfall. It is recommended that as part of the SEMP process, this 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.

Within these high-risk locations, areas such as wetlands, streams and protected areas, physical signage and demarcation will be installed to ensure all personnel on site understand the associated risk profile.

Indicative methodologies for both fill deposition area establishment and placement and streamworks/culvert placement have been developed and are outlined in Section 6.6 and 6.7 of this Report. Again, these methodologies will be defined further and confirmed through the SEMP development.

7.2 Winter works

It 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 SEMP 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 SEMP 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 Horizons and GWRC 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 erosion and sediment control methodologies and any additional erosion and sediment controls 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 erosion and sediment control methodologies.

For the winter period this risk assessment, which shall be undertaken within the SEMP 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); and
- Maintenance consideration of structural controls to ensure effective access can be achieved to undertake the maintenance and controls continue to work efficiency.

8. Monitoring

The overall approach to monitoring is to ensure that what is implemented on site is appropriate and can be adapted as necessary over time to ensure that the best water quality outcomes can be achieved as necessary. This will include an integrated approach whereby the Project team itself will undertake monitoring as detailed below and in addition to this a regular council inspection is expected to occur whereby specific consent condition monitoring will also occur.

For each SEMP location this monitoring will be confirmed, and any specific monitoring requirements identified.

Prior to the commencement of construction, pre-commencement photographs will be taken in the vicinity of the proposed discharge points and any receiving environments near these works. These records will show the visual state of the receiving environment at and within the vicinity of the discharge point prior to works commencing. This photographic record will be compiled into a logbook and will allow a visual comparison of before, during and at completion of the construction of the Project.

8.1 Qualitative monitoring

8.1.1 Receiving environment - On-site visual assessments

The construction manager will have an important role, to ensure that visual assessments of the receiving environment are maintained 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 however, the wider freshwater environment will also be subject to visual inspections.

Any noticeable change in water clarity from the water clarity prior to the rainfall event, or the water clarity upstream of the site of works, as a result of the earthworks activity will result in a review of the measures and practices and additional measures will be implemented and changes made as necessary under the adaptive management procedures.

8.1.2 Weather forecasting during Project implementation

To assist with identification of higher risk periods, such as during rainfall events, the Project will utilise on site manual rainfall gauges to provide data for the Project relating to both rainfall quantities which will assist with confirming adequacy of the ESC measures and methodologies.

In addition, the Project will utilise rain forecasting (such as metvuw) to understand forecast weather patterns and therefore enable more focused management of higher risk activities during

rainfall periods. This may include ensuring that any works within stream or channel systems are fully stabilised prior to rain events to minimise scour and erosion. This will also support the recommended 14-day maximum period of leaving exposed areas with no works occurring and will act as a further critical risk reduction element.

8.1.3 On-site monitoring of water management devices

Monitoring of onsite devices is referred to as 'Devices Monitoring' and refers to environmental compliance for the Project during the construction period. It 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 constructed, operated and maintained so they remain fully effective at all times.

Devices monitoring is aimed at the early detection of activities or problems that have the potential to result in an adverse environmental effect. The device monitoring will act as an immediate trigger, and if required, together with scheduled ecological monitoring, for more detailed 'trigger event' monitoring.

The frequency of the devices monitoring will vary throughout the year and will reflect areas of changing activity and risk along the Project. During the construction period the monitoring will be undertaken daily and more frequently during heavy rainfall as defined by 25mm in 24 hrs or 7mm in a one-hour period.

The inspections will include qualitative monitoring of the following:

- The integrity and effectiveness of all construction related water management devices;
- Construction activities onsite upstream of the water management device;
- General site conditions and other land disturbing activities occurring within the catchment; and
- General status of the immediate receiving environment.

To ensure a full understanding of the area of works is available, prior to construction commencing, photographs will be taken in the vicinity of proposed discharge outlet points and any streams in the vicinity of the works.

These records will illustrate the visual state of the receiving environment at and within the vicinity of the discharge point. This photographic record will allow a visual comparison of before, during and at completion of the construction of the Project.

The monitoring data will help to determine whether any further action is necessary. Where issues with the integrity and/or effectiveness of the devices and/or methodologies are observed these shall be rectified immediately.

8.2 Quantitative monitoring

In addition to the above, quantitative monitoring will be undertaken on the Project. The objective of this monitoring programme is to provide data for an array of rainstorms of different magnitudes and intensities to support the ESC effectiveness and identify areas of improvement.

This monitoring will be based on manual monitoring of all SRP discharges and the receiving environment streams (upstream and downstream) during a rainfall event as defined above, unless the health and safety of the sampling personnel may be compromised. This monitoring will include determination of turbidity using a field turbidity meter.

This manual monitoring will allow for ongoing comparative analysis over time and will provide for continuous improvement and adaptive management of the ESC measures and methodologies adopted on the site.

8.3 Independent audit and council inspections

In addition to the monitoring as detailed above, an independent monthly external audit of all water management measures (including erosion and sediment control) will be implemented for the Project. This will provide an independent audit, allow for risk and/or issues to be proactively identified, determine solutions for any risk or issues and also will provide for further training opportunities.

The project is split between 2 regional councils and as such will be subject to compliance monitoring from these organisations. It is envisaged that efficiencies of this process can occur with 1 compliance officer representing both council interests, and also potentially local council compliance roles. The frequency of this compliance monitoring will be dependent upon the risk associated with the earthworks at the time, and compliance history, but will be expected to be a minimum of 1 visit per month.

8.4 Other monitoring triggers

Further monitoring will be undertaken in response to certain “triggers”. The triggers for these more intensive / repeat investigations include observations such as:

- Activities observed to be happening on-site that are likely to compromise the effectiveness or integrity of that site’s erosion and sediment controls;

- Taking into account antecedent climatic conditions, a conspicuous change of water colour at the downstream receiving environment that is very different to the colour that is normally associated with conditions at the same site, and with such change in colour not evident at upstream locations above the construction zone;
- Obvious accumulation of sediment in the vicinity of the discharge points, or anywhere else within or in proximity to the active construction zones;
- Streambank collapse or obvious signs of channel erosion / instability in the immediate receiving environments;
- Visual reports / evidence of changes to downstream community structure (e.g. fish kills, death or discolouration of instream plant communities, increased weed growth); and
- Spillage / accident reports by site personnel.

If the results of any routine device monitoring identify any of these triggers, then a more detailed response will occur as follows:

- Ascertain that in all probability the issue is associated with the Project earthworks;
- Inform and liaise with Horizons and Greater Wellington Regional Council;
- Ascertain the magnitude of the adverse effects (this may involve undertaking immediate monitoring of the ecological variables);
- If the effects have been more than minor, ascertain what response is necessary including any ecological response;
- Determine how to monitor the effectiveness of the response(s); and
- Implement and monitor the response.

A continual feedback loop is included in this process until it has been verified that the implemented responses have been successful. Changes to earthwork site practices or to specific devices may also need to be implemented to avoid any future similar events.

If chemical treatment is utilised within the ESC methodologies then a specific chemical treatment management plan will be developed and this will include monitoring of associated discharges from these devices.

9. Assessment of construction effects

9.1 RMA Considerations

Section 104(1) of the RMA requires regard to be had to specific factors, subject to Part 2 of the RMA (Purposes and Principles). The purpose of the RMA is to promote the sustainable management of natural and physical resources.

Sustainable management means the use, development and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural wellbeing and for their health and safety while:

- Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations and;
- Safeguarding the life-supporting capacity of air, water, soil, and ecosystems; avoiding, remedying or mitigating any adverse effects of activities on the environment.

Sections 105 and 107 of the RMA require regard to be had to additional matters associated with the discharge of contaminants.

9.2 Overall assessment

From an overall Project perspective, we assess that the effects of the construction aspects of the Project, in particular the discharge of sediment, are minor.

The following key points are noted for the Project.

- The statutory framework and policy guidance from Horizons and GWRC require that the Project be aware of and ensure implementation of appropriate construction water management (including ESC) controls including construction and maintenance of these devices.
- It is clear that those 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.
- The Project's will rely on detailed SEMPs to be submitted to Horizons and GWRC at a later date, before any construction activity takes place, to allow for contractor input.

