TECHNICAL MEMORANDUM

DATE	March 25, 2013	**PROJECT No.**	11-1118-0074 (9000)
TO	Christian Laroche Osisko Hammond Reef Gold Ltd.	**DOC. No.**	2013-004
CC	Darrin Johnson (Golder); Steve Parker (Golder)		
FROM	Robert Douglas and Mark Guthrie	**EMAIL**	Robert_Douglas@golder.com

OSISKO HAMMOND REEF GOLD PROJECT – SITE ACCESS ROAD AND TAILINGS PIPELINE ALIGNMENT

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) was retained by Osisko Hammond Reef Gold Ltd. (OHRG) to develop the conceptual horizontal and vertical alignment for the site access road and the tailings pipeline between the proposed mine site and Tailings Management Facility (TMF). The TMF is approximately 8 km northeast of the process plant. The conceptual design will be incorporated into the Project Description section of the Environmental Impact Statement/Environmental Assessment Report (EIS/EA Report) and provide support for OHRG's Feasibility Study.

The site access road (known as Reef Road) intersects the main access road (known as Sawbill Bay Road) near the accommodation camp location at the north end of Sawbill Bay and runs down to the proposed mine site and process plant. It will carry a variety of traffic types including mining and construction equipment, truck traffic associated with deliveries/shipments to and from the mine site, and passenger vehicles transporting employees to and from the mine site. The length of the site access road is approximately 8.4 metres (m) from the intersection with Sawbill Bay Road to the process plant.

The tailings disposal pipeline will follow the site access road alignment and will deliver thickened tailings from the processing plant to the TMF. In addition, a reclaim water pipeline will parallel the tailings disposal pipeline and carry reclaimed water from the TMF back to the processing plant for reuse.

The proposed site access road and tailings pipeline alignments are shown on Figure 1. Plan and profile drawings are included in Appendix A.

This Technical Memorandum describes the conceptual design of the horizontal and vertical alignments for the site access road and the tailings disposal/reclaim water pipelines.

2.0 SCOPE OF WORK

The following is a summary of activities that were completed by Golder to develop the site access road and tailings disposal/reclaim pipeline horizontal and vertical alignments:

- Background data collection and review including traffic characteristics, preliminary pipe size estimates, process flows, topography, subsurface conditions, and natural environmental features;
- Site reconnaissance visits during the weeks of July 16 and August 07, 2012;
- Development of design requirements including design vehicle and speed, preliminary cross sections and geometric constraints;
- Review of pipeline hydraulic analysis and design recommendations completed by others for the purpose of identifying pipeline alignment constraints and limitations;
- Development of preliminary horizontal and vertical alignment to minimize earthworks and pipeline lengths; and
- Development of preliminary estimates of earthworks quantities.

2.1 Battery Limits

The battery limits for the conceptual design of the site access road alignment are from the intersection with the main access road adjacent to the exploration/construction camp location to the mine site security station and parking lot at the mine site. It is recognized that the site access road will extend beyond the mine site security station and connect with the on-site road network.

The southerly limit for the design of the conceptual tailings and reclaim water pipeline alignments is near the mine site security station and parking lot at the mine site. The northerly limit for the tailings pipeline is the top of the ultimate tailings cone within the tailings deposition area of the TMF, and the northerly limit for the reclaim water pipeline will be westerly limit of the reclamation pond at the southeast side of the TMF.

3.0 BACKGROUND INFORMATION

Background information was derived from the following sources:

- Base mapping information - Natural Resources and Values Information System (NRVIS) published by Ontario Ministry of Natural Resources (MNR).
- Mine site General Arrangement information – OHRG February 2013.
- TMF configuration – Tailings Management Facility Feasibility Study Design Report (Golder 2013).
- Hydraulic Analysis – Osisko Hammond Reef Gold Ltd., Hammond Reef Gold Project - Tailings Lab Testing and Hydraulic Analysis Study – Rev. E, November 2012 (Ausenco).

4.0 DESIGN REQUIREMENTS

4.1 Road

4.1.1 Design speed

The site access road will accommodate a variety of traffic ranging from passenger vehicles and light trucks, to tractor trailers and heavy equipment. The design speed has been selected as 70 kilometres per hour (km/h) in anticipation of a posted/travelling speed of 60 km/h. Where localized topographic characteristics warrant, the design speed may be reduced to no less than 40 km/h and posted accordingly.

Based on the selected design speeds the following geometric design parameters shown in Table 1 were used to develop the horizontal and vertical alignments for the access road.

