RidleyDunphy
environmental & planning consultants

Barrytown Mineral Sand Operation

Erosion and Sediment Control Plan

TiGa Minerals and Metals

Ridley Dunphy Environmental Limited
31st March 2023
Final Draft - Version C

Document title:	Barrytown Erosion and Sediment Control Plan
Version:	Final Draft - Rev C
Date:	31st March 2023
Prepared by:	Graeme Ridley, RDE Limited
Reviewed by:	RDE Limited
File name:	Barrytown Erosion and Sediment Control Plan Final Draft

TiGa Minerals and Metals Limited

Quality Assurance Statement			
Prepared by:	G.J. Ridley	Graeme Ridley	Ridley Dunphy Environmental
Approved for release:	G.J. Ridley	Graeme Ridley	Ridley Dunphy Environmental

Revision schedule		
Rev. Number	**Date**	**Description**
A	10th February 2023	Draft for Project Review
B	28th March 2023	Final Draft
C	31st March 2023	Final Review
D	xxx	Final for Lodgement

Glossary of 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.
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 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 abbreviations

Report relevant abbreviations	Definition
AWP	Annual Work Programme
BPO	Best practicable option
ESC	Erosion and sediment control
ESCP	Erosion and sediment control plan
GD05 Guidelines	Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland region. June 2016 incorporating Amendment 2 (February 2020).
HMC	Heavy Mineral Concentrate
SF	Silt fence
SRP	Sediment retention pond
SSF	Super silt fence
WCP	Wet Concentrator Plant
WCRC	West Coast Regional Council

Contents

1. Introduction 1
1.1 Purpose and scope of this report 1
1.2 Erosion and sediment control and SSESCP development process 1
1.3 Project description and features 2
1.4 ESCP content and project specific construction activities 6
1.5 Roles and responsibilities 6
2. Existing environment 7
2.1 Rainfall 7
2.2 Geology and hydrology 7
2.3 Water quality 8
2.4 Overall sensitivity of the receiving environment 8
3. Erosion and sediment control and water management principles 9
3.1 ESC principles 9
4. Overview of erosion and sediment control and design criteria 11
4.1 General overview 11
4.2 Key erosion control measures 14
4.2.1 Construction staging and stabilisation 14
4.2.2 Rock check dams 15
4.2.3 Stabilised construction entranceway 15
4.3 Key sediment control measures 16
4.3.1 Sediment impoundment locations 16
4.3.2 Chemical treatment 19
4.3.3 Dirty water diversions (DWD) 19
4.3.4 Silt fence (SF) and Super silt fence (SSF) 20
4.4 Decommissioning of devices 20
4.5 Pumping 21
4.6 Stream crossing 21
5. Monitoring 24
5.1 Qualitative monitoring 24
5.1.1 On-site visual assessments 24
5.1.2 Weather forecasting during Project implementation 25
5.2 Quantitative monitoring 25
6. Recommendations and conclusions 27
7. References 28

Appendix A **Overall Project Site Plan**

Appendix B **ESC Principles**

Appendix C **ESCP Plan**

Appendix D **Soil Bench Tests**

Appendix E **CWD Calculations**

1. Introduction

1.1 Purpose and scope of this report

This Erosion and Sediment Control Plan (ESCP) is prepared in support of land disturbance and associated mining activity relating to a proposed mining operation for ilmenite, garnet and other minerals over an area of approximately 63ha (covered by Mining Permit MP 60785) at Barrytown, Westcoast of South Island, New Zealand. Within this ESCP the overall mining operation is referred to as the Project and is shown within Appendix A of this ESCP.

This ESCP supports the Project and confirms the overall approach to erosion and sediment control (ESC) and associated water management during the mining operation.

1.2 Erosion and sediment control and SSESCP development process

Our assessment of the ESC and practices likely to be required for the Project is based on the detail within this ESCP and also the supporting information supplied as part of the overarching consent application. This ESCP outlines the principles that will need to be applied throughout the adopted approach for all activities and associated water management.

As the Project works have the potential to result in sediment yields downstream, the focus during earthworks remains on best practice erosion and sediment control implementation.

This ESCP provides the overarching approach to water management on site. Prior to any work activity a detailed Site Specific ESCP (SSESCP) will be established for the Project which will include specific design details and will also provide the ability for the various parties to have further input into the methodologies implemented to ensure enhanced outcomes and the opportunity for other innovative practices to be implemented.

The SSESCP will primarily be based upon the principles detailed within this ESCP and will reconfirm the methodologies and construction sequence to be followed. The benefits of allowing this management plan approach to be confirmed at implementation time is to ensure ongoing innovation and flexibility remains and enables the Project team and the consent authority to have further input into the methodologies implemented.

In addition, this ESCP confirms a monitoring programme that will be implemented throughout the earthworks and mining activity that will inform future activities and water management approaches. This monitoring programme will form a key component of an Annual Work Programme (AWP) which will confirm the outcomes from the previous 12 months and confirm the approach for the upcoming 12-month period.

Some amendments to the water management approach may be determined through the AWP once works commence and these will be discussed and documented on site with West Coast Regional Council (WCRC) as necessary.

Figure 1 below confirms this management plan approach.

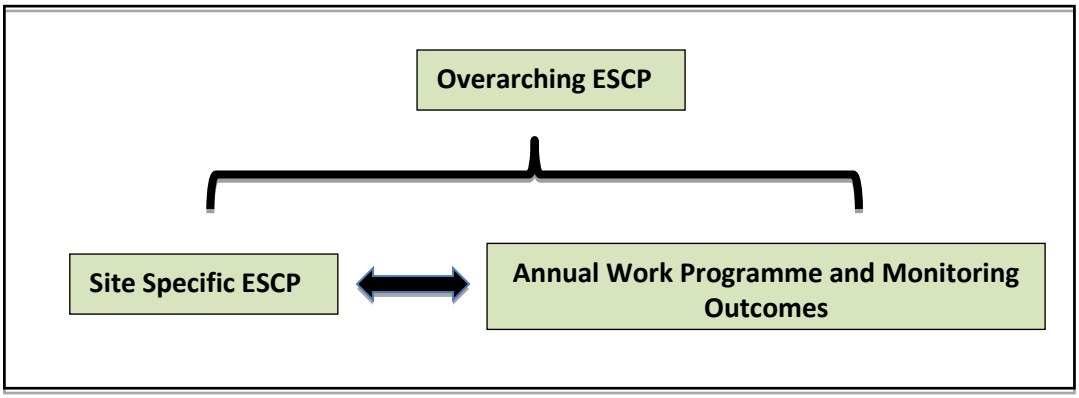


Figure One: ESCP Management Plan Approach

1.3 Project description and features

The Project site is currently used for dairy farming and is considered a highly modified humped and hollowed parcel of farmland located adjacent to State Highway 6 (SH6). The site has some wetland features bordering the site to the south and west, a small unnamed manmade drainage channel on the northern boundary, and Collins Creek on the southern boundary. There are springs on the adjacent property to the south of the site utilised for domestic and stock water supply. An artificial watercourse has been previously established through the central portion of the site and is referred to as the Central Drain.

The only vegetation other than pasture on the site is a small area of flax which has been planted as a wind break around a stock run off pad in the middle of the site. Watercourses have not been fenced from stock and other than limited riparian planting for a small section of Collins Creek, the banks of waterbodies are unstable and subject to erosion due to stock access and lack of vegetation. A photo of Collins Creek and the Central Drain is included below.