- An adaptive monitoring programme will be implemented which will allow for ongoing continuous improvement of the construction water methodologies.

I assess that based on the nature of the earthworks, the proposed erosion and sediment control measures and the information gathered through this assessment and the site visits, that the earthworks can occur within the Turbine Envelope and Turbine Exclusion Zones and still achieve an overall minor effect only.

We recommend conditions of consent that reflect the approach as outlined within this report and in particular the SEMP process and adaptive management and monitoring regime. In addition, the criteria associated with the identification of the fill sites is important and should be reflected within conditions of consent. With these in place it will ensure the effects of the Project are managed appropriately and remain minor.

The maters of discretion, as identified above, are detailed below with the project specific response and detail outlined for the specific matters identified.

Matter for consideration	**Project detail**
Effects of the activity and associated sediment run-off on soil conservation, surface water quality and aquatic ecology and the methods to be taken to avoid, remedy or mitigate them.	Addressed in full within this Construction Water Management Plan and Effects Assessment Report. Section 8 allows for monitoring and ongoing checks and balances of the earthwork activity to ensure effective management throughout.
The provision of an Erosion and Sediment Control Plan, prepared to a standard that satisfies each Council. In the Greater Wellington Region, the erosion and sediment control measures must include consideration of hazard mitigation and the risk of any associated accelerated soil erosion.	This Construction Water Management Plan and Effects Assessment Report provides an overview of the approach to be taken and provides an assessment of the various activities. Prior to construction a SEMP will be established and certified by Councils with the detail and content of this SEMP confirmed within this Report.
Compliance with visual clarity water quality targets in receiving waters.	Section 8 allows for monitoring and ongoing checks and balances of the earthwork activity to ensure effective management throughout. This includes measuring turbidity during rain events.

Matter for consideration	Project detail
Staging of works and progressive stabilisation.	Progressive stabilisation forms a key principle of all earthworks for the Project. The SEMPs to be established also require specific identification of risk and details of how non stabilised areas will be managed.
The placement and treatment of stockpiled materials on the site, including requirements to remove material if it is not to be reused on the site.	Fill sites will be established as part of the Project implementation. No material is to be removed from the site. The fill sites will be managed as independent fill locations and will be subject to the full requirements of this Report and the SEMP process.

