Engineering Geology Ltd
CONSULTING GEOTECHNICAL, GEOLOGICAL AND EARTHQUAKE ENGINEERS

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Ref: 7261

OCEANA GOLD (NEW ZEALAND) LTD
MACRAES GOLD PROJECT
CORONATION NORTH PROJECT
EROSION AND SEDIMENT CONTROL

Prepared for:

29 April 2016

Oceana Gold (New Zealand) Ltd
P O Box 5442
Dunedin
OTAGO

CONTENTS

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1.0 INTRODUCTION

Oceana Gold (New Zealand) Ltd (OceanaGold) operates a gold mine, known as the Macraes Gold Project (MGP), at Macraes Flat in East Otago. The mine is located between Middlemarch and Palmerston as shown in Figure 1. Gold extraction from the current mining operation involves mining of open pits and underground (Frasers Underground). Associated with the MGP are waste rock stacks (WRS) for disposal of pit overburden material and tailings storage facilities for disposal of tailings.

The MGP was extended in 2015 with the commencement of the Coronation Project, comprising the Coronation Pit, Coronation WRS and haul road to the current MGP mining operation. The Coronation Project is located on the ridgeline to the north of Deepdell Creek and Horse Flat Road, as shown in Figure 2 and 3. The project is located within the upper reaches of Camp Creek (draining to the Shag Catchment to the south) and the Maori Hen Creek and Trimbells Gully Creek (draining to the Taieri Catchment to the north).

OceanaGold propose an extension to the existing Coronation Project, referred to as the Coronation North Project. The extension comprises:

- A western extension of Coronation Pit to increase the potential ore from about 5Mt to 8.5Mt.
- Development of the new Coronation North Pit to the north of the currently consented Coronation WRS. The new pit is estimated to contain about 9Mt of ore.
- Development of the new Coronation North WRS to the east and north east of the current Coronation Project including approximately 270Mt of waste rock and covering an area of about 230Ha. The new WRS is capable of containing all the waste rock excavated from the eastern extension to Coronation Pit and Coronation North Pit.
- The existing haul road to the MGP will be extended northwards across the currently consented Coronation WRS and then between the proposed Coronation North Pit and WRS.

The new Coronation North Project will require erosion and sediment control throughout the life of the project until it is completed and rehabilitated, estimated to be about 5 years. It is proposed that an erosion and sediment control plan (ESCP) be prepared prior to construction commencing.

This report outlines the proposed concepts for managing erosion and sediment control to support the Assessment of Environmental Effects (AEE) for consents for the Coronation North Project. It identifies the practises and procedures to minimise erosion and sedimentation associated with the Coronation North Project, and the treatment of runoff prior to discharge. The Coronation North Project is located on the northern side of the water divide along the ridge and all the runoff will be within the upper tributaries of the Taieri Catchment.

The purpose of this report is to provide information on the proposed erosion and sediment control approach and mitigation so that the Otago Regional Council (ORC) can be confident that any effects from activities will be no greater than minor. The intention is to develop an appropriate ESCP for the elements of the Coronation Project following procurement of resource consents. It is recommended that the Coronation North WRS is subject to detailed design and the preparation of construction drawings and specifications prior to construction. The ESCP can form part of this documentation.

All plans grids, references and geological orientations referred to in this report are to mine north, which is approximately 45 degrees anti-clockwise from true north.

2.0 EROSION AND SEDIMENT CONTROL PLAN

The ESCP will be developed for the individual elements of the Coronation North Project following procurement of the consents. The ESCP will follow the principles embodied in the Environment Canterbury's Erosion and Sediment Control Guideline (Ref.1), but adapted to suit local conditions and experience, in particular anticipated rainfall and soil type.

The ESCP will detail the design of specific erosion and sediment control devices, responsibilities for implementation, construction details and standards, construction timetable, maintenance, monitoring and reporting procedures, response to storm events and contingency measures. There is an ESCP for the current MGP and the ESCP for the Coronation North Project will follow the same good practice which has achieved the required objectives for the mining operations at the MGP.

3.0 SITE DESCRIPTION

The current Coronation Project is located on the ridge line between Sister Peaks and Highlay Hill, north of Horse Flat Road, as shown in Figures 2 and 3. The existing Coronation Pit and WRS straddle the divide between the Shag Catchment to the south and the Taieri Catchment to the north. The proposed Coronation North Project is located further to the north and east of the current Coronation Project. Both the Coronation North Pit and WRS are north of the divide and fall within the Taieri Catchment.

Overland flow from the Coronation North Pit is mainly to the north via Maori Hen Creek and Trimbells Gully which then flow into Mare Burn. The western extremity of Coronation North WRS and Coronation North Pit drain via tributaries of Coal Creek to the north west then to Mare Burn. The Mare Burn ultimately joins the Taieri River which flows south past Middlemarch.