Table 1: Geometric Design Parameters

Parameter	70 km/h (Design speed)	60 km/h	40 km/h
Minimum horizontal curve radius (m) †	190	130	55
Maximum grade (%)	10	10	10
Stopping sight distance (m) ‡	110	85	45
Vertical curve k value (m/%) ‡	30 (crest); 25 (sag)	18 (crest); 18 (sag)	5 (crest); 7 (sag)
Maximum superelevation (%)	6	6	6

† Transportation Association of Canada (TAC) Geometric Design Guide for Canadian Roads (2009).
‡ Transportation Association of Canada (TAC) Manual of Geometric Design Standards for Canadian Roads (1986).

4.1.2 Cross section

Between the intersection with Sawbill Road and the TMF, the preliminary design criteria for the cross section of the road consists of a 10 m platform on tangent sections (two 3.5 m driving lanes, 1.5 m shoulders including rounding) and 12 m in curves with a radius of less than 190 m (additional 1.0 m lane widening each side). As the road will be constructed with a granular surface, a 4% crossfall will be used to promote surface drainage.

Between the TMF and the mine site, the preliminary design criteria for the cross section of the road consists of a 20 m platform on tangent sections (two 8.5 m driving lanes, 1.5 m shoulders including rounding) and 22 m in curves with a radius of less than 190 m (additional 1.0 m lane widening each side). The road structure is subject to detailed design investigations, and assumed to be 1.0 m of granular material placed on a prepared subgrade. It is assumed that the road structure will be constructed using crushed rock from the road excavation or from other borrow areas.

A typical 10 m and 20 m platform cross section has been defined. For the purpose of conceptual design, the pipeline is assumed to be fixed at a constant horizontal and vertical distance from the road centerline alignment. During detailed design, and based on detailed field survey and subsurface investigations, it may be appropriate to adjust the pipeline profile to eliminate minor high or low points and to cross under the road to accommodate drainage concerns.

4.1.3 Horizontal and Vertical Alignment

The horizontal and vertical alignments were developed based on the geometric design parameters provided in Table 1 and the cross section criteria described above, and a desire to minimize/balance the earthwork cuts and fills required.

4.2 Pipelines

4.2.1 Pipeline Hydraulics

The tailings disposal pipeline hydraulic assessment was completed by Ausenco under contract with Osisko. The assessment included several scenarios using high-density polyethylene (HDPE) and carbon steel (CS) pipe materials in single and twin pipe configurations, temperatures extremes of 5C and 35C and tailings concentrations by weight (C_w) between 66% and 68%.

In each case a primary pumping station will be located at the process plant, and a secondary pumping station will be located at the south boundary of the TMF to pump the tailings onto the deposition area. The carbon steel alternative will permit higher initial pumping pressures than the HDPE alternative thereby reducing the need for intermediate pumping stations. Also, the twin pipeline configuration will increase operating security as well as enabling the opportunity to operate a single pipeline during low flow conditions with a reduced risk of particle deposition. In all cases the pipe material used for the segment between the secondary pumping station and the TMF will be HDPE, so the carbon steel pipeline alternative is described as a “hybrid” scenario in the Ausenco report.

The nominal tailings throughput is 2717 tonnes per hour (t/h) and the design throughput is 3125 t/h. At a C_w of 68% this corresponds to a nominal flow rate of 2270 m^3/h and a design flow rate of 2611 m^3/h. The hydraulic analyses resulted in the development of the potential tailings pipeline configurations shown in Table 2.

Table 2: Potential Pipeline Configurations

Configuration	Pipe Material	
	Hybrid	HDPE
Single Pipeline	24 in (CS) 32 in (HDPE	32 in
Twin Pipeline (each pipe)	18 in (CS) 24 in (HDPE)	24 in
Intermediate Pumping Station	Not required	1 required

4.2.2 Size, materials, supports

Based on the security and operational advantages of a twin pipeline system, and the desire to avoid an intermediate pumping station, Osisko has selected the twin carbon steel pipeline option as the preferred design alternative. The tailings disposal and reclaim water pipelines will be laid parallel to each other in a common containment trench.

4.2.3 Secondary Pumping Stations

Due to the length and vertical profile of the pipeline alignments, a secondary pumping station will be required at the location where the tailings pipeline enters the TMF to boost pipeline pressures and maintain desired flow rates. Flow splitting will be incorporated into the pumping station design to allow the total flow to be distributed to various discharge locations around the TMF.