Table 6 – Earthworks effects assessment – matters of discretion

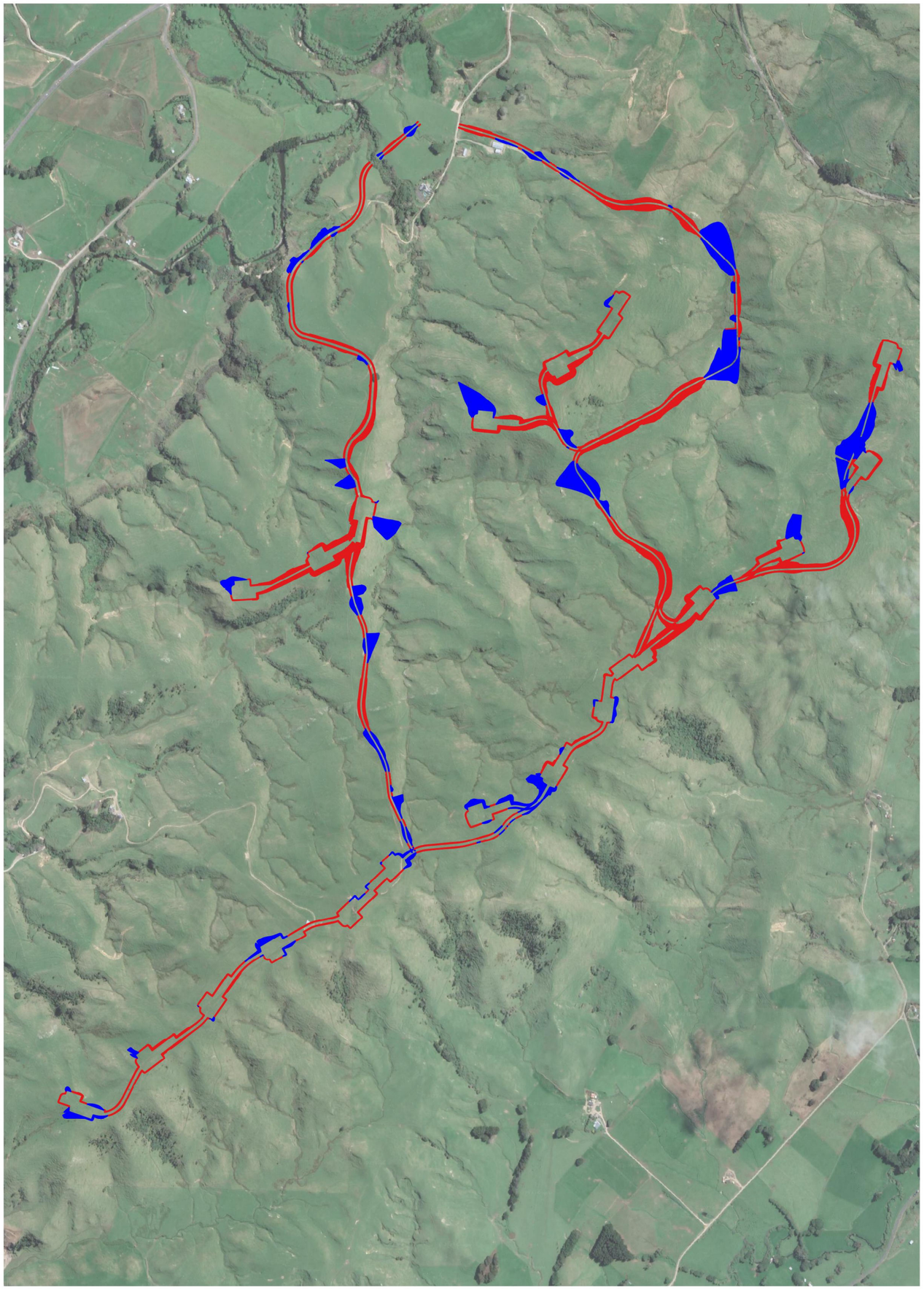
10. References

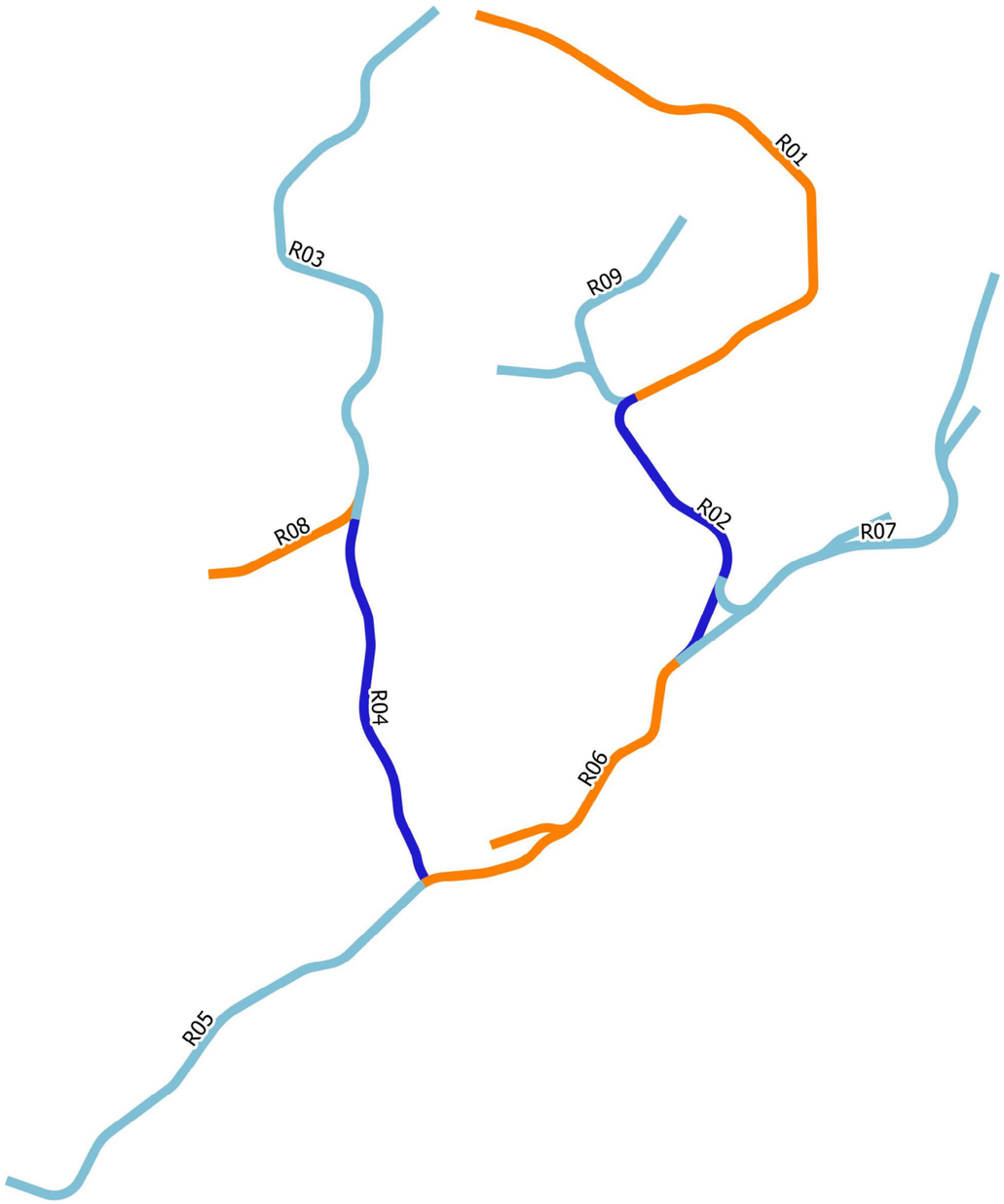
Auckland Regional Council (1994). Storm Sediment Yields from Basins with Various Land-uses in Auckland Area.

Goldman, Steven J, Jackson, Katharine, Bursztynsky, Taras A. Erosion and Sediment Control Handbook. (1986)

Greater Wellington Regional Council (2021). Erosion and Sediment Control Guide for Land Disturbing Activities in the Wellington Region (February 2021).

Appendix A. Project Layout and Earthworks Cut Fill





Road Section	Topsoil stripping	Cut (m3)	Fill (m3)
R01	13,800	200,200	209,000
R02	6,300	106,600	47,200
R03	6,100	123,500	10,300
R04	4,200	63,000	14,100
R05	1,600	52,100	3,600
R06	1,500	30,100	5,100
R07	9,800	205,400	45,800
R08	1,700	89,700	
R09	2,000	64,500	600
Total	47,000	935,100	335,700

Appendix B. ESC Principles

A2.0 Fundamental principles of erosion and sediment control

An awareness of where water goes and the sensitivity of the receiving environments are fundamental to determining requirements for erosion and sediment control for land disturbing activities. The following ten fundamental principles of ESC provide best-practice guidance for minimising the adverse effects of erosion and sedimentation through the planning, construction and maintenance phases of a project. These should be followed when preparing and implementing an ESC plan.

1. Minimise disturbance

Consistent with the concepts of water sensitive design, the identification and retention of existing site attributes should be incorporated into project designs, and earthworks should be minimised to the greatest practicable extent.

Land development should be fitted to land sensitivity and where possible, disturbance should avoid steeper slopes and other features such as streams and wetlands.

For any development, the total area of earthworks should be the minimum necessary to achieve the design outcome (including temporary works). The area of earthworks exposed to erosion at any given time should also be minimised through staging and progressive stabilisation.

2. Stage construction

Carrying out bulk earthworks over the whole site maximises the time and area that soil is exposed and prone to erosion. By only exposing those areas that are required for active earthworking at any one time, the duration of exposure and risk of erosion/sediment discharge can be minimised. 'Earthworks staging', where the site has earthworks undertaken in smaller units over time with progressive revegetation, limits erosion.

Careful planning is needed. Temporary stockpiles, access and utility service installation all need to be planned. Earthworks staging needs to be planned in conjunction with the overall construction sequencing to ensure that it accommodates the contractor's requirements.

3. Protect slopes

If slopes are worked and require stabilisation, simple vegetative covers such as topsoiling and seeding may not be immediately effective and additional measures may be required. These are described in Section E3.0 of Part 2 - Practices. Disturbance of existing slopes should be avoided wherever possible, particularly steep slopes which have a higher risk of erosion. To minimise erosion, clean water runoff from above the site must be diverted away from the exposed slopes.

4. Protect receiving environments

Receiving environments including sensitive receiving environments, existing streams, watercourses and proposed drainage patterns need to be mapped. Earthworks and the removal of vegetation beside or within streams (including intermittent streams), wetlands and the coast, typically require consents from Greater Wellington Regional Council. GWRC should be consulted on these matters prior to finalising project designs.

All receiving environments, limits of disturbance and protection measures should be mapped on the ESC Plan. In addition, all practices to be used to protect new drainage channels should be marked, as well as crossings, disturbances and associated construction methods.

5. Rapidly stabilise exposed areas

Disturbed soils should be progressively stabilised with vegetation, mulch, grassing or other stabilising methods after each earthworks stage and at specific milestones within stages. Available stabilisation methods are site-specific and are described in Section E3.0 of Part 2 - Practices.

6. Install perimeter controls and diversions

Perimeter controls and diversion measures help separate 'clean water' from outside the area of disturbance from 'dirty water' that has flowed through the disturbed area. Minimising the earthworks catchment by diverting clean runoff away from the works area is a critical erosion control measure. It also reduces the size of sediment control devices required for any given works area. Perimeter and diversion controls can also retain or direct sediment-laden runoff within the site. Common controls are diversion drains and earth bunds. These are detailed in Section E2.0 of Part 2 – Practices.

7. Employ sediment retention devices

Even with the best ESC practices, earthworks will discharge sediment-laden runoff during and immediately following storms. Along with erosion control measures, sediment retention devices are needed to capture runoff so generated sediment can settle out and be retained on site. These are detailed in Section F1.0 of Part 2 – Practices.

The fine-grained nature of Wellington soils means sediment retention ponds will usually require flocculant treatment (flocculation) to maximise their efficiency. All sediment retention devices must be sized and maintained in accordance with this guideline, and must be appropriate for any given location within a site.

8. Get trained and develop experience

As contractors are generally responsible for installing and maintaining ESC practices, a trained and experienced contractor is an important element of an ESC Plan. Trained and experienced staff can save projects time and money through proactive construction and maintenance of ESCs. Staff should be encouraged to become experienced in ESC. Key staff should also be assigned to provide that role, so that the appropriate level of experience and supervision is available for each new project.

9. Adjust the ESC Plan as needed

An effective ESC Plan is modified as a project progresses from bulk earthworks to a fully developed site. Factors such as weather, changes to grade, altered design including drainage and formation of roads can require changes to initial ESC design.

The ESC Plan should be updated to suit site adjustments in time for the pre-construction meeting and initial inspection of installed ESCs. The Plan must also be regularly referred to and available on site. Prior to works commencement, consideration should be given as to how the site will change throughout the project, and how the ESC Plan will need to evolve to reflect this.

Note: For consented sites, adjustments to the ESC Plan may require sign-off from Greater Wellington Regional Council.

10. Assess and adjust your ESC measures

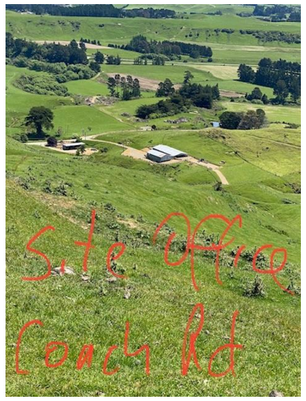
ESC measures need to be inspected, monitored and maintained.