4.0 SITE SOILS AND EROSION POTENTIAL

From the geological map (IGNS, Geological Map 19, Waitaki), experience at the current Coronation Project , and site mapping the soils on the site are anticipated to consist of a sequence of:

- topsoil;
- loess (silt) that varies in depth and is anticipated to be generally less than 1m thick. These soils are fine and erodible;
- colluvium (gravel sized rock with some sand/silt) located near the base of slopes
- The underlying bedrock at the location of the proposed Coronation North WRS comprises Haast Schist of the Rakaia terrane, formed during Early and Middle Jurassic regional metamorphism. The Haast Schist in this area has abundant Quartz veining which generally runs either parallel to local lineation's within the schist rocks or along the strike of the schistosity. The well foliated schist generally dips towards the east at an average angle of about 14°. Outcrops of volcanic origin, associated with the tertiary Dunedin volcanic field, are evident to the southwest and east of this location. From observations of rock outcrops and our relevant experience in the area, the underlying bedrock is anticipated to be at shallow depth (typically less than 1m)

Waste rock will be predominantly overburden material from the pit and disposed in the Coronation North WRS. It comprises rockfill varying from gravel to boulders (typically 10mm to 0.5m).

The surficial soils that blanket the site are erodible (i.e. loess). The waste rock is coarse in nature and is low risk with respect to erosion and sediment loads. Stripping of the surficial soils is the main risk and so management of this activity and the use of appropriate erosion and sediment controls are necessary.

5.0 EXISTING EROSION AND SEDIMENT CONTROL

OceanaGold has been operating the MGP for over 20 years. Management of erosion and sediment control has been an important part of the operation and has followed the principles embodied in the guidelines prepared by the Auckland Regional Council (Ref.2), and more recently the Environment Canterbury Guidelines (Ref.1), modified where appropriate based on operating experience. Runoff from pits and associated haul roads generally collects in the base of the pits and is pumped to the Process Plant where it is used in the processing of ore, or used for dust control. Runoff and seepage water from the WRSs reports to silt ponds. Water is decanted and discharged downstream to existing watercourses, pumped back to the Process Plant or used for dust control. Runoff from tailings storage facilities (TSF) during construction has either been directed to silt ponds or pits. The MGP has a water deficit and water has to be pumped from the Taieri River to make up the water for the operation of the Process Plant. This is advantageous for sediment control in that excess water does not have to be released from site. Photographs of some existing silt ponds (Clydesdale, Deepdell North, Deepdell South, Frasers West and Murphy's Creek) are shown in Plates 1-5 respectively.

Erosion and sediment control for the existing Coronation WRS has been managed by earth bunds, to contain and minimise concentrated runoff in disturbed areas, and small

downstream silt ponds. All rainfall falling within Coronation Pit is contained within the pit and used for dust suppression, or discharged to Trimbells Gully when conditions allow. The existing Coronation Haul Road down to Horse Flat Road includes regular silt traps down the side of the road to collect the stormwater runoff and silt. The proposed general control of stormwater runoff from disturbed areas within the Coronation Project was set out in EGL's report Erosion and Sediment Control report (Ref.4). To date we are not aware of any significant discharge of silt to the downstream environment and the current measures appear to be operating satisfactorily.

The existing erosion and sediment control practice at the MGP includes:

- silt ponds to allow time for settlement of suspended solids associated with runoff from disturbed areas;
- diversion drains to divert runoff from disturbed areas to silt ponds;
- cleanwater diversion drains to divert runoff from undisturbed areas away from disturbed areas;
- progressive stripping of WRS footprints only as required;
- steep gullies are not stripped beneath WRSs, except in the base of gullies at the toe of the WRSs, so as to leave a buffer that acts to intercept sediment from areas stripped above;
- stripping of topsoil and loess soils is only undertaken in dry weather conditions, generally over summer months;
- management of surface water on the surface of the WRSs including preventing runoff from discharging over the outside shoulder, excavation of soak pits to allow surface runoff to soak into the waste rock (which acts to filter out fines) and end-tipping to create coarser rock in gullies which act as underdrains;
- progressive rehabilitation of WRS and TSF embankments consisting typically of 0.3m of oxidised waste rock and 0.2m of topsoil and grassing to minimise bare areas;
- benches provided on shoulders of WRSs and TSF embankments at 20m vertical intervals to control runoff on slopes steeper than about 1V:3H;
- adoption of appropriate sediment control practise (e.g. silt fences, decanting bunds) in accordance with the Auckland Regional Council (ARC) Technical Publication No 2 ‘Erosion and Sediment Control Guidelines for Earthworks’ (Ref. 2), and more recently the Environment Canterbury ‘Erosion and Sediment Control Guidelines for the Canterbury Region’ (Ref.1);
- monitoring of discharges as required by consent conditions;
- regular inspections of silt ponds and diversion drains to check condition and undertake maintenance if required.

Silt ponds have been constructed at the MGP in advance of placement of waste rock in WRSs or construction of TSFs. In all cases the silt ponds have been created by construction of dams across gullies or streams immediately downstream of the disturbed areas. Typically the dams have been zoned embankments consisting of a central core of low permeability fill with rockfill shoulders. The low permeability fill has either been sourced locally from loess and colluvium or from overburden material from the pits. The rockfill has largely been sourced from pit overburden material. The design criteria for the silt ponds have changed with time. The initial silt pond in Maori Tommy Gully, downstream of the Mixed Tailings Impoundment TSF, was designed to store the runoff from a 2 year - 7 day storm event from a 150ha catchment, allowing for pump back to the Process Plant at 162m^3/hr. Other smaller silt ponds associated with the initial project development were designed to store the runoff from either a 10 year -1 hour or 2 year - 1 hour storm. Runoff was calculated with runoff coefficients that varied between 0.6 and 0.7

depending on whether the catchments were undisturbed or disturbed. The spillway for the Maori Tommy Silt Pond was designed to pass the 100 year flood event while the smaller ponds that had limited life were designed to pass the 10 year flood event.