4.2.4 Thermal Protection

It is understood that OHRG does not intend to thermally protect the tailings disposal nor the reclaim water pipelines through the use of heat tracing and insulation. Where the alignment is particularly straight, pipelines should be laid in a serpentine fashion to allow movement due to thermal expansion and contraction without placing undue stress on the pipelines. Areas were serpentine layout can by implemented will be identified during the detailed design phase.

4.2.5 Emergency containment areas

Emergency spill containment is required along the length of the pipeline alignment to contain thickened tailings and/or reclaim water in the event of a pipe leak or rupture. The pipelines will be contained within cut slopes in cut areas and earth berms will be placed in fill areas. Containment areas will be constructed at low points in the vertical alignment sized to contain the volume that could be pumped in the time between the leak or rupture occurring and the pumps being shut down, plus the pipe volume between adjacent high points.

We understand that the tailings disposal and reclaim water systems will be operated with an instrumentation and control system that will monitor pipeline pressures, flows, and pump on/off status on a continuous basis. The instrumentation and control system will include alarms and automatic pump shut off capabilities in the event of a significant pressure loss or flow mismatch that could mean that a leak or rupture has occurred.

Based on information provided by Osisko, the anticipated response and pump shutdown time to be used for design of the emergency spill containment areas is two (2) hours.

To provide containment, the containment channels will be connected to containment ponds located at key low points on the profile. Each containment pond will be sized to hold two hours of pumping volume at 2611 m3/hour or 5222 m3, plus the volume in the pipe between adjacent high points that could drain to the adjacent low point. An allowance of 30% of the required pond volume for containment has been added to allow for rainfall/precipitation entrapment. Estimated emergency containment pond areas are shown in Table 3.

Table 3: Summary of Emergency Containment Areas

Containment Area #	Station	High Point Down chainage	High Point Up chainage	Pipeline Volume plus 5222 m^3	Pond Volume factored by 1.3 (m^3)	Pond Area If 1.5m deep (m^2)
1	2+580	2+420	2+700	5257	6834	4556
2	2+800	2+700	2+900	5247	6821	4548
3	3+100	2+900	3+380	5282	6867	4578
4	3+750	3+380	4+000	5300	6890	4593
5	4+300	4+000	4+700	5310	6903	4602
6	5+400	4+700	5+900	5373	6985	4656
7	6+350	5+900	6+530	5301	6892	4594
8	6+650	6+530	6+780	5253	6829	4553
9	6+980	6+780	7+100	5262	6841	4561
10	7+200	7+100	7+550	5279	6862	4575
11	7+950	7+550	7+810	5255	6831	4554

Containment Area #	Station	High Point Down chainage	High Point Up chainage	Pipeline Volume plus 5222 m^3	Pond Volume factored by 1.3 (m^3)	Pond Area If 1.5m deep (m^2)
12	8+280	7+810	8+400	5296	6885	4590

Each containment pond will be graded to permit access the pond to remove debris and sedimentation. Each pond will also be equipped with an overflow weir, and a bypass sluice gate to allow collected precipitation or runoff to be manually drained from the pond.

The shape/depth of each pond will be determined during detailed design and will be configured to suit the available land area/shape and site specific constraints.

4.2.6 Security – protection, access

To provide physical security to the tailings disposal and reclaim water pipelines they will be both be contained within a protection berm located between the roadway and the pipe alignment to protect against traffic that inadvertently leaves the roadway. The top of the protection berm will be a minimum of 0.5 m above the centerline elevation of the road.

The protection berm will also provide spill containment along the pipeline alignment in the event of a leak or rupture. A second berm will be constructed along the opposite side of the pipeline alignment from the road where there is no cut slope or where the cut slope is less than the height of the roadside protection berm.

5.0 CONCEPTUAL ALIGNMENT

The site access road horizontal alignment was designed to respect the horizontal design parameters (Table 1) and in conjunction with the vertical alignment to minimize cut and fill volumes and earthwork haul distances. An attempt was made to follow the alignment of the existing road where possible. In addition, the shortest alignment was sought to minimize pipeline lengths and hence capital and operating (i.e. pumping) costs. The topography was examined to find an alignment that would result in minimum vertical gradients. Natural features such as muskeg deposits were avoided where possible. An attempt was made to use existing water crossing locations where possible.

A sensitivity analysis was carried out to determine whether or not the pipeline trench should be built on an alignment independent of the road alignment. Three cases were examined:

- The road alignment was developed first, and then the pipeline trench was aligned in close proximity to the road alignment;
- The pipeline trench was aligned independently of the road alignment; and
- A cross section with the pipeline trench tied directly to the road cross section, and the alignment of the joint road/trench established.