Inspection and maintenance of controls is especially important prior to and following a storm event. A large or intense storm can leave ESC measures in need of repair, replacement, reinforcement or cleaning out. Maintaining and repairing measures as soon as possible after a storm event will maximise the ongoing efficiency of the measures and minimise adverse environmental effects.

Appendix C. ESC Plans

N

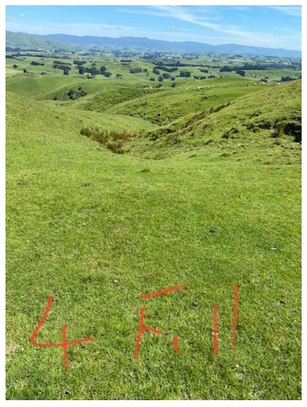
Focus Area # 1 – Site Compound.



Focus Area # 2 – Main Access Track.

Focus Area # 3 – Secondary access road fill and some cut.

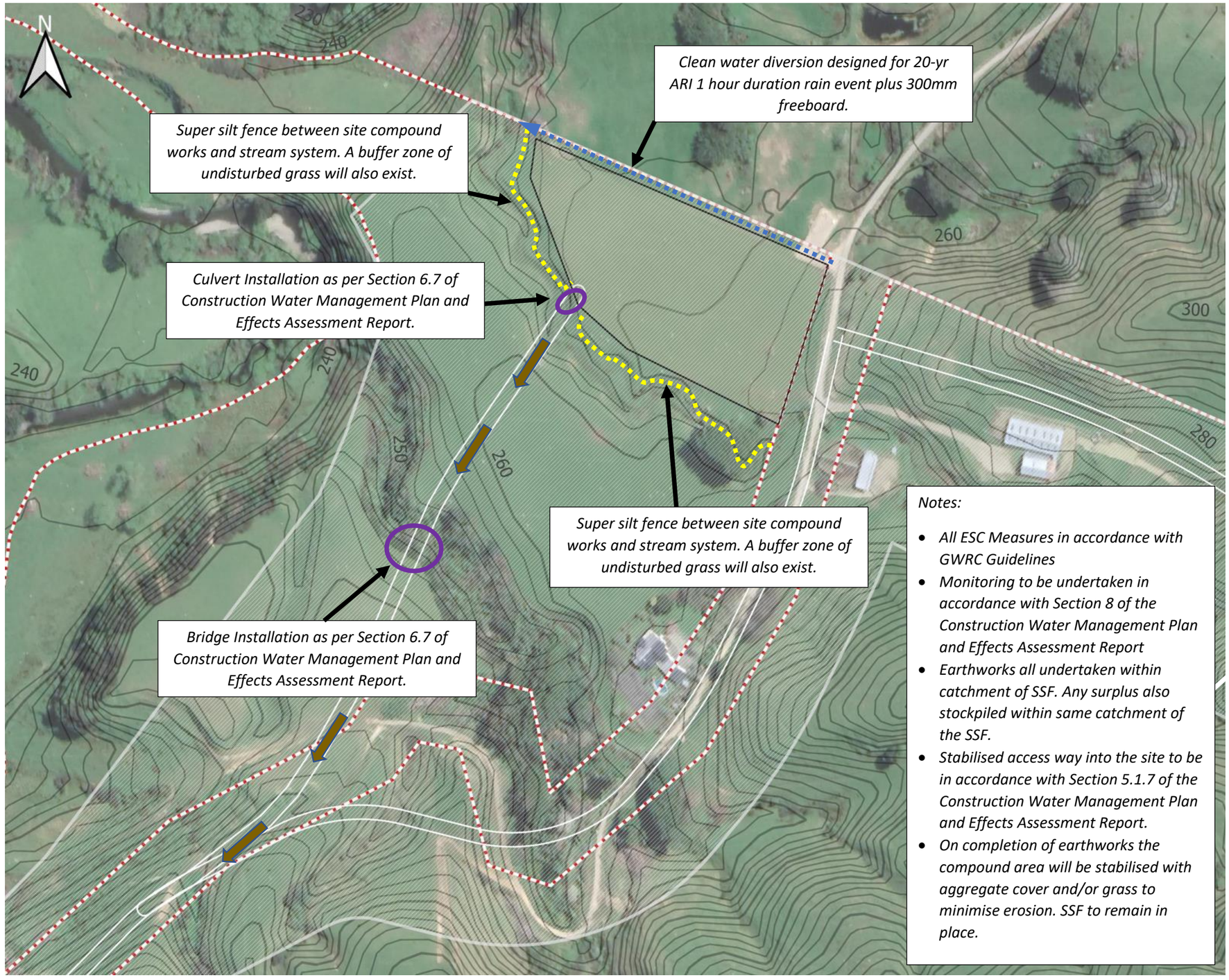
Focus Area # 4 – Fill Location – below Turbine 4.



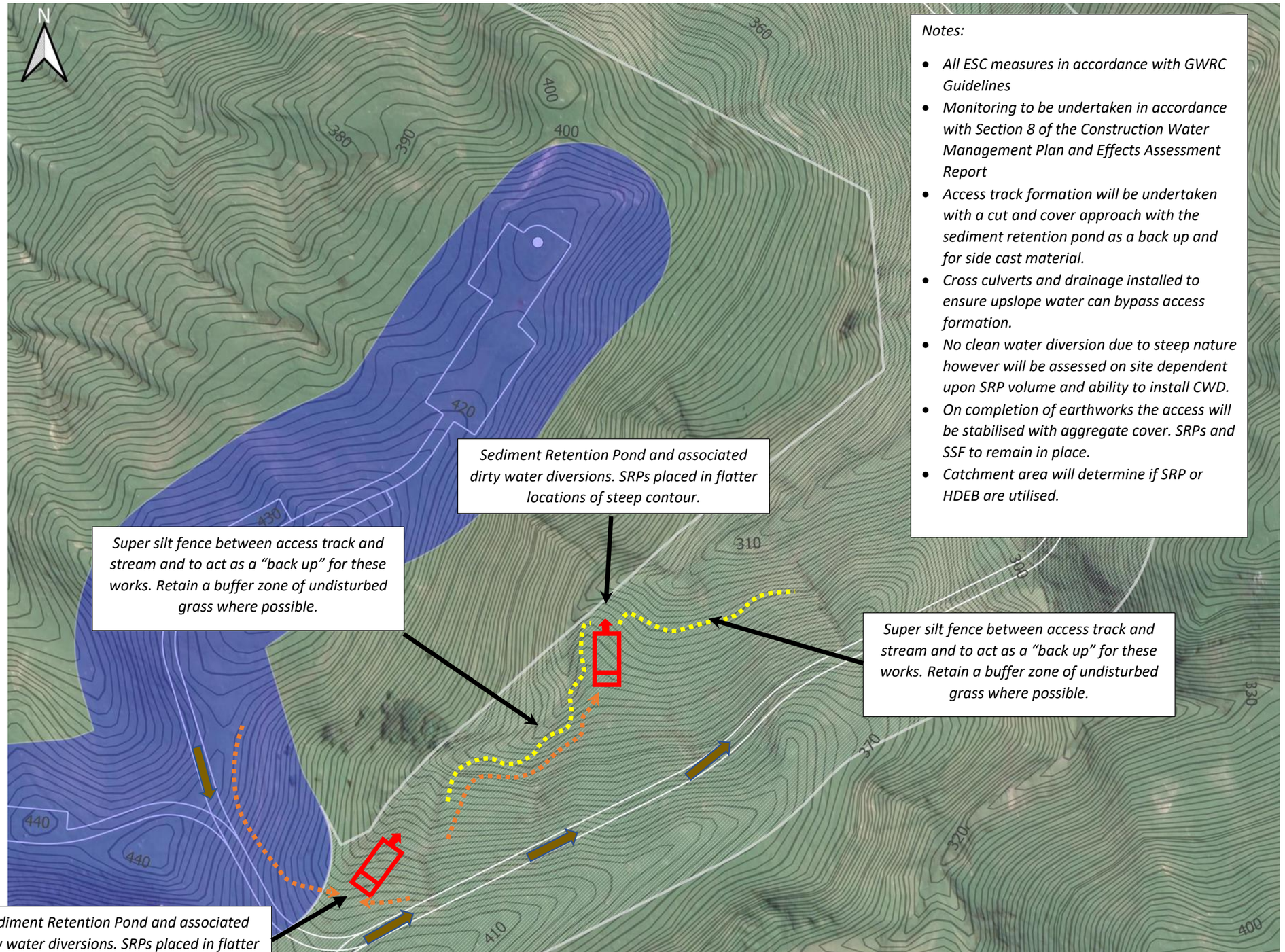
Focus Area # 5 – Typical Turbine Location. Turbine 3.