Silt ponds designed later in the life of the project for WRSs were designed according to the criteria summarised in Table 1.

Table 1. Silt Pond Design Criteria

No.	Criteria
1.	Storage sufficient to contain at least the initial 24 hour rainfall from a 2 year -72hour rainfall event (70mm rainfall)
2.	Service and emergency spillways capable of passing flows from 10year and 100year return period rainfall events respectively
3.	Ponds provided with either pump-back facilities or a constricted flow outlet to decant impounded water. Pump or decant designed to recover the minimum live storage in no more than 5 days
4.	Dam, spillway and associated structures designed, constructed, operated and maintained for the life of the dam in accordance with the general principles of New Zealand Society of Large Dams (NZSOLD) Dam Safety Guidelines (Ref.3)

Storage volumes have typically been calculated using runoff coefficients (C) of between 0.32 and 0.70. Higher runoff coefficients have been adopted for small catchments. Experience is that a large proportion of rainfall either infiltrates or evaporates and that this is more significant for larger WRS and justifies lower runoff coefficients. The existing Murphys Creek silt pond was designed with a runoff coefficient of C=0.32 and operating experience indicates that this has been more than sufficient. The same runoff coefficient is proposed for the final catchments for the Coronation North WRS.

The decant facility adopted for most silt ponds has been a perforated manhole structure as shown in Plate 6. This simple design has proven to work effectively at the MGP rather than floating decants which were tried in the early stage of the project but were found to require considerably greater ongoing maintenance and were prone to damage. The manhole also acts as the service spillway. The perforated holes have typically been set at a level which provides generous dead storage and water is sometimes drawn-down further by pumping for dust control. More recently a floating decant has been used again for the silt pond for the construction of the new Top Tipperary TSF embankment, and appeared to operate successfully during the short life of the silt pond.

Experience to date is that stormwater runoff from the WRS is typically low in suspended solids. This is apparent in the small volumes of silt that have been collected in the existing silt ponds, the clarity of discharge and measurements of the suspended solids content of the discharge by OceanaGold. It is due to a combination of the low rainfall, the limited exposure of fine soils and the permeable nature of the waste rock in the WRS and in the downstream shoulders of the TSF embankments. This last factor is of particular importance as the permeable nature of the waste rock results in a high proportion of rainfall infiltrating the WRSs and TSF embankments. The runoff from the waste rock does not have a particularly high sediment load, but as it drains through the waste rock most sediment is trapped and filtered out. The waste rock is typically end dumped in high lifts.

This results in segregation with coarse rock at the base of each lift as shown in Plates 7 and 8 which acts as an underdrain beneath the WRS. High volumes of water can percolate through such material. The surface of the WRS is sloped away from the outside shoulder so that runoff flows back to the contact with natural ground as shown in the schematic in Figure 4. Infiltration of runoff into the WRSs is actively encouraged by the digging of sumps, as necessary, if water begins to pond on the active fill surface.

The critical time for generation of sediment is at the initial stage of construction of the WRS. Typically the foundations will be stripped, except where the ground is too steep to be practical, and this can expose loess. Until waste rock is placed above, these soils can be moderately erodible. For the existing Coronation WRS, runoff was minimised by creating a series of earth windrows during stripping to increase the detention time within the disturbed areas and reduce the runoff velocity and concentration of stormwater. Steep gullies are not stripped beneath WRSs, except in the base at the downstream toe, and the remaining vegetation acts to assist in intercepting and retaining sediment from higher ground. It is, however, necessary to construct initial silt ponds in gullies downstream of the disturbed areas. Once waste rock is placed then the potential for generation of sediment is significantly reduced.

OceanaGold has been operating the MGP for over 20 years. The existing erosion and sediment control practices have worked well throughout the life of the mine to date and no known issues have been identified.

6.0 CORONATION NORTH PROJECT EARTHWORKS

The areas of disturbed land associated with the Coronation North Project that will require erosion and sediment control are summarised in Table 2.

Table 2. Summary of Areas Requiring Erosion and Sediment Control

Area	Disturbed Area (ha)
Extension to Coronation Pit	25
Coronation North WRS	230
Coronation North Pit	65

The disturbed areas given in Table 2 are the anticipated maximum working areas for the individual facilities and does not include the new haul road and other potential land disturbance to develop the individual facilities. It is estimated that the total additional disturbed area north of the existing Coronation Project will be about 320ha. This does not include the extension to the existing Coronation Pit as all the stormwater runoff from the additional disturbed area will report directly to the existing pit such that no significant erosion and control measures will be required.

It is noted that runoff from Coronation North Pit will only require erosion and sediment control during the very early stages of development. Once the pit reaches sufficient depth all the runoff will be contained within the pit and the water will either be used for dust suppression or pumped to a silt pond, the same as for the existing pit at the Coronation Project. Furthermore, the area of the Coronation North WRS will be progressively stripped, backfilled and rehabilitated such that the area susceptible to erosion is kept to a minimum.

7.0 PROPOSED EROSION AND SEDIMENT CONTROL PRACTICE

7.1. General

Prior to commencement of construction an ESCP will be prepared. The Plan will be consistent with the ESCP for the existing MGP and will incorporate modern erosion and sediment control practices that are documented in the Environment Canterbury Guidelines (Ref.1), except that site specific design criteria will be adopted for sizing silt ponds for the Coronation North WRS and Pit that are based on experience at the site.