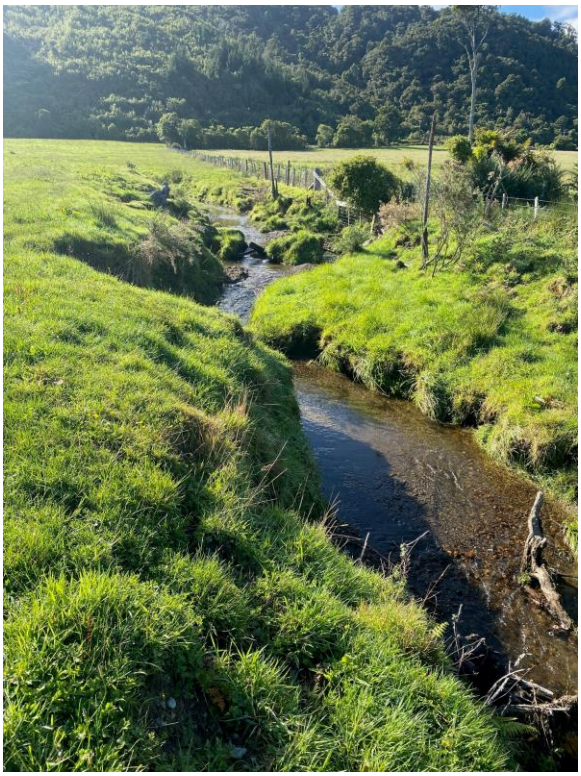


Plate One: Collins Creek South Eastern Extent

Plate Two: Central Drain

The mining activity generally includes removal of topsoil and excavation of mineral sands by an excavator, which will be pumped to the onsite processing plant. Specifically:

(a) Topsoil, approximately 0.2- 0.6m thick, and overburden will be removed and stockpiled for rehabilitation using an 85 tonne excavator, and 40 tonne articulated trucks. Once in mining sequence, topsoil will be removed ahead of mining and placed straight onto rehabilitated ground behind the mining pit.

(b) The sand ore will be mined via excavator and deposited onto a mining bench. The ore will then be picked up by frontend loader directly to the in-pit mining hopper. Maximum mining depth will be 9m.

(c) The slurry will pass through a trommel and desliming circuit before being pumped to a Wet Concentrator Plant (WCP). Reject large material from the trommel and slimes will be returned to the mine pit. Heavy minerals will be separated from the ore using a water and gravity circuit, drained of excess moisture and stored at the processing plant in a covered building.

(d) Excavated material will be processed at the processing plant to extract the Heavy Mineral Concentrate (HMC). Un-mineralised sands will be pumped back to the pit cavity where a cyclone will be used to remove the water from them before they are discharged to the mining void, which will be progressively filled as the mine pit progresses.

Actual mining is expected to take approximately 5-7 years to full stabilisation based on an extraction rate of 1,100,000 tonnes per year.

Figures 2 and 3 below show the general project location.

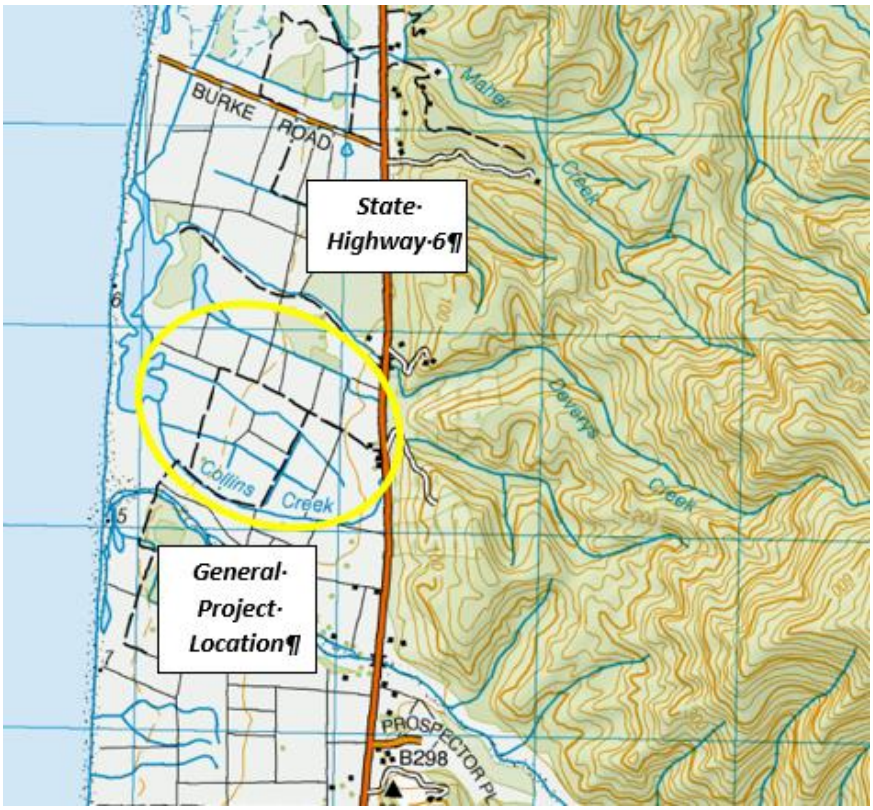


Figure Two: General Project Location

Figure Three: Project Aerial and Watercourse Features

The project description provided with the application confirms the processing plant requirements and general arrangement.

1.4 ESCP content and project specific construction activities

As part of the development of this ESCP, consideration has been given to WCRC expectations with respect to the erosion and sediment control design and ESCP content. The concepts of this ESCP have been discussed with WCRC and generally confirmed as appropriate. Importantly the principles and practices from within Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region. June 20016 incorporating Amendment 2 (February 2020) (GD05 Guidelines) have been applied.

This ESCP therefore has been developed with consideration of the following detail:

a. Details of all principles, procedures and practices that will be implemented to minimise the potential for sediment discharge from the site;

b. The design criteria, supporting calculations, dimensions and contributing catchments of all key ESC and water management structures, including (but not limited to) diversion bunds/channels and impoundment structures;

c. Works timetable and sequencing for the proposed mining activity;

d. Timetable and nature of progressive site rehabilitation and re-vegetation proposed;

e. Maintenance, monitoring and reporting procedures; and

f. Rainfall response and contingency measures including procedures to minimise adverse effects in the event of extreme rainfall events and/or the failure of any key ESC structures.

1.5 Roles and responsibilities

TiGa as the consent holder will have the overall responsibility for meeting the requirements of this ESCP. The contractors and sub-contractors whom are yet to be formally engaged and will be located on site, will include an environmental manager (or equivalent) that will implement this ESCP (and subsequent SSESCPs) including all required monitoring, management and necessary communication to the regulatory agencies including WCRC.

This ESCP and the SSESCPs will be implemented for the duration of the mining works and a copy will be kept in an accessible location for the duration of the Project.

This ESCP and SSESCPs will also continually be reviewed during works and will be subject to amendments as necessary in consultation with WCRC as part of the AWP process.

2. Existing environment

2.1 Rainfall

Punakaiki is reported to experience approximately 2800mm rainfall per year, with the rainfall relatively consistent throughout the year. Figure 4 below illustrates this rainfall pattern which is assessed to be similar for the Project site. On average October is the wettest month and February is the driest month.