Erosion and Sediment Control Focus Areas for Conceptual ESC Specific Plans

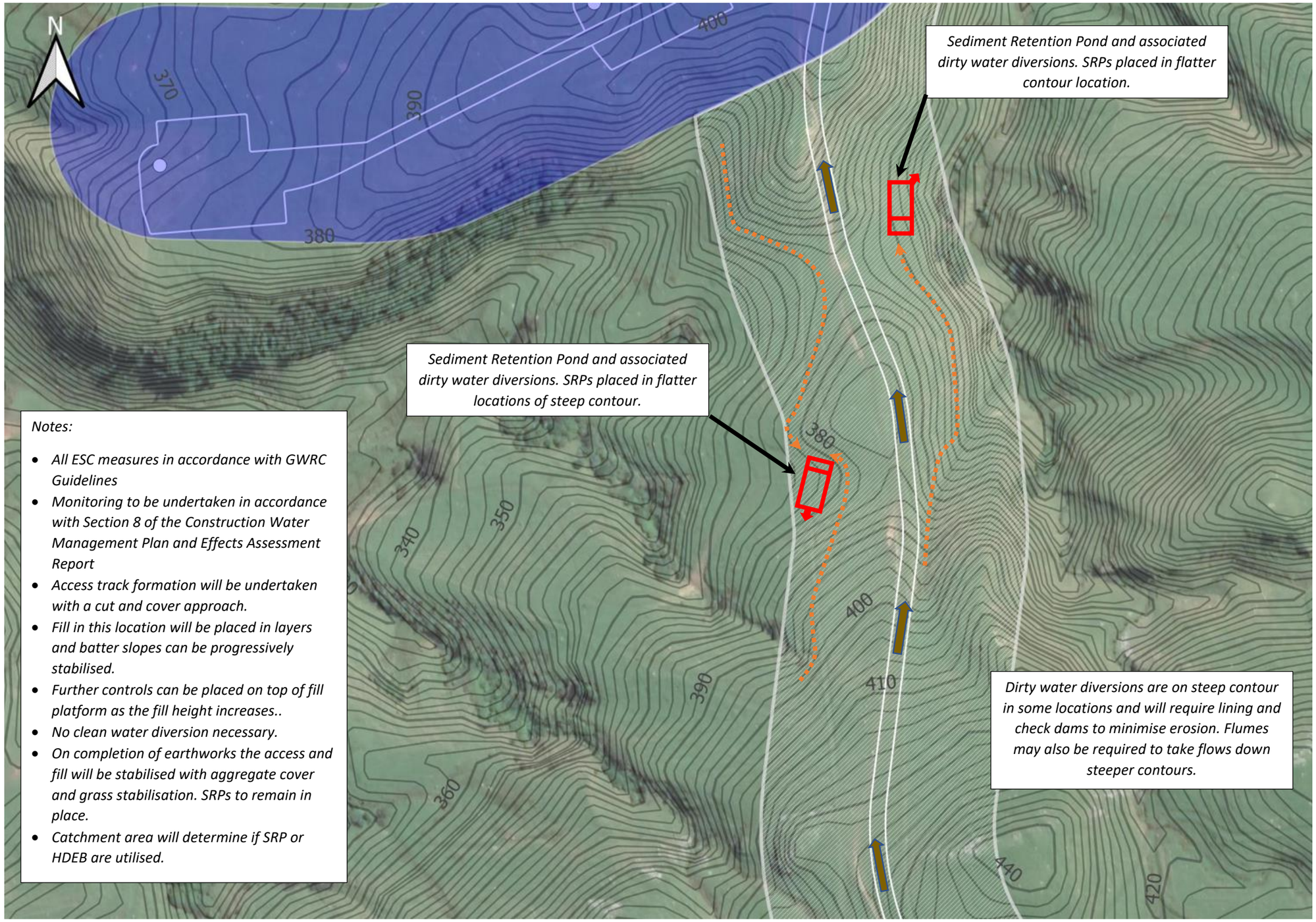
Meridian Energy Mt Munro Wind Farm. Erosion and Sediment Control Conceptual Plan for Focus Area 1 – Site Compound. Not designed as a Specific Environmental Management Plan for Implementation. Note plan is not to scale.



Meridian Energy Mt Munro Wind Farm. Erosion and Sediment Control Conceptual Plan for Focus Area 2 – Main Access Track. Not designed as a Specific Environmental Management Plan for Implementation. Note plan is not to scale.



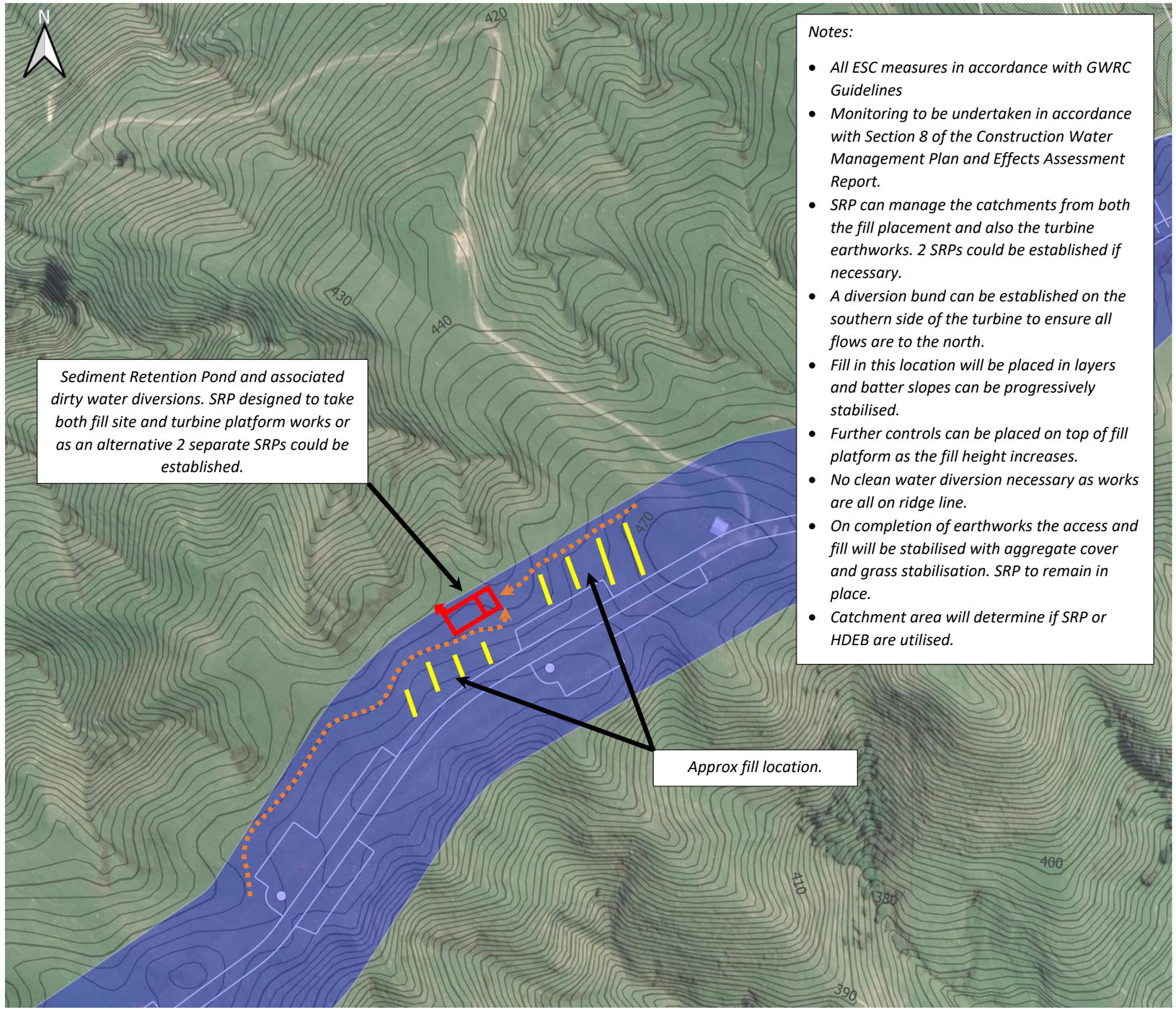
Meridian Energy Mt Munro Wind Farm. Erosion and Sediment Control Conceptual Plan for Focus Area 3 – Secondary Access Track. Not designed as a Specific Environmental Management Plan for Implementation. Note plan is not to scale.