Based on the estimated earthwork volumes and construction and operation considerations, it is recommended that the pipeline trench alignment be tied to the road alignment rather than be independent of it.

For the road alignment, the minimum horizontal curve radius was 190 m, and the minimum vertical curve k value was 18 m/%. Based on these figures, the road geometric design would limit the design vehicle to a maximum speed of 60 km/h (other factors might cause slower speeds). The maximum gradient on the road alignment was 10%.

Tying the pipeline trench cross section directly to the road cross section resulted in a maximum pipe gradient of 10% and horizontal bend radii of no less than approximately 170 m.

6.0 OPERATIONAL ISSUES

6.1 Access Road

Maintenance associated with the access road includes:

- Visual inspection of road surface, drainage features (ditches, culverts), signage, roadside vegetation;
- Grading;
- Winter snow control (plowing/sanding);
- Dust suppression;
- Repairs as required – pot holes, washouts, cleaning of drainage features (ditches, culverts); and
- Record keeping (asset management).

Seasonal load limits may be required depending on actual subsurface conditions and should be assessed at the detailed design and construction stage.

6.2 Tailings Disposal and Reclaim Pipelines

Maintenance activities associated with the tailings disposal and reclaim water pipelines includes:

- Visual inspection of pipes, protection berms, secondary pumping stations, spill containment areas;
- Monitoring and review of SCADA data, including flow and pressure trends (C-values), pump shutdown frequency, alarms, etc.;
- Internal pipe swabbing (frequency depends on operational experience);
- Internal pipeline inspection for abrasion, buildup (frequency depends on operational experience);
- Repairs as required; and
- Record keeping (asset management).

7.0 QUANTITY ESTIMATE

7.1 Road and Pipe Trench

Based on the horizontal and vertical alignments discussed above, the estimated earthworks quantity is 256,000 m3. This figure is based on balancing the cut and fill requirements and not requiring any borrow from off the road alignment or waste to sites off the road alignment. The following assumptions were made:

- Cut material is solid rock (i.e. no overburden);
- Bulking factor is 1.3 (in-situ rock excavated and compacted as fill);
- Cut slopes are in rock at 1:4 (horz/vert); and
- Fill slopes are compacted rock fill (drilled and blasted) at 1:1 (horz/vert).

In addition to the rock fill obtained from cuts along the road alignment, there will be a need for imported fill. Coarse blinding gravel will be needed to chink the voids in the rock fill surface, both on the road and on the pipe trench, and finer crushed rock will be needed to provide the riding surface of the road. Preliminary estimates are that approximately 51,200 m^3 (compacted volume) of blinding gravel will be needed, together with approximately 21,700 m^3 (compacted volume) of crushed surfacing rock. To derive the estimates, it was assumed that on the road, the blinding gravel will be approximately 0.3 m thick, covered by approximately 0.15 m of crushed surfacing rock. On the pipe trench, it was assumed there would be no surfacing rock, and that the blinding gravel would be 0.15 m thick.

8.0 CLOSURE

We trust this technical memorandum meets your expectations and current requirements. If you have any questions or wish to discuss this memorandum, please contact the undersigned.

GOLDER ASSOCIATES LTD.

<Original signed by>

<Original signed by>

Robert A. Douglas, P.Eng.
Senior Geotechnical Engineer - Low-Volume Roads

Mark Guthrie, P.Eng.
Senior Project Manager

CDH/RAD/MG/AB/sv

Attachments:

Figure 1 – Mine Site Road and Tailings Pipeline Alignment
Appendix A – Plan and Profile Drawings