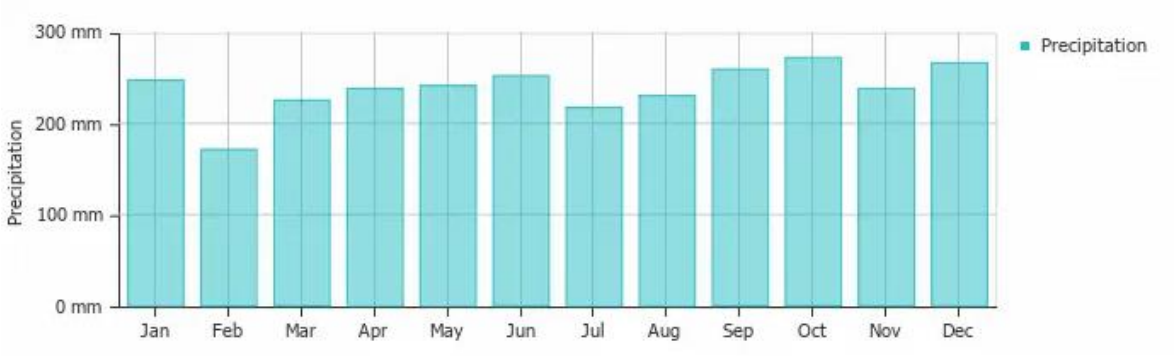


Figure Four: Punakaiki Annual Rainfall Patterns

2.2 Geology and hydrology

Two thirds of the Barrytown Flats are underlain by O'Keefe Formation muddy sandstone and the southern third is underlain by Karamea granitic basement. Granite Creek and Little Granite Creek have their headwaters in the Karamea granitic batholith rocks. The Barrytown creeks north of Canoe Creek have their headwaters in softer, more erodible O'Keefe Formation sandstones.

The mineral sands that are the focus of this Project comprise post-glacial coastal sand and gravel deposits (Suggate, 1989). The mineral sands are considered to have been set down in a series of north – south trending prograding strand lines. The sediment supply for deposition of the sands is inferred to have been long-shore drift from the south.

The hill backdrop to the Barrytown flats is dissected by 17 individual stream and creek catchments. Canoe Creek is the largest of these and has headwaters at the Paparoa Range crest. Granite Creek and Fagan Creek are the main catchments draining the face of the coastal range south of Canoe Creek and adjacent to the Barrytown settlement.

There are several springs along the southern boundary of the Project area which are used by the neighbouring landowner for stock water and for water tank top-up in dry weather. In addition, a coastal lagoon known as Canoe Creek lagoon is located on the western border of the Project site. The lagoon receives water from Collins Creek and Deverys Creek towards the centre and from Maher Creek to the north. The creek is also likely to be recharge via groundwater seepage.

Groundwater throughout the flats is fresh with low dissolved salts content including along the coastline. This suggests the aquifer is fully flushed with fresh water recharged from rainfall excess and creek infiltration. Investigations have confirmed there is mixed grain size alluvium in the east of the Project that peters out to the west and is largely absent at the eastern margin of the proposed sand extraction operations area. Groundwater flows relatively slowly and weakly through the mineral sands, tending to follow preferential pathways within sandy gravel. The main groundwater hydraulic gradient is from the eastern reaches of Collins Creek and soil drainage to seepage emergence in wetlands and coastal lagoons.

2.3 Water quality

Collins Creek on the southern extent of the proposal is a highly modified natural watercourse and has been channelised throughout much of its length and the riparian vegetation on the true right (north) of the upper parts of the stream has been removed by grazing. Aquatic habitat was variable and included riffles, runs and small pools and diverse water velocities. Streambanks are reported as steep, unstable, pugged and eroding/slumping within the site.

On the northern boundary of the site is the Northern Drain which is a highly modified soft-bottomed (sand/silt) watercourse with a straight channel alignment.

As reported within the ecology assessment, the aquatic species present represent a reasonably intact freshwater fish fauna. The ecological values of the site are however very limited. The values have been adversely affected by previous land uses which have resulted in the removal of wetlands, removal of almost all of the indigenous vegetation and the degradation of aquatic habitats in streams through livestock grazing.

2.4 Overall sensitivity of the receiving environment

Based on the knowledge of the receiving environment and the extent of the Project works, that while the Project works are assessed as low risk due to soil types and flat grades it is important that the minimisation of discharges from the mining activity occurs at all times. It is also important to recognise, and account for, that due to frequent heavy rainfall at the Project location, streams in the area experience frequent episodic high turbidity events, and that following these events water returns to low turbidity relatively quickly.

From a water management perspective, the Project risk is increased due to groundwater infiltration, in particular the volumes of groundwater that are expected to be encountered. Groundwater infiltration will therefore be a key consideration and best practice erosion and sediment control measures will need to be designed, implemented and maintained with a BPO approach to ensure appropriate environmental outcomes can be achieved overall.

3. Erosion and sediment control and water management principles

This ESCP outlines the ESC and water management measures to be utilised for the Project with these based on:

- Viewing the Project in a holistic manner. The combined effects of the mining activity on the receiving environment, are considered as a whole (including both the mine process water and also rainfall runoff) and not in isolation from each other. In addition this ESCP considers other land disturbance activities that will occur as part of the overall implementation;
- Minimising the potential adverse effects on the receiving environment, by using measures, both structural and non-structural that meet industry best practice and GD05 Guideline;
- Having regular 'toolbox' meetings onsite with relevant personnel in attendance as part of the ongoing mining activity;
- Ensuring that any water and associated sediment discharges are considered and assessed as part of the Project implementation;
- Ensuring that all ESC and water management measures utilised are structurally sound and designed appropriately; and
- The implementation of an adaptive monitoring programme, to inform the effectiveness of the ESC and water management measures on site and to adapt and amend these as necessary to minimise the discharge of sediment (and other contaminants) into the receiving environment.

The Project will adopt a set of key principles that apply to all work activities. Appendix B of this ESCP contains the erosion and sediment control principles as reflected within the GD05 Guideline with the specific Project principles outlined in Section 3.1 below.

3.1 ESC principles

1. ESC measures will be based on a range of structural (physical measures) and non-structural (methodologies and construction sequencing) measures.

2. ESC measures will, where practicable, meet the minimum criteria as detailed in this ESCP and will incorporate innovative ideas and procedures to ensure best practice applies and to match any local challenges and opportunities.

3. Progressive and rapid stabilisation of disturbed areas (including using mulch) will be on-going during the mining activity. Any stabilisation alternatives (not outlined within GD05 Guideline) will first be verified as an appropriate and WCRC authorised stabilisation media.

4. 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 exposed area. Stabilisation is designed for both erosion control and dust minimisation and will be progressively implemented.

5. A monitoring and management approach which allows a response to water quality (turbidity and other contaminants) monitoring outcomes will be utilised for the mining activity through qualitative monitoring (which will include visual surveys and recording of any discharges and the downstream environment) and quantitative monitoring (which will include water quality sample collection and analysis).

4. Overview of erosion and sediment control and design criteria

4.1 General overview

As outlined above, for this Project we have adopted a BPO approach which reflects the current state of knowledge (as per the GD05 Guideline), the specific physical conditions to be encountered on the site and the previous knowledge of the Project team (from other similar projects) which will be reflected in the measures adopted.

Attached to this ESCP in Appendix C are plans of the proposed erosion and sediment control and water management measures that supports the Project.

In terms of general water management measures the following applies:

1. The Processing Plant may require an initial water take from Canoe Creek which will be located adjacent to the existing farm access track near the coast (or via a direct surface water take) with a maximum rate of 63 litres/second to fill up the Processing Plant circuit including the fire water tank. A water take may be required sporadically during mining to top up the water circuit, and to augment flows in Collins Creek and the Northern Drain.