Notes:

- *All ESC measures in accordance with GWRC Guidelines*
- *Monitoring to be undertaken in accordance with Section 8 of the Construction Water Management Plan and Effects Assessment Report*
- *Access track formation will be undertaken with a cut and cover approach.*
- *Fill in this location will be placed in layers and batter slopes can be progressively stabilised.*
- *Further controls can be placed on top of fill platform as the fill height increases..*
- *No clean water diversion necessary.*
- *On completion of earthworks the access and fill will be stabilised with aggregate cover and grass stabilisation. SRPs to remain in place.*
- *Catchment area will determine if SRP or HDEB are utilised.*

Meridian Energy Mt Munro Wind Farm. Erosion and Sediment Control Conceptual Plan for Focus Area 4 and 5 – Fill and Turbine Location. Not designed as a Specific Environmental Management Plan for Implementation. Note plan is not to scale.



Appendix D. Soil Bench Test Results

Meridian Energy Mt Munro Wind Farm

Soil Bench Test Results

March 2023

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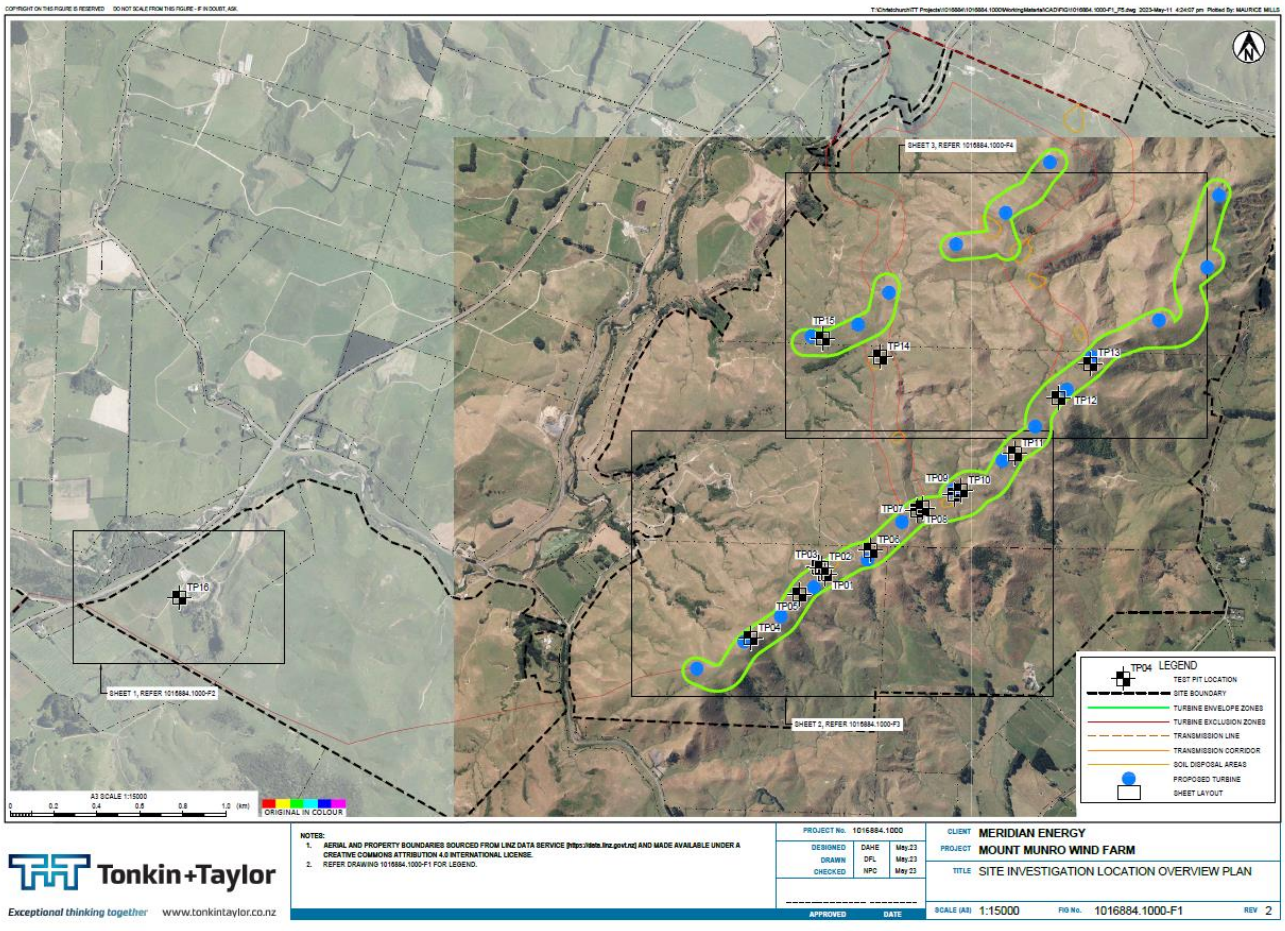
1. Project Soil Types

1.1 Test pit locations

Geotechnical investigations were carried out at the project site on 14 and 15 December 2021. The investigations comprised the excavation of sixteen (16) test pits. The test pits were undertaken by Goodman Contractors, under the supervision of an engineering geologist. In all cases, the test pits were dug until they encountered rock or until instability of the pit walls made it difficult to continue digging.

The locations of the test pit investigations were surveyed by handheld GPS and are presented in the plan below.