In general terms the design of erosion and sediment control measures for the Coronation WRS and Pit will follow existing MGP practice which is summarised in Section 5.0. Specific erosion and sediment control measures will include:

- Cleanwater diversion drains with small dams located in gullies where necessary to divert runoff into the diversion drains. The storage capacity of these dams is anticipated to be less than 20,000m^3. Temporary cleanwater diversion drains will be designed for a 1 in 20 AEP storm with 0.25m freeboard. Any permanent cleanwater diversion drains will be designed for a 1 in 100 AEP storm with 0.25m freeboard. Where necessary (e.g. steeper ground, erosive soils) the drains will be lined (e.g. rockfill, geotextile) and energy dissipation will also be provided at high energy locations (i.e. at the bottom of steep sections of drain where velocities are high).
- Permanent Silt ponds downstream of disturbed areas will be designed according to existing criteria that are summarised in Table 1. The sizing depends on the catchment area and runoff coefficient. The silt pond will also be designed to store the runoff from an initial disturbed catchment of 20ha with a higher runoff coefficient 'C' of 0.6. This assumes that clean water diversion drains will reduce the overall catchment if it is greater than 20ha. Decants similar to those currently on site will be adopted. If a perforated manhole is used for the decant then it will be designed to allow for the future attachment of a floating decant, if required. Service and emergency spillways will be provided and designed to pass the flows from 10year and 100year return period rainfall events.
- Shoulders of the Coronation WRS will either be benched about every 20m vertical height to control runoff or flatter batter slopes adopted (about 1V:3H) to minimise erosion of the rehabilitation layer.
- Perimeter surface water drains located around the perimeter of Coronation North WRS and Pit where appropriate, to ensure runoff is conveyed to the base of gullies without erosion. Temporary drains will be designed for a 1 in 20 AEP storm with 0.25m freeboard. Permanent drains will be designed for a 1 in 100 AEP storm with 0.25m freeboard. Such drains will be lined where necessary and energy dissipation will be provided at high energy locations (i.e. at the bottom of steeper sections of the drains where velocities are high).

Comments on the proposed erosion and sediment controls for the Coronation North WRS and Pit are discussed in more detail in the following sections.

7.2. Coronation North Waste Rock Stack

Erosion and sediment control concepts for the Coronation WRS are shown in Figure 5. They have previously been described in Section 5.0, based on current practice at the MGP. The critical stages are the initial stripping and placing waste rock within the individual catchments. The silt ponds downstream of these areas will be designed for a high runoff coefficient from the initial disturbed footprint (C=0.6). They will also be designed for the ultimate disturbed catchment using a lower coefficient (C=0.32) to reflect the reduced runoff due to infiltration into the WRS and discharge via the coarser rock at the base of the WRS.

The proposed erosion and sediment control concepts for the Coronation WRS are shown in Figure 5 and discussed below.

Stripping of the site and placement of waste rock will be carried out progressively starting within the lower northern area that falls within the Maori Hen Creek catchment. Stormwater runoff will be contained within the disturbed area by earth bunds, as per the existing Coronation WRS, or report to a silt pond constructed just downstream of the WRS in Maori Hen Creek. Stormwater runoff will also be diverted west to the Coronation North Pit. Some minor temporary erosion and silt control measures, including a silt pond, may be required for the creeks draining north west to Coal Creek. Clean water diversion drains will divert clean water away from disturbed areas.

As the WRS is built up it will extend progressively southwards and then reach Trimbles Gully catchment. The stormwater runoff from the disturbed areas within this catchment will be treated in the same way as above. However, the waste rock will initially be placed lower down within the catchment with a large undisturbed upstream area. It is therefore proposed to construct a temporary culvert to collect the clean stormwater runoff upstream of the WRS and convey in along the creek, beneath the WRS, to discharge downstream of the silt pond. This will reduce the volume of water that needs to be treated by the Trimbells Gully silt pond. An earth embankment will be constructed across the creek with intake manhole to collect the clean upstream runoff then discharge it via a pipe culvert along the creek. The embankment and clean water intake will need to be moved further up the creek, and the culvert extended, as the WRS is developed further south. The approximate alignment of the culvert is shown in Figure 5.

By a combination of keeping the upstream clean stormwater runoff away from the disturbed areas, containing and controlling stormwater within the disturbed areas by earth bunds, diverting runoff to Coronation North Pit and progressively rehabilitating the completed areas of WRS it is proposed to minimise the stormwater runoff that needs to be contained and treated in the silt ponds. It is anticipated that with careful management the maximum initial catchment area for the silt ponds can be limited to no greater than 20ha and the maximum final non rehabilitated WRS catchment area for any pond to less than about 70ha. Consequently the storage capacity of silt ponds could be less than 20,000m^3. At times additional silt ponds may be constructed on the surface of the WRS if required (e.g. if the coarser rock at the bottom of the WRS has insufficient capacity). The need for and locations of such ponds would be determined during construction.

7.3. Coronation North Pit

During the initial clearing and excavation for the Coronation North Pit it is anticipated that some short term sediment control measures will be required together with clean water diversion drains. A temporary silt pond may also be required within the tributary to Coal Creek as shown in Figure 5. As the pit excavation progresses i.e gets deeper, a stage will be reached where all the stormwater runoff from the disturbed area will report directly to the pit. Water collected in Coronation North Pit will then either be used for dust suppression or pumped to the silt ponds constructed for the Coronation North WRS

7.4. Extension to Coronation Pit

No significant additional erosion and sediment control measures are anticipated and stormwater runoff will be directed to the existing pit.