2. The Processing Plant water will be recovered mechanically from the HMC product and un-mineralised sands via a series of cyclones and recirculated for reuse. Some of the process water will be retained in the HMC and some will be pumped back to the pit cavity with the unmineralized sand slurry.

3. Stormwater generated in the Processing Plant area will be captured and directed to settling ponds via pumping to the treatment ponds (referred to as Ponds 1 and 2) before treated water discharges to the central drain which will convey discharged water from the mine water facility to finishing ponds (Ponds 3 and 4) in the north-western corner of the property.

4. Water from the mining void and stormwater runoff from the process plant area will be diverted or pumped to Pond 1 and Pond 2. Pond 1 includes two separate forebay impoundments which are designed to capture most of the sediment prior to flow into the main body of Pond 1 and then over a level spreader to Pond 2. Where sediment laden water will enter the Pond 1 forebay a flocculant will be added to the water to assist with sediment settlement. Appendix D confirms the soil settling tests undertaken with various flocculants, all of which demonstrate the benefits of chemical treatment. While Polyaluminium Chloride provided excellent flocculation outcomes, the specific flocculant to be used on site however will be determined prior to works commencing.

5. Maintenance of the Pond 1 forebays will be ongoing to ensure capacity remains as best practicable at all times. While 1 forebay is subject to maintenance the other forebay will be utilised. If required, the main body of Pond 1 will also be subject to maintenance clean outs. Pond 2 can also be subject to maintenance clean outs however this is not expected or will be infrequent.

6. The clean water from Pond 2 will then discharge via a pump to the central drain or be used in the process plant. The central drain has a series of rock check dams installed and these will assist with flow reduction and also will capture some sediment over time.

7. The central drain will flow to a finishing pond and the clean water facility (referred to as Ponds 3 and 4) in the southwestern corner of the property. Excess water from Pond 3 will overflow (or be pumped) into the clean water facility (Pond 4) before discharging to the environment.

8. Excess water from this finishing pond will be directed to infiltration trenches in the first instance to recharge groundwater and avoid surface water depletion. Whatever water that cannot be directed to infiltration trenches will be discharged from the finishing pond into the drain which discharges to Canoe Creek Lagoon if water quality and clarity allows.

9. If the water quality or clarity parameters are not met, the discharge water will be managed, in order of preference,

    i. The water will be recirculated into the processing plant and mine water facility if there is capacity in the system;

    ii. The water will be left to flood the mine void until such a time as water quality is acceptable and/or the water management system is amended; and

    iii. The water will be discharged to further infiltration trenches around the perimeter of the mine, with excess water being pumped to the Canoe Creek infiltration basin.

10. In addition to the mining itself there will be other land disturbance activities associated with bund establishment, access provisions and ancillary works. These activities are also to be addressed in full through the SSESCP process and are subject to the principles and practices as outlined within this ESCP.

11. The Project has committed to having a maximum area open at any one time of 8.0ha. This includes all the bund establishment and road access provisions. This has the effect of ensuring, including through site establishment phases, that progressive stabilisation is implemented and the risk of sediment generation and discharges are greatly reduced. It is

recognised that if greater than 8ha is required for a specific task that this will be for short duration periods only and only would occur with WCRC certification.

The mine water management process is illustrated below in Figure 5.

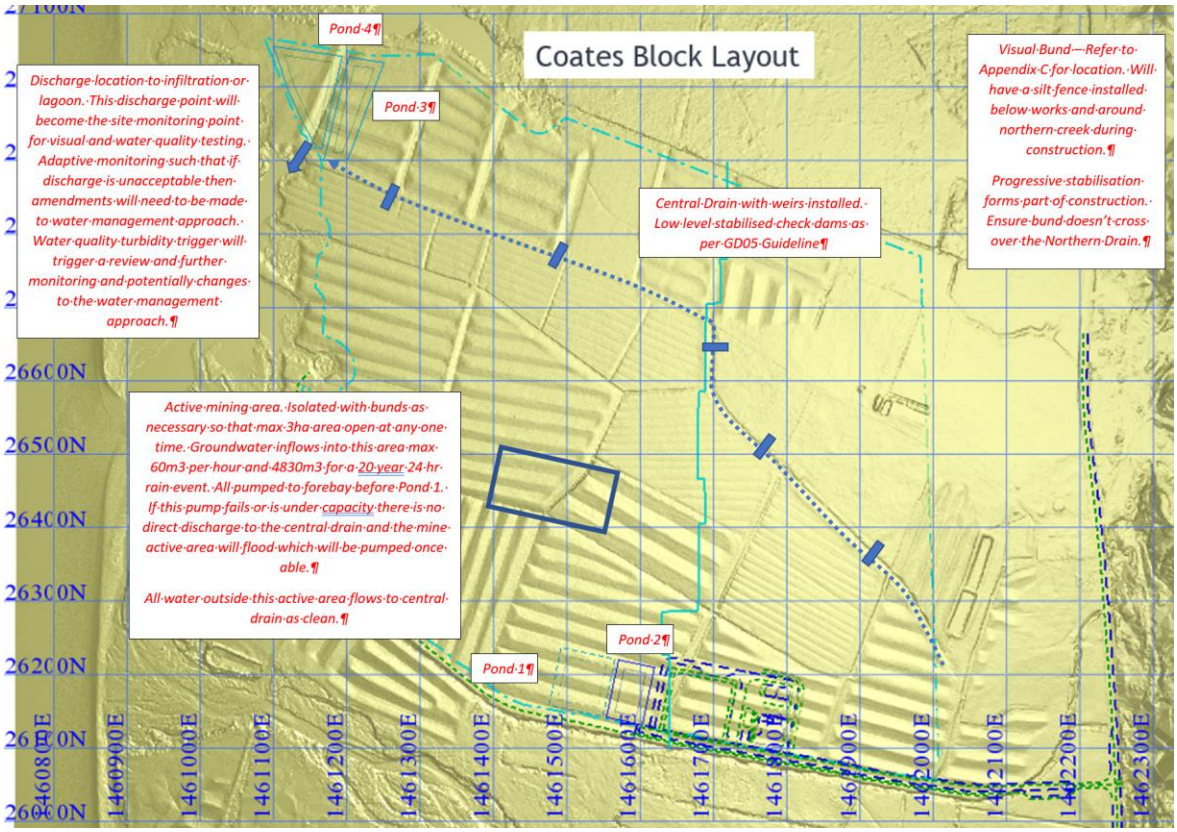


Figure Five: General Water Flow and Treatment Facility Locations

Mining will progress in strips, with a dimension of 100m wide (strip width) and 300m long. The mine pit area will be 3ha, including 0.5ha of stripping occurring ahead of the mine pit and 0.5ha of active rehabilitation occurring behind the mine pit. The processing plant area will be 2.5ha in area including the mine access road. The total disturbed area of the mine is therefore approximately 5.5 ha in area. Mining will commence in the southwest of the area (Panel 1 as per Appendix A), and progressively moves eastwards on 100 wide strips/panels. Each subsequent strip of mining is located north of the previous strip, with the exception of Panel 9, which is located in the southwestern most extent of mining. Mining along each strip is always from the west to the east.

20m mining setbacks will apply to the northern and southern property boundaries, Collins Creek and the coastal lagoon area. The area south and west of Collins Creek is also excluded from the mining area.

This mining process is illustrated below in Figure 6.