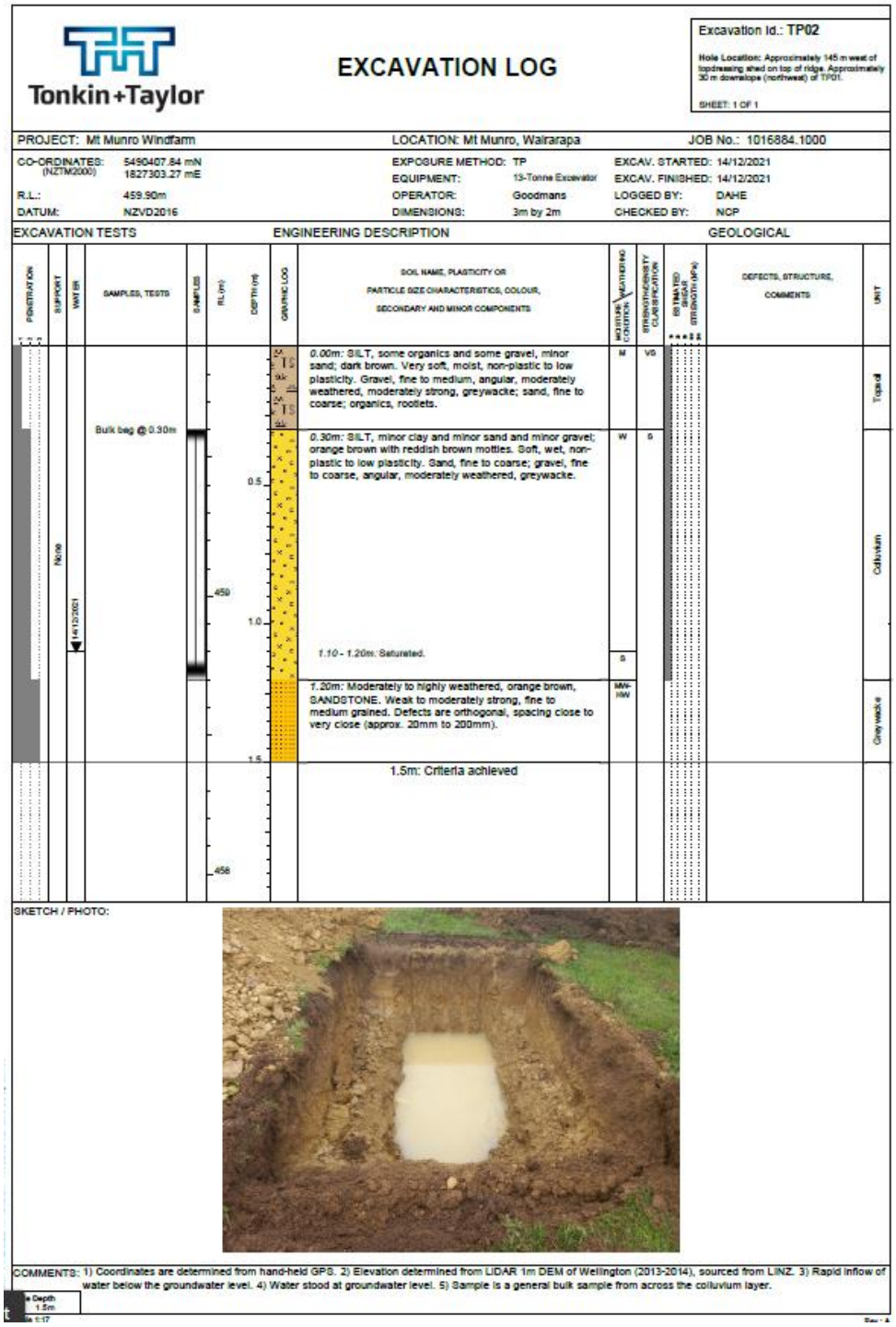


Plan One: Soil Test Pit Locations

1.2 Specific soil types

The following provides the test pit logs which are linked to those soil types that were subject to bench testing. Refer to Geotechnical Factual Report for original logs.

Test Pit 02 – Silt Soils



Tonkin+Taylor

EXCAVATION LOG

Excavation Id.: TP02

Hole Location: Approximately 145 m west of topdressing shed on top of ridge. Approximately 30 m downslope (northwest) of TP01.

SHEET: 1 OF 1

PROJECT: Mt Munro Windfarm		LOCATION: Mt Munro, Wairarapa		JOB No.: 1016884.1000	
CO-ORDINATES: (NZTM2000)	5490407.84 mN 1827303.27 mE	EXPOSURE METHOD:	TP	EXCAV. STARTED:	14/12/2021
		EQUIPMENT:	13-Tonne Excavator	EXCAV. FINISHED:	14/12/2021
R.L.:	459.90m	OPERATOR:	Goodmans	LOGGED BY:	DAHE
DATUM:	NZVD2016	DIMENSIONS:	3m by 2m	CHECKED BY:	NCP

EXCAVATION TESTS | ENGINEERING DESCRIPTION | GEOLOGICAL

PENETRATION	SUPPORT	WATER	SAMPLES, TESTS	GRAPHIC	R.L.(m)	DEPTH (m)	GRAPHIC LOG	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	WEATHERING CONDITION	STRENGTH/DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH (kPa)	DEFECTS, STRUCTURE, COMMENTS	UNIT
	None	14/12/2021	Bulk bag @ 0.30m		459	0.5	TS	0.00m: SILT, some organics and some gravel, minor sand; dark brown. Very soft, moist, non-plastic to low plasticity. Gravel, fine to medium, angular, moderately weathered, moderately strong, greywacke; sand, fine to coarse; organics, rootlets.	M	VS			Topsoil
						1.0		0.30m: SILT, minor clay and minor sand and minor gravel; orange brown with reddish brown mottles. Soft, wet, non-plastic to low plasticity. Sand, fine to coarse; gravel, fine to coarse, angular, moderately weathered, greywacke.	W	S			Colluvium
								1.10 - 1.20m: Saturated.	S				
								1.20m: Moderately to highly weathered, orange brown, SANDSTONE. Weak to moderately strong, fine to medium grained. Defects are orthogonal, spacing close to very close (approx. 20mm to 200mm).	MW-HW				Greywacke
					458	1.5		1.5m: Criteria achieved					

SKETCH / PHOTO:

COMMENTS: 1) Coordinates are determined from hand-held GPS. 2) Elevation determined from LIDAR 1m DEM of Wellington (2013-2014), sourced from LINZ. 3) Rapid inflow of water below the groundwater level. 4) Water stood at groundwater level. 5) Sample is a general bulk sample from across the colluvium layer.

Depth 1.5m

Test Pit 05 – Sandstone Soils

Tonkin+Taylor

EXCAVATION LOG

Excavation Id.: TP05

Hole Location: Approximately 200 m west of topdressing shed on hilltop. Located off the fenceline on the north side of the ridge.

SHEET: 1 OF 1

PROJECT: Mt Munro Windfarm | LOCATION: Mt Munro, Wairarapa | JOB No.: 1016884.1000

CO-ORDINATES: (NZTM2000)	5490285.38 mN 1827201.42 mE	EXPOSURE METHOD:	TP	EXCAV. STARTED:	14/12/2021
		EQUIPMENT:	13-Tonne Excavator	EXCAV. FINISHED:	14/12/2021
R.L.:	468.80m	OPERATOR:	Goodmans	LOGGED BY:	DAHE
DATUM:	NZVD2016	DIMENSIONS:	2.3m by 1m	CHECKED BY:	NCP

EXCAVATION TESTS | ENGINEERING DESCRIPTION | GEOLOGICAL

PENETRATION	SUPPORT	WATER	SAMPLES, TESTS	S-NAP LEG	RL (m)	DEPTH (m)	GRAPHIC LOG	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE / WEATHERING CONDITION	STRENGTH/DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH (kPa)	DEFECTS, STRUCTURE, COMMENTS	UNIT
	None	14/12/2021	Bulk bag @ 0.30m		468	0.5		0.00m: SILT, some organics and some gravel, minor sand; dark brown. Very soft, wet, non-plastic to low plasticity. Gravel, fine to medium, angular, moderately weathered, greywacke; sand, fine to coarse; organics, rootlets.	W	VS			Topsoil
						1.0		0.30m: Moderately to highly weathered, SANDSTONE. Weak to moderately strong. Defects are orthogonal, spacing close to very close (approx. 20mm to 200mm).	MW-HW				Greywacke
					467	1.5		1.5m: Criteria achieved					

SKETCH / PHOTO:

COMMENTS: 1) Coordinates are determined from hand-held GPS. 2) Elevation determined from LIDAR 1m DEM of Wellington (2013-2014), sourced from LINZ. 3) Slow inflow of groundwater below 1 m. 4) Sample is a general bulk sample from across the upper layer of the rock head.

Hole Depth 1.5m

Scale 1:17

Rev: A

Test Pit 10 – Clay Silt Soils

Tonkin+Taylor

EXCAVATION LOG

Excavation Id.: TP10

Hole Location: In gully approx. 40 m northeast of TP09. Approx. 610 m NE of topdressing shed on hilltop. Approx. 550 m SW of meitreat.