7.5. Coronation North Haul Road

The Coronation North Project will include a short northern extension to the existing haul road down to Horse Flat Road. The extension will effectively be contained within the Coronation WRS and then between the Coronation North Pit and WRS as shown in Figure 5. Sediment control on the haul road can be accommodated by silt traps on the side of the road, similar to the existing haul road, and excess runoff diverted down into the pit for treatment and management with the pit water. Some small intermediate detention sumps may possibly be required depending on the final design.

8.0 SUMMARY AND CONCLUSIONS

OceanaGold propose to extend the existing Coronation Project operations at the Macraes Gold Project. The proposed Coronation North Project includes an extension to the existing Coronation Pit as well as a new Coronation North Pit and WRS to the north and east of the existing operation.

An erosion and sediment control plan will be developed prior to construction to manage and control erosion and sediment associated with construction and operation of the Coronation North WRS, Pit and haul road. Silt ponds, clean water diversion drains and culverts will be constructed for the WRS. Runoff from the pit, once sufficiently deep, will be captured in the base of the pit and either used for dust suppression or pumped to the Coronation North WRS silt ponds. No specific sediment control is required for the pit. Silt traps will be constructed along the length of the haul road, possibly with some small intermediate detention sumps as required.

OceanaGold has been operating the Macraes Gold Project for over 20 years. Existing erosion and sediment control practices have worked well and so similar practices are proposed for the Coronation North Project.

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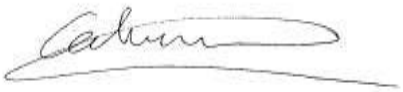
Report Prepared By



C Wu (Geotechnical Engineer)

Report Reviewed By

J A Yeats (CPEng)

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FIGURES

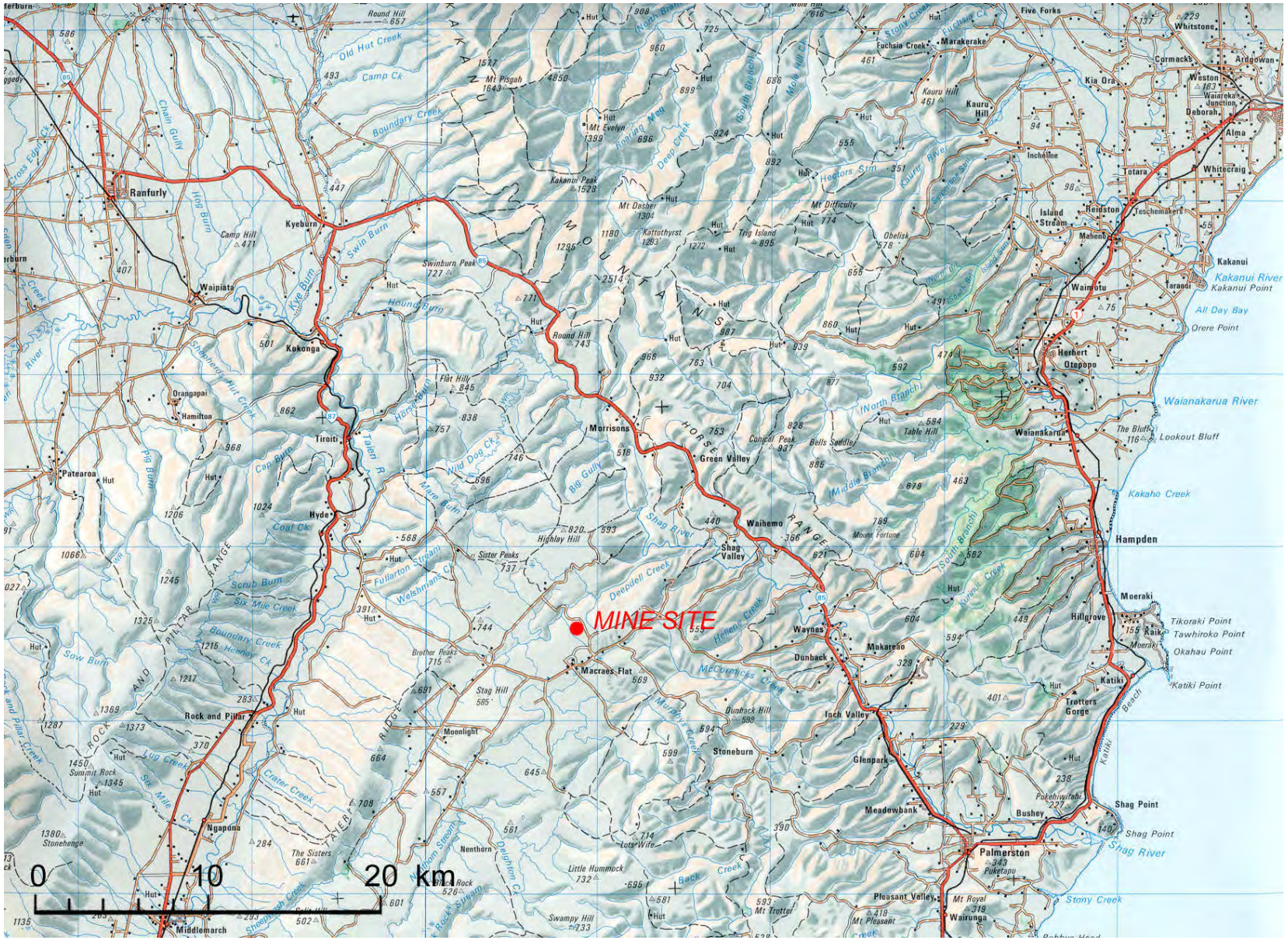

Figure 1

Source: NZMS Sheet 15 Waitaki.