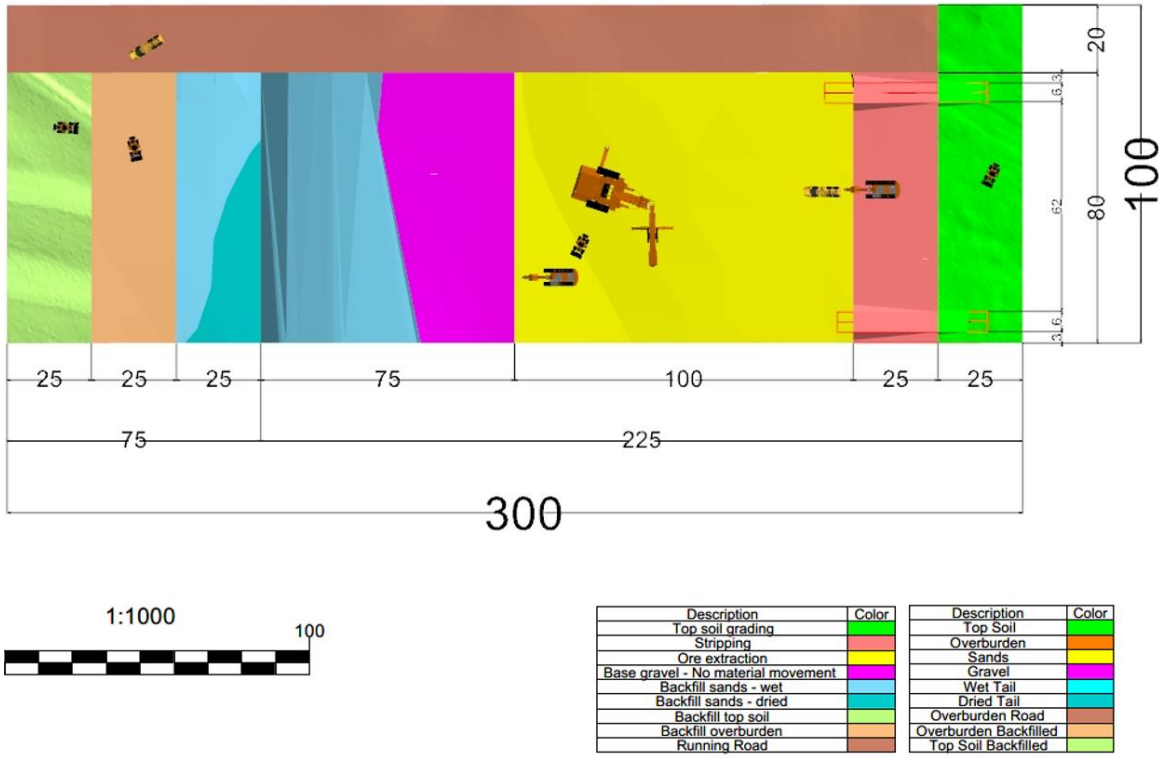


Figure Six: Mining Sequence

4.2 Key erosion control measures

In general, the erosion control measures to be applied to the Project are as below.

4.2.1 Construction staging and stabilisation

As a general approach to all land disturbance, but with specific reference to the mining activity, the Project will minimise soil exposure and undertake progressive rehabilitation and stabilisation as areas of the mine are completed. As detailed above an ongoing 0.5ha of rehabilitation will be ongoing at all times following the mine advancement.

The staging will progress from west to east and in this fashion will be formally staged hence limiting the exposed open area, and therefore the risk, throughout.

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.

Typical revegetation will include seeding and fertiliser application on topsoiled areas and hydroseeding, however where instant stabilisation is required, hay and/or straw mulch may be utilised.

In addition to the mine rehabilitation process, the visual bund to be established along SH6 (see Appendix A) will also be planted as detailed within the Landscape assessment report.

Importantly, utilising traditional grass sowing methodologies is not considered stabilised until such a time as 80% vegetative cover is established on site however the use of hay or straw mulch and as well as hardfill with clean aggregate is confirmed as immediately creating a stabilised surface. If alternatives, such as polymer/soil binder products or hydroseeding are to be utilised they will need to be verified by WCRC as achieving a stabilised surface prior to on site use.

The use of stabilisation is designed with 2 key purposes being dust suppression and also erosion control.

4.2.2 Rock check dams

Check dams are small dams made of rock rip-rap or other non-erodible material constructed across a swale or channel to act as grade-control structures. Their purpose is to reduce the velocity of concentrated flows and they are often placed in series down a channel and used to reduce invert scour in drains or channels.

Rock check dams will be utilised on the Project within the central drain to assist with slowing velocity of any flows, ensure scour and erosion of this drain is minimised and also will perform a secondary function of collecting and trapping any sediment that may remain in flows at that point. In addition, these rock check dams will be constructed with limestone rock for the purpose of increasing water hardness to avoid potential toxicity of naturally present metals in water pumped from the mining void.

4.2.3 Stabilised construction entranceway

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. On this Project stabilised entrances will be utilised with SH6. GD05 Guideline will assist with the provision of 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. The processing plant location and

associated access roads will all be aggregate stabilised and as such will in themselves act as stabilised entrance ways.

4.3 Key sediment control measures

Sediment control on the Project will involve the treatment of sediment-laden runoff and mine process water from the various areas of the Project but in particular the active mining area. Sediment control will be established through the use of recognised sediment control measures and site management practices.

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

4.3.1 Sediment impoundment locations

Treatment of surface runoff and sediment contaminated groundwater infiltration from the mining area will occur to ensure that sediment is removed to the maximum extent possible from the construction runoff before being discharged to the receiving environment. Sediment Retention Ponds (SRPs) provide the most robust and effective measure in achieving sediment removal from construction runoff.

It is assessed for this Project that while the GD05 Guideline reflect the most up to date and best practice SRP design criteria, that due to the infiltration rates of groundwater within the mining area itself, that a large volume impoundment will provide the best approach and will be utilised. This impoundment has a volume significantly larger than that from within GD05 Guideline design criteria and will capture surface runoff from the 3.0ha maximum open area and also up to 60m^3 per hour of infiltration of groundwater.

Two formal forebays will be established at Pond 1 with the discharge from these forebays to occur over a level spreader to the main body of Pond 1. Pond 1 will then discharge into Pond 2 via a level spreader (or pumping) to Pond 2 which will also provide a polishing of runoff prior to discharge to the Central Drain.

The general water management discharge sequence is as follows:

1. Active mining area and associated activities maximum 3.0ha plus 2.5ha of processing plant.

2. This area (and groundwater infiltration) will discharge via pumping to Pond 1 which has a capacity of 32,500m^3. This pond has the capacity for a 20 year rain event in addition to groundwater infiltration and will take approximately 16 days to reach capacity (excluding the forebay volume). In addition, this pond is expected to have some natural groundwater infiltration and as such a longer capacity duration is expected.

3. Pond 1 will have two forebays (each having a capacity of 3,200m^3) which will assist with maintenance and also flocculation. While Polyaluminium Chloride provided excellent flocculation outcomes, the specific flocculant to be used on site however will be determined prior to works commencing.

4. Clean water diversions (CWD) will be installed around the mining void and also other earthwork areas as and when necessary to ensure only the active area can discharge to Pond 1 or the designation sediment control measure. While the specific sizing of the CWD will be detailed within the SSESCP, Appendix E of this ESCP provides an example of a CWD design that may apply to the Project.

5. Pond 1 will flow via a level spreader or pumping to Pond 2 which has a capacity of 20,300m^3.

6. Pond 1 and 2 (particularly the forebays of Pond 1) will need to be maintained on a regular basis.

7. Pond 2 will be used as process water or discharge via pump to the Central Drain. This Central Drain already exists but weirs will be installed within it to assist with any further sedimentation that remains in the flows. These weirs are designed as check dams and they will be removed over time.