SHEET: 1 OF 1

PROJECT:	Mt Munro Windfarm	LOCATION:	Mt Munro, Wairarapa	JOB No.:	1016884.1000
CO-ORDINATES: (NZTM2000)	5490766.48 mN 1827949.46 mE	EXPOSURE METHOD:	TP	EXCAV. STARTED:	14/12/2021
		EQUIPMENT:	13-Tonne Excavator	EXCAV. FINISHED:	14/12/2021
R.L.:	465.90m	OPERATOR:	Goodmans	LOGGED BY:	DAHE
DATUM:	NZVD2016	DIMENSIONS:	5m by 1.5m	CHECKED BY:	NCP

EXCAVATION TESTS | ENGINEERING DESCRIPTION | GEOLOGICAL

PENETRATION	SUPPORT	WATER	SAMPLES, TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	WEATHERING CONDITION	STRENGTH/DENSITY CLASSIFICATION	ESTIMATED ROCK STRENGTH (MPa)	DEFECTS, STRUCTURE, COMMENTS	UNIT
	None	14/12/2021	Bulk bag @ 0.20m		465 464 463 462 461	0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5	TS	*0.00m:* SILT, some organics and some sand and some gravel; dark brown. Very soft, saturated, non-plastic to low plasticity. Sand, fine to coarse; gravel, fine to medium, angular, moderately weathered, greywacke; organics, rootlets. *0.20m:* Clayey SILT, some sand, minor gravel; greyish brown. Very soft to soft, saturated, low to medium plasticity. Sand, fine to coarse; gravel, fine to medium, angular, moderately weathered, greywacke. *3.40m:* Moderately weathered, grey, SANDSTONE. Weak to moderately strong. Defects are orthogonal, spaced closely to moderately widely (approx. 100mm to 250mm). Excavator refusing on rock head. 3.5m: Target depth. Side collapse.	S MW	VS VS-S			Topsoil Colluvium Greywacke

SKETCH / PHOTO:

COMMENTS: 1) Coordinates are determined from hand-held GPS. 2) Elevation determined from LIDAR 1m DEM of Wellington (2013-2014), sourced from LINZ. 3) Rapid inflow of water on all sides of hole. 4) Water pooling at ground-level in the vicinity of the hole, with overland flow identified. 5) Significant collapse of pit walls. 6) Sample is a general bulk sample from across the colluvial layer.

Hole Depth 3.5m

Scale 1:40 Rev: A

Test Pit 15 – Silts and Sands

Tonkin+Taylor

EXCAVATION LOG

Excavation Id.: TP15

Hole Location: North face of farm at far end of farm track. Approx. 1 km north of topdressing shed on hilltop. Approx. 285 m NW of TP14.

SHEET: 1 OF 1

PROJECT: Mt Munro Windfarm		LOCATION: Mt Munro, Wairarapa		JOB No.: 1016884.1000	
CO-ORDINATES: (NZTM2000)	5491470.04 mN 1827308.12 mE	EXPOSURE METHOD:	TP	EXCAV. STARTED:	15/12/2021
		EQUIPMENT:	13-Tonne Excavator	EXCAV. FINISHED:	15/12/2021
R.L.:	381.80m	OPERATOR:	Goodmans	LOGGED BY:	DAHE
DATUM:	NZVD2016	DIMENSIONS:	5m by 1m	CHECKED BY:	NCP

EXCAVATION TESTS | ENGINEERING DESCRIPTION | GEOLOGICAL

PENETRATION	SUPPORT	WATER	SAMPLES, TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH (kPa)	DEFECTS, STRUCTURE, COMMENTS	UNIT
	None	15/12/2021	Bulk bag @ 0.30m		381 380 379 378	0.5 1.0 1.5 2.0 2.5 3.0 3.5		0.00m: Organic SILT, trace sand; dark brown. Soft, moist, non-plastic. Sand, fine; organics, rootlets (fresh). 0.30m: Silty fine to medium SAND, some gravel; orange brown. Loosely packed, moist, poorly graded. Gravel, fine to coarse, angular, completely weathered, extremely weak. Gravel breaks down to same material as sand in major fraction. 2.70m: Moderately to highly weathered, orange brown, SANDSTONE. Weak to moderately strong. Defects in rock are orthogonal, very closely to closely spaced (approximately 50mm to 200mm spacing). 3.6m: Criteria achieved	M MW-HW	S L			Topsoil Colluvium Greywacke

SKETCH / PHOTO:

COMMENTS: 1) Coordinates are determined from hand-held GPS. 2) Elevation determined from LIDAR 1m DEM of Wellington (2013-2014), sourced from LINZ. 3) Slow inflow of groundwater below 3.7 m. 4) Sample is a general bulk sample from across the residual soil layer.

Hole Depth 3.6m

Scale 1:33 | Rev.: A

2. Bench Test Results

2.1 Overview

The application of polyaluminium chloride (PAC) has the potential to affect the receiving environments pH levels by lowering pH. Native freshwater fish species are sensitive to pH changes and accordingly it is typically recommended that the discharges from the sediment control devices should not cause a reduction in the downstream pH of less than 5.5. This however is noted to not be an effects trigger and simply provides a response trigger to ensure further monitoring can occur if necessary, and no effects result. This pH level is also placed in the context of the receiving environment and natural soil pH levels.

In addition, it is noted that an upper pH limit of 8.5 would apply to all discharges from the SRPs or HDEBs.

The PAC used for the bench testing for these soils was sourced from IXOM. This PAC is confirmed by the supplier as meeting the requirements of the Standard for the supply of polyaluminium chloride for use in water treatment, 2013, Second Edition, and the New Zealand Drinking Water Standard (2008).

2.2 Test pit soil TP02

Plate One – TP02 Soil Sample

Plate Two – TP02 - Immediately After Mixing

Plate Three – TP02 - 30min After Mixing

Plate Four – TP02 - 60 Minutes After Mixing

2.3 Test pit soil TP05

Plate Five – TP05 Soil Sample

Plate Six – TP05 Immediately After Mixing

Plate Seven – TP05 30min After Mixing

Plate Eight – TP05 60 Minutes After Mixing

2.4 Test pit soil TP10

Plate Nine – TP10 Soil Sample

Plate Ten – TP10 - Immediately After Mixing

Plate Eleven – TP10 - 30min After Mixing

Plate Twelve – TP10 - 60 Minutes After Mixing

2.5 Test pit soil TP15

Plate Thirteen – TP15 Soil Sample

Plate Fourteen – TP15 - Immediately After Mixing

Plate Fifteen – TP15 - 30min After Mixing

Plate Sixteen – TP15 - 60 Minutes After Mixing

2.6 Overall analysis

Soil Sample TP02				
Aluminium Dose (mg/l)	**Visual (60min)**	**Clarity (60min)**	**pH (60min)**	**NTU (60min)**
0	Clear	90mm	6.00	45.8
2	Very Clear	100mm	5.50	28.3
4	Very Clear	100mm	5.10	19.1
6	Very Clear	100mm	4.70	29.4
8	Very Clear	100mm	4.40	25.6

Table One – TP02 Results

Soil Sample TP05				
Aluminium Dose (mg/l)	**Visual (60min)**	**Clarity (60min)**	**pH (60min)**	**NTU (60min)**
0	Cloudy	70mm	6.00	78.2
2	Very Clear	100mm	5.65	36.5
4	Very Clear	100mm	5.10	31.7
6	Very Clear	100mm	4.90	38.1
8	Very Clear	100mm	4.70	37.6

Table Two – TP05 Results

Soil Sample TP10				
Aluminium Dose (mg/l)	**Visual (60min)**	**Clarity (60min)**	**pH (60min)**	**NTU (60min)**
0	Cloudy	20mm	6.30	377
2	Cloudy	50mm	5.91	30
4	Clear	100mm	5.65	15.78
6	Very Clear	100mm	5.32	17.28
8	Very Clear	100mm	4.95	38.9

Table Three – TP10 Results

Soil Sample TP15				
Aluminium Dose (mg/l)	**Visual (60min)**	**Clarity (60min)**	**pH (60min)**	**NTU (60min)**
0	Clear	90mm	5.70	43.9
2	Very Clear	100mm	5.57	32.5
4	Clear	80mm	5.41	52.8
6	Slightly Cloudy	60mm	5.10	74.6
8	Slightly Cloudy	50mm	4.80	151

Table Four – TP15 Results

3. Discussion

The results, for the samples taken, show that PAC achieved effective removal of suspended solids. Some minor settlement was recorded without any addition of PAC however PAC was noted to have an immediate effect and improve the clarity provided. Minimal impact on pH was recorded with the addition of PAC.

Settlement with PAC occurred relatively quickly. At a higher dose rate for some soils the turbidity was noted to increase slightly within the bench test results. This may indicate resuspension of the sediments and it is recommended that lower dose rates will achieve a better outcome.