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OCEANA GOLD (NEW ZEALAND) LTD
Macraes Gold Project
Locality Plan

Ref. No.: 1410
Date: 26 June 2002
Drawn: SP
File: local.grf

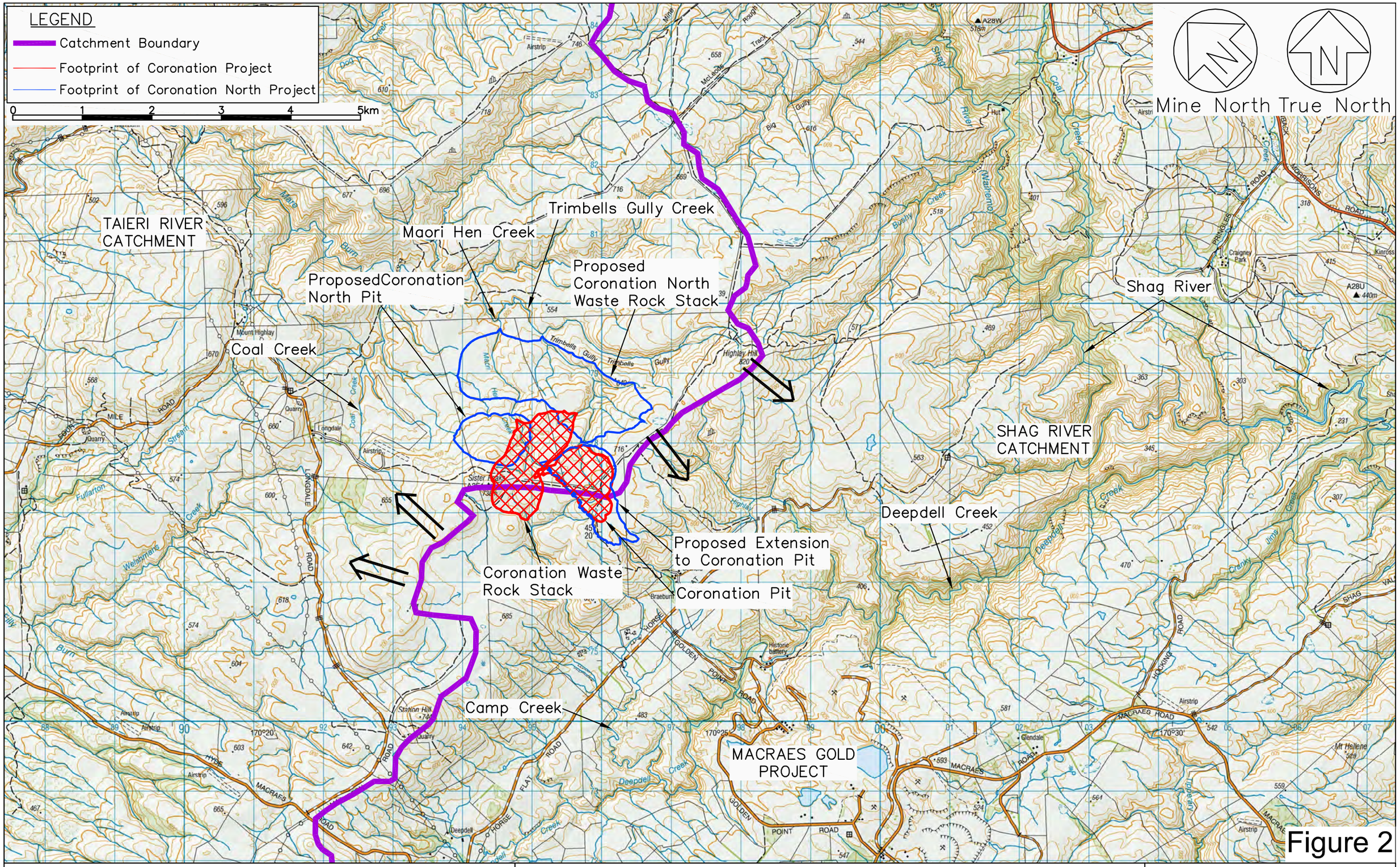

Figure 2

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OCEANA GOLD (New Zealand) LTD, MACRAES GOLD PROJECT
Coronation North Project
Major Creeks and Catchments