8. This Central Drain will flow into Pond 3 which has a total volume of 28,100m^3. This will act as a further coarse sediment trap and this in turn discharges to Pond 4 with a capacity of 36,800m^3 via a level spreader.

9. The Central Drain will require some amendments over time as the mine void progresses to allow mining in those locations where the Central Drain currently exists. This has been observed on site and will be the subject of a SSESCP however it is likely that the Central Drain will be diverted south through the completed Panel 3 once the Panel 3 mine void is fully rehabilitated.

10. Pond 4 will discharge in order of priority as follows:

    - pump to the infiltration trenches on the northern and western boundaries for groundwater recharge;
    - if groundwater recharge is not necessary pump to surface water which could include the coastal lagoon avoiding direct discharges to the coastal environment. This can only occur if water quality criteria is achieved;
    - if water quality criteria can not be achieved then pump to infiltration pit adjacent to Canoe Creek; and

- as a final option if the other alternatives are not feasible , at capacity or criteria can not be achieved, then the mine operation can cease, pumping can also cease and the mine void will be flooded. This will provide time and the ability to reconsider other options.

The process and operating procedures to ensure that the above sequence occurs and achieves the environmental outcomes is provided within Mr Etheridge's assessment.

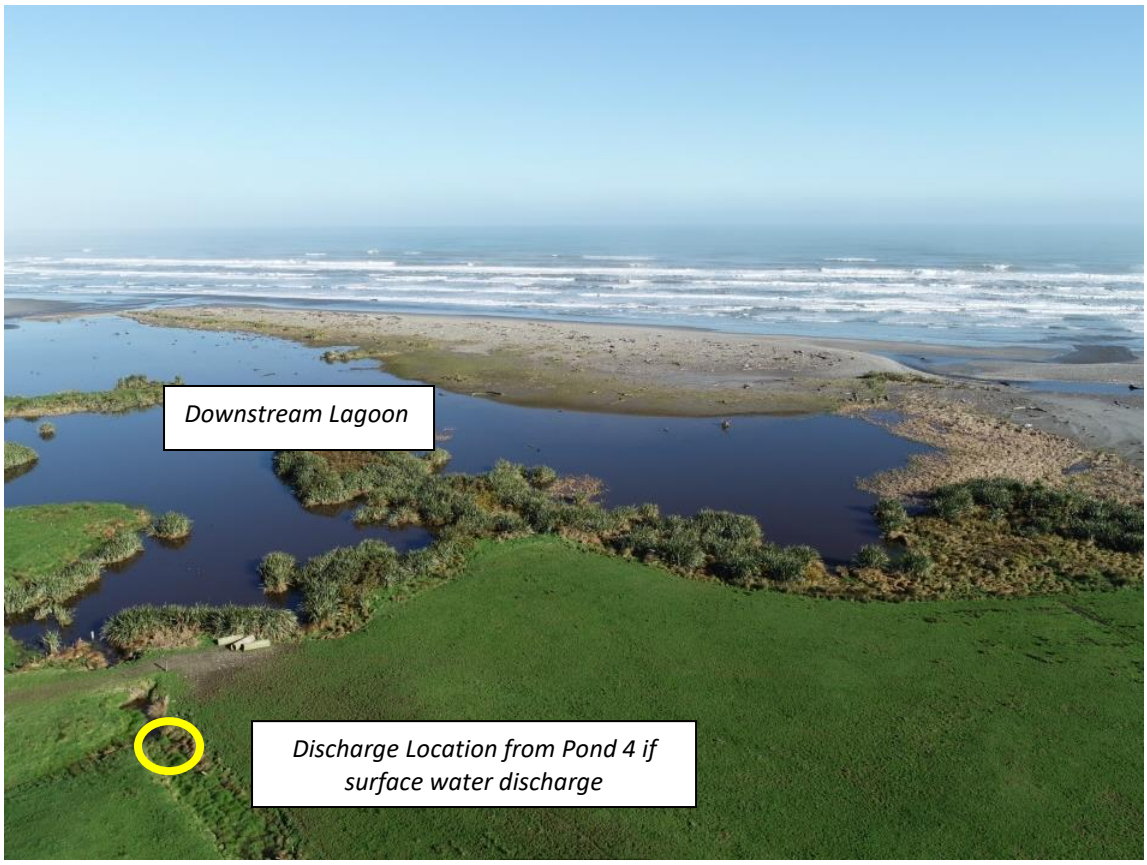


Figure Seven: Discharge Location

This above process is illustrated in Figure 5 above and further in Figure 8 below for Ponds 1 and 2.

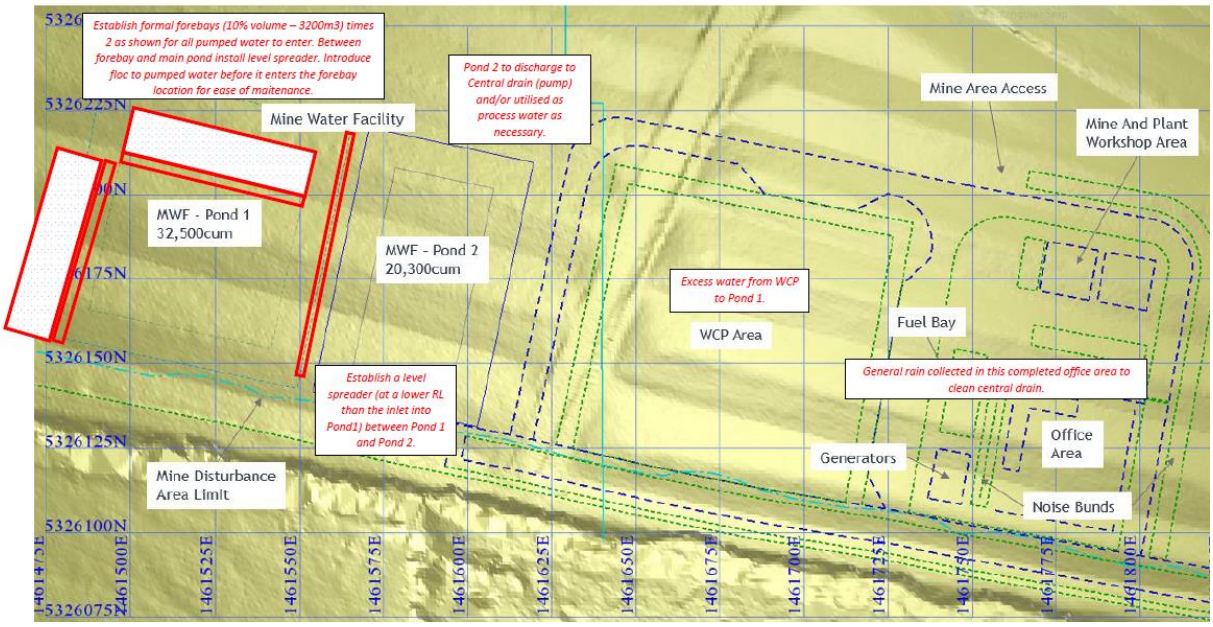


Figure Eight: Ponds 1 and 2 Details

4.3.2 Chemical treatment

Attached in Appendix D is a report outlining the results of chemical treatment of the soils and associated runoff that will eventuate from these. This report confirms the benefits of flocculation and for this Project the specific chemical used, dose rates and the design will all be confirmed prior to works commencing. This will be detailed within the SSESCP to be submitted and updated and verified further through the AWP.