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Date:	4 March 2016
Drawn:	DLM/BL/JS
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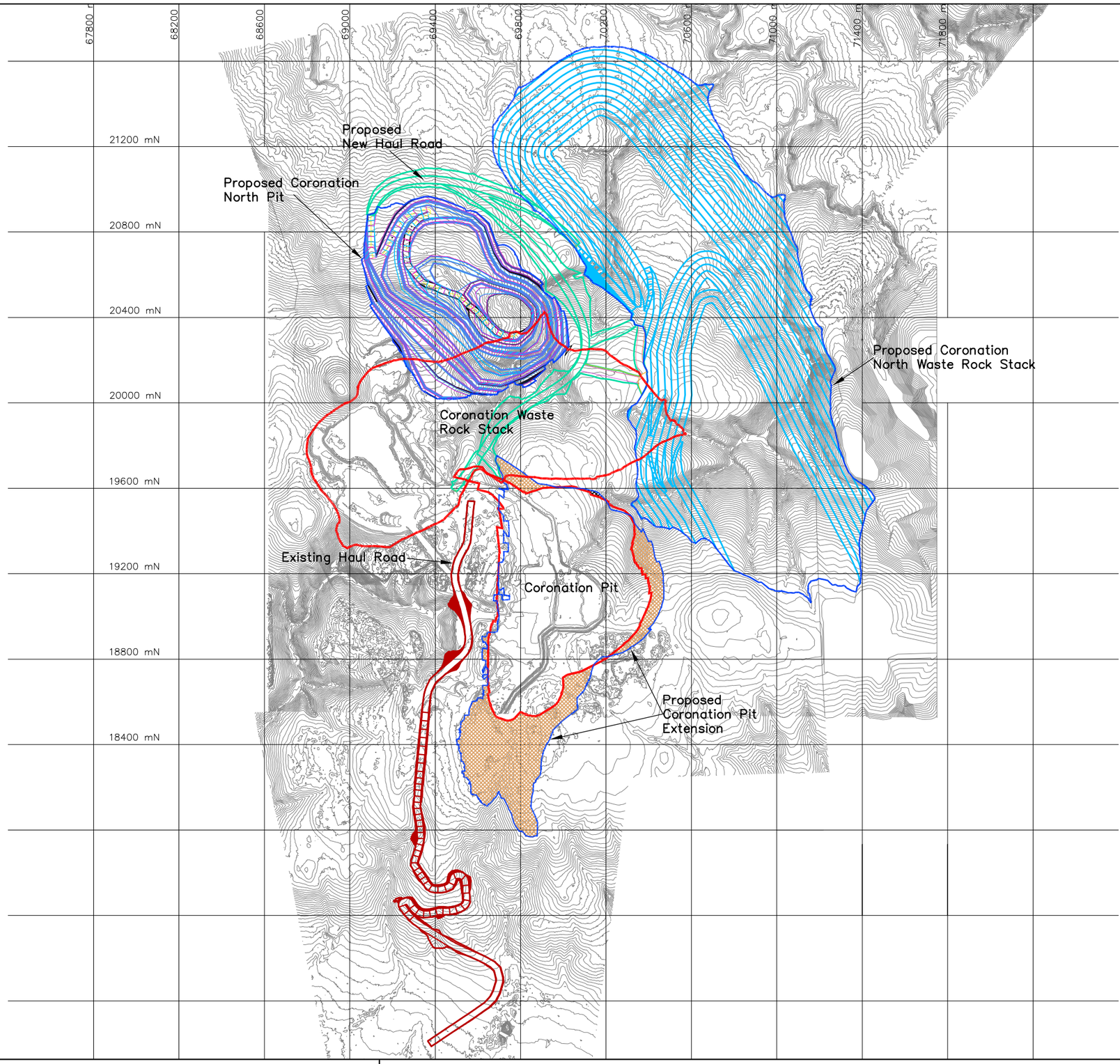

Mine North True North

Figure 3

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OCEANA GOLD (NEW ZEALAND) LTD, MACRAES GOLD PROJECT
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Coronation North Waste Rock Stack and Pit

Drawing No.	7261-Fig 3
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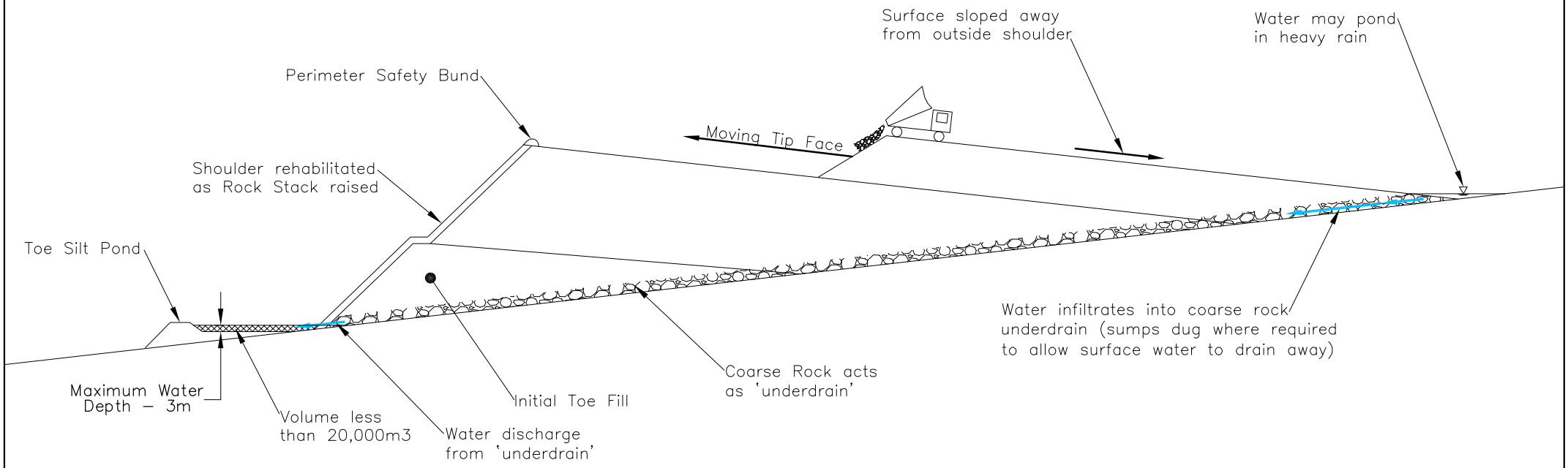