4.3.3 Dirty water diversions (DWD)

DWDs transfer sediment laden water to treatment devices. 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). Due to the nature of the mining sequence, it is unlikely that DWD will be required for the Project as all dirty water will be pumped to Pond 1 forebays. If required however, the DWD design criteria for the Project will ensure that all construction runoff from the active mining location (including any areas not yet stabilised) from rain events up to the 20-year ARI event will be transferred to Pond 1. 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.

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.

These DWD will be moved on an ongoing basis as the mine area also moves to ensure that there is always flow from this active area to Pond 1.

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

SF and SSF are fabric fences reinforced with waratahs / 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 GD05 Guideline.

SFs will be utilised as part of the visual bund establishment along SH6 and access road establishment. The SF will be returned up the Northern Drain in order to protect this from any earthworks and sediment runoff. These SFs will be complemented with progressive stabilisation.

In addition, for the central bund and pre-mining ore stockpile location this will be protected with SFs as shown within Appendix C. These stockpiles and bunds will be placed progressively, will avoid direct placement over the Central Drain and will be stabilised as they progress. Adjacent to the Central Drain itself SSF will be utilised to provide more robust control measures.

The GD05 Guideline notes that design criteria as below which will be adopted.

Table 13: Silt fence design criteria

Slope steepness %	Slope length (m) (maximum)	Spacing of returns (m)	Silt fence length (m) (maximum)
Flatter than 2%	Unlimited	N/A	Unlimited
2 – 10%	40	60	300
10 – 20%	30	50	230
20 – 33%	20	40	150
33 – 50%	15	30	75
> 50%	6	20	40

Table One: GWRC 2021 Guideline Table 13 Silt Fence Criteria

4.4 Decommissioning of devices

All ESC measures will remain in place until such a time as the mining operation has ceased or the circumstance where the catchment contributing to that device is stabilised. Once the contributing catchment is considered stabilised, or other measures are in place as agreed with WCRC, the measure will be decommissioned in consultation with WCRC.

For the mining activity itself, as described above the ESC measures will remain for the full operation and duration of activity.

4.5 Pumping

Pumping will be necessary in some parts of the Project. Pump intakes will be fitted with floating intakes and all pumping will only be to impoundment areas or the infiltration device. There will be no pumping of any on site water directly to the receiving environment.

If problems eventuate with water clarity from pumping then the associated pump can be switched of and flood the mine area while the issues are resolved.

The contractor may also wish to initiate a permit to pump system whereby pumping can only occur with a specific “internal” permit in place which confirms all the necessary criteria, including water quality, have been achieved prior to the pumping itself.

4.6 Stream crossing

Collins Creek is to be crossed with an access road as shown in Appendix A and Figure 9 below. This will include installation of a culvert or equivalent design.

The works will be undertaken in a dry environment. This will be achieved by undertaking culvert installation offline prior to diversion of flows or pumping flows around the area of works will occur. No formal channel diversions are expected to be required as part of the culvert establishment.

Prior to works commencing, the specific methodology will need to be determined and will be detailed within the SSESCP for the location in question. This information will include specific culvert sizing, based on upstream catchment area and characteristics, timing of works and the expected duration of works.

The general approach to achieving a dry environment for the culvert installation is as follows:

- A pump will be installed approximately 5m upstream of the works extent of an upstream temporary bund. This pump will pump upstream flows around the work area to discharge back downstream of the culvert works. Sand bags or similar will be used to impound flows for this pump. The inlet of the pump will be supported above the base of the impoundment area to minimise sediment input. It is important to note that the capacity of the pump will be determined to manage the low flows during works.

- The initial excavation will remove any vegetation or other material from the work area followed by the excavation of unsuitable material. This excavated material will be

disposed of elsewhere on the Project site within the catchment of other erosion and sediment controls.

- Once all unsuitable material has been removed, the crossing area will be backfilled with bedding material to an appropriate depth for culvert installation. The culvert will be installed with associated wingwalls, retaining walls and backfill as necessary. Rock rip-rap erosion control will also be installed at the inlet and outlet of the culvert.

- The associated activity over the crossing will occur (filling etc) with other erosion and sediment controls in place which typically includes the installation of a super silt fence. When the works have been completed any disturbed area will be fully stabilised with either hardfill or mulch.

- The culvert will be installed in accordance with Regulation 70 of the National Environmental Standard for Freshwater Management 2020, including providing unimpeded fish passage.

For all culvert works:

- Prior to any works commencing with the installation, a suitable weather window will be confirmed (3-day fine weather window recommended) and any concerns or further clarification at the time, will be addressed immediately and prior to any works commencing on site.

- Any water within the works area that results from the pipe installation will be pumped to and approved location or sucker truck for removal from the site.

- In the event of high rainfall during the course of crossing installation, or prior to leaving the site for more than a 24 hour period, the Project team will ensure the following:

    - Any loose material that could enter a stream system is to be removed;

    - Any downstream sand bag barriers will be checked and, if required removed for heavy rainfall and stream flow events; and

    - All existing and additional sediment control measures will be inspected and secured and maintained where required should a significant rainfall event be imminent.

The key construction water management process is ensuring that at the end of every day, and in particular prior to rain events, that a fully stabilised work site remains that can effectively continue to operate as required with minimal scour and contaminated discharge.

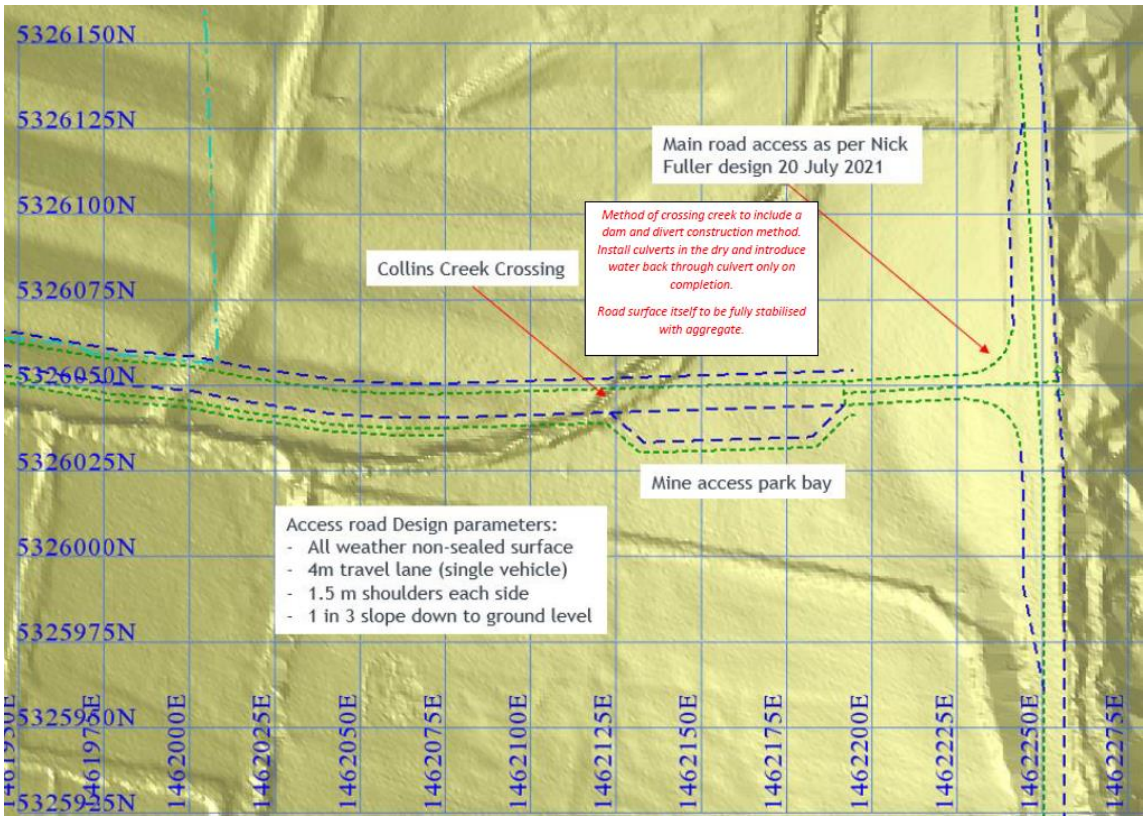


Figure Nine: Collins Creek Crossing

5. Monitoring

An adaptive monitoring programme will be implemented for the Project. This monitoring programme will involve ongoing site monitoring to check that the ESC water management measures have been installed correctly and that methodologies are being followed and are functioning effectively throughout the duration of the works. This will also directly inform the AWP for the Project.