Rock Stack – Schematic of Erosion and Sediment Control Features

Figure 4

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OCEANA GOLD (NEW ZEALAND) LTD, MACRAES GOLD PROJECT
Coronation North Project
Waste Rock Stack Schematic of Erosion and Sediment Control Features

Drawing No.	7261–Figure 4
Date:	4 March 2016
Drawn:	BL/JS
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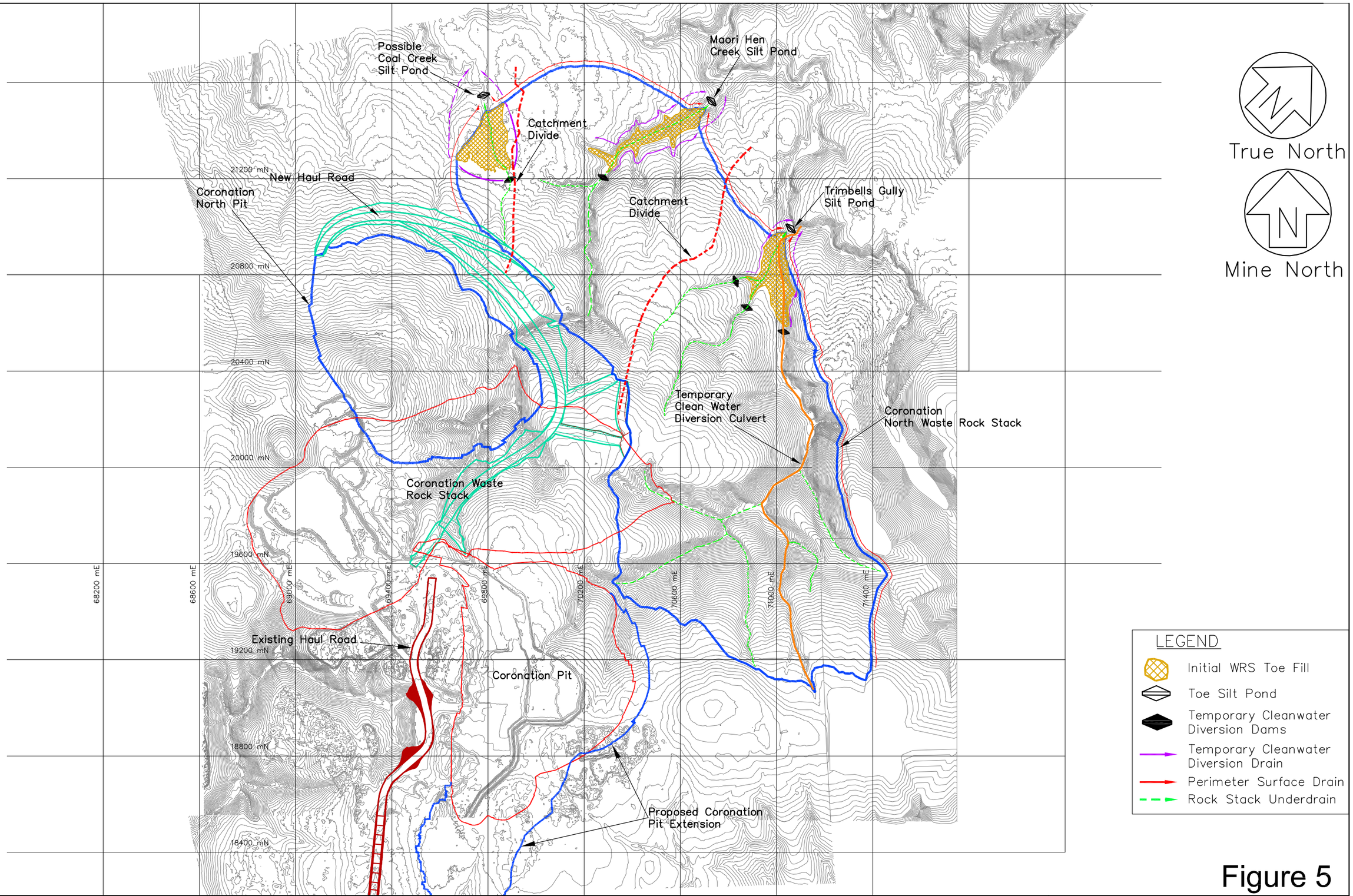

Figure 5

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OCEANA GOLD (NEW ZEALAND) LTD, MACRAES GOLD PROJECT
Coronation North Project
Coronation North Waste Rock Stack and Pit
Erosion and Sediment Control Features

Drawing No.	7261-Fig 5
Date:	4 March 2016
Drawn:	DLM/BL/JS
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Filename:	7261-Fig5.dwg

PLATES

Plate 1. Clydesdale Silt Pond

Plate 2. Deepdell North Silt Pond

Plate 3. Deepdell South Silt Pond

Plate 4. Frasers West Silt Pond

Plate 5. Murphys Creek Silt Pond

Plate 6. Typical Silt Pond Decant Structure

Plate 7. Rock Stack Tip Face (initial lift)

Plate 8. Rock Stack showing segregation of waste with coarse rock at base of lift