Monitoring results that eventuate, as defined below, will also be used to identify future risks to the environment and will identify any continuous improvement opportunities that should be considered by the construction team.

Water management measures and methodologies may be identified as requiring modification or improvement, including those causing raised levels of sedimentation.

The monitoring programme will include risk assessment to determine what further measures are required to reduce construction discharges. The adaptive monitoring will include a continual feedback loop until it has been verified that the implemented responses have been successful in minimising discharges from the Project construction.

5.1 Qualitative monitoring

5.1.1 On-site visual assessments

Visual assessments of the receiving environment will be undertaken regularly throughout the works period with particular attention paid before, during and after periods of rainfall.

In the context of visual assessment, the receiving environment is defined as the infiltration trench and any discharges to surface water including the downstream coastal lagoon.

This monitoring will include visual observations of all pond outlets, all pump discharge locations, the central drain and the receiving environment. This will occur a minimum of once per day and also after rainfall with a record kept of these 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 water management measures and practices and additional measures will be implemented, and changes made as necessary under the adaptive management process.

In addition, inspections of the devices themselves will include qualitative monitoring of the following:

- The integrity and effectiveness of all construction related water management devices with a focus on the treatment ponds and requirement for maintenance;

- Construction and mining activities onsite;
- 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 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 will be rectified immediately.

5.1.2 Weather forecasting during Project implementation

Weather forecast monitoring will form an important part of the Project implementation to ensure that these higher risk periods are proactively managed appropriately.

We note the extensive use of weather forecasting that now occurs with most land-disturbing activities and the value that it provides in informing projects of upcoming weather systems. Metvuw is assessed as an appropriate tool in this regard and within this tool, utilisation of a red rainfall warning will allow for proactive pre rain inspections to occur. This is a qualitative assessment as above and is to ensure that all measures are fully functional prior to the rain event.

5.2 Quantitative monitoring

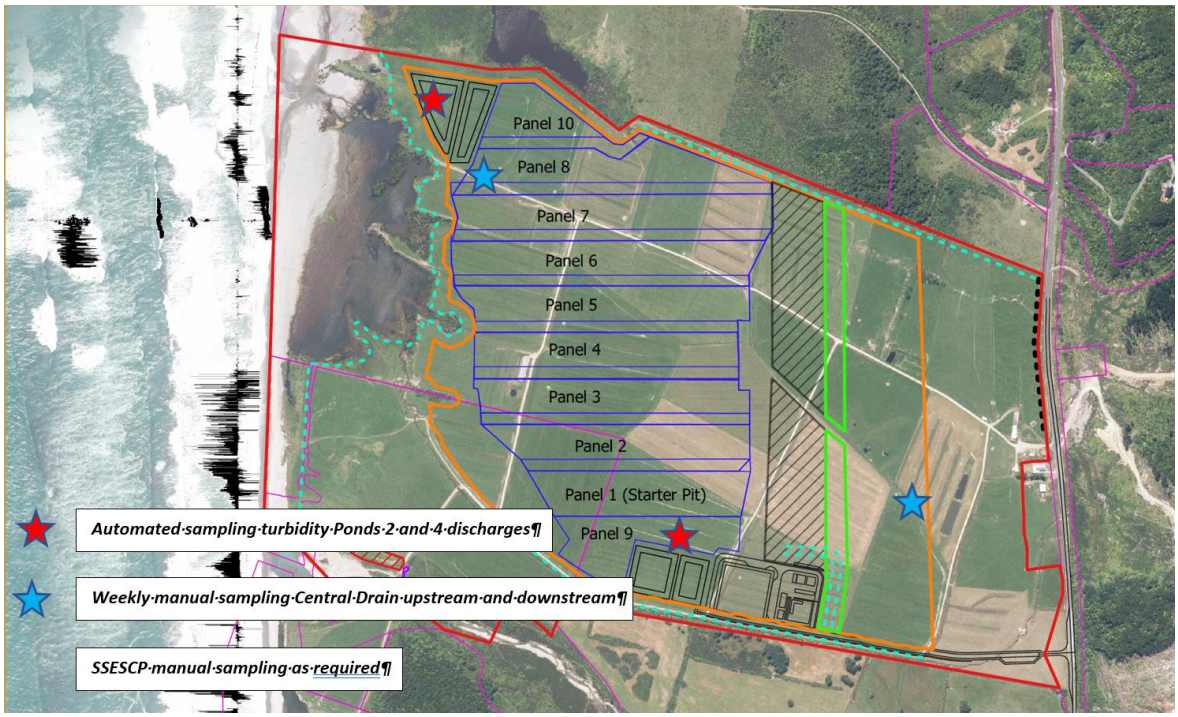
Quantitative sampling for sediment discharge will include:

- Automated continuous sampling for turbidity at the discharge from Pond 2;
- Automated continuous sampling for turbidity at the discharge from Pond 4;
- Manual sampling for turbidity using field meters or grab samples on a weekly basis within the Central Drain upstream of the mining activity;
- Manual sampling for turbidity using field meters on a weekly basis within the Central Drain immediately prior to Pond 3; and

- Other manual grab water quality sampling of turbidity and total suspended solids on a SSESCP basis dependent upon the activity and the discharge location..

While no specific discharge water quality standards are recommended within this ESCP it is assessed that a trigger turbidity level be established and that this act as a trigger to determine further investigation and assessment of the ESC measures. An appropriate trigger is assessed as a percentage increase in turbidity from upstream to downstream of the discharge location.

A plan of proposed sampling locations is included below.



6. Recommendations and conclusions

The following key points are noted for the Project.

- Due to the controlled nature of the mining works and the staged approach and progressive stabilisation of rehabilitated areas, the risk of erosion and consequential sediment discharges is low.
- All other land disturbance activities are short term and will be managed with ESC measures that are compliant with GD05 Guideline.
- The highest risk of sediment discharge is a result of the high groundwater infiltration that may result. This infiltration rate will be variable and will be managed appropriately through the proposed water management systems.
- A range of ESC and water management measures are proposed on the Project that meet the GD05 Guideline criteria or provide an alternative best practice measure. ESCs will be based on both structural and non-structural measures with an emphasis placed on the non-structural management techniques.
- An adaptive monitoring programme will be implemented which will allow for ongoing continuous improvement of the ESC and water management measures and will allow for annual reporting and adaptations all detailed within the AWP.

7. References

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

Auckland Council 2020. Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland region. June 2016 incorporating Amendment 2.

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

Appendix A. Overview Project Site Plan