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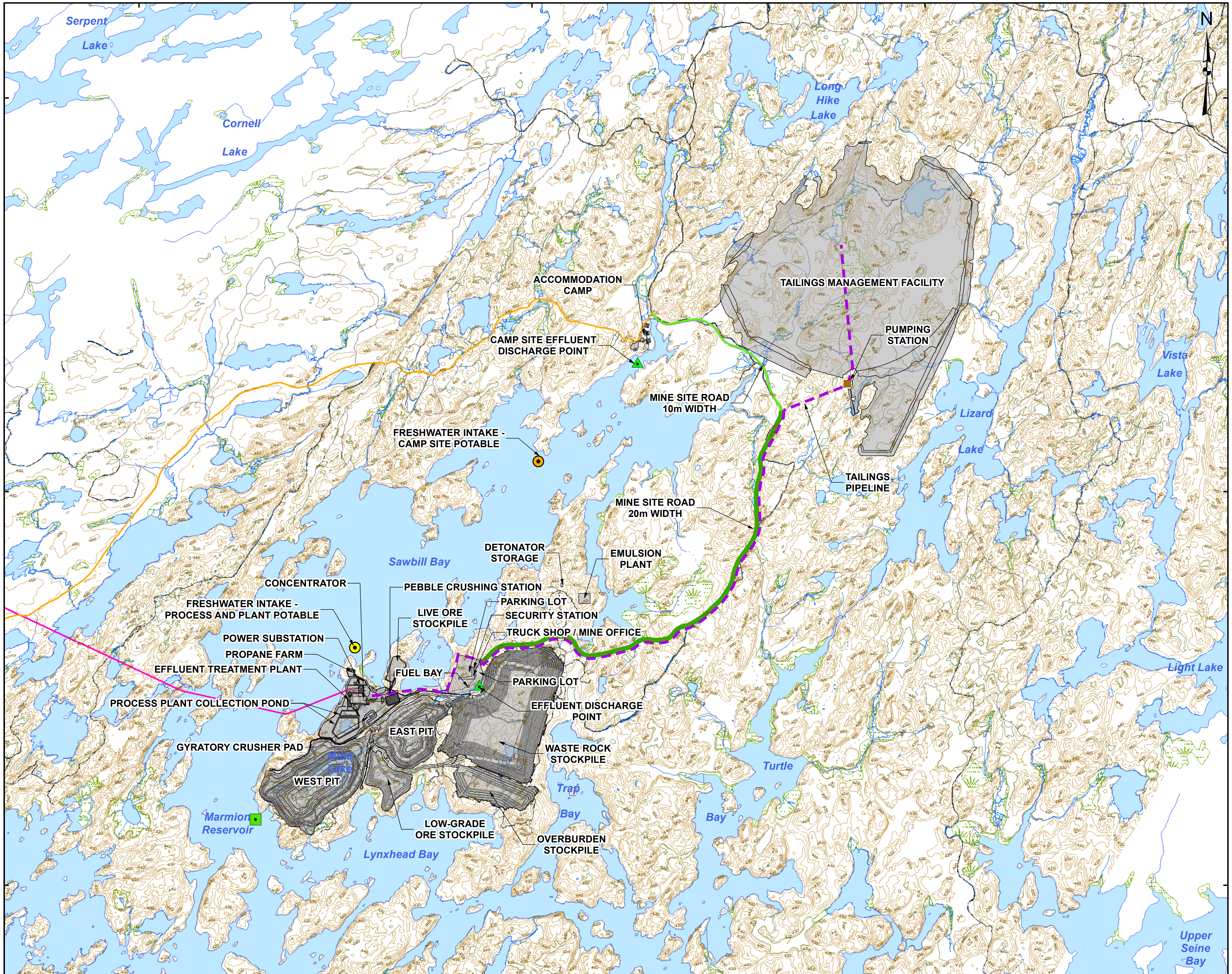
9.0 LIST OF UNITS

Unit	Abbreviation
centimetre	cm
cubic metre	cm^3
metre	m^3
day	d
hour	hr
kilometre(s)	km
metre(s)	m

10.0 REFERENCES

Ausenco 2012. *Osisko Hammond Reef Gold Ltd. Hammond Reef Gold Project – Tailings Lab Testing and Hydraulic Analysis Study, Hydraulic Analysis Study,* 2100-G-G-001 Revision E, November 2012.

FIGURE



LEGEND

- Freshwater Intake - Camp Site Potable
- Freshwater Intake - Process and Plant Potable
- Discharge Location
- Effluent Discharge Point
- Index Contour (5m interval)
- Ditch
- Marsh/Swamp
- River/Stream
- Road
- Trail
- Lake
- Wetland
- Mine Site Road - 10m Width
- Mine Site Road - 20m Width
- Access Road (Hardtack / Sawbill)
- Project Transmission Line
- Tailings Pipeline
- Mine Facilities

REFERENCE

Base Data - Provided by OSISKO Hammond Reef Gold Project Ltd.
Base Data - MNR NRVIS, obtained 2004
Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2008
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 15N

500 0 500 1,000 1,500 2,000 2,500
SCALE 1:50,000 METERS

PROJECT
HAMMOND REEF GOLD PROJECT
ATIKOKAN, ONTARIO, CANADA

TITLE
MINE SITE ROAD AND
TAILINGS PIPE LINE ALIGNMENT

Golder Associates
Mississauga, Ontario

PROJECT NO. 11-1118-0074			SCALE AS SHOWN	REV. ION 1
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CHECK	DCJ	8 Mar. 2013		
REVIEW	DCJ	8 Mar. 2013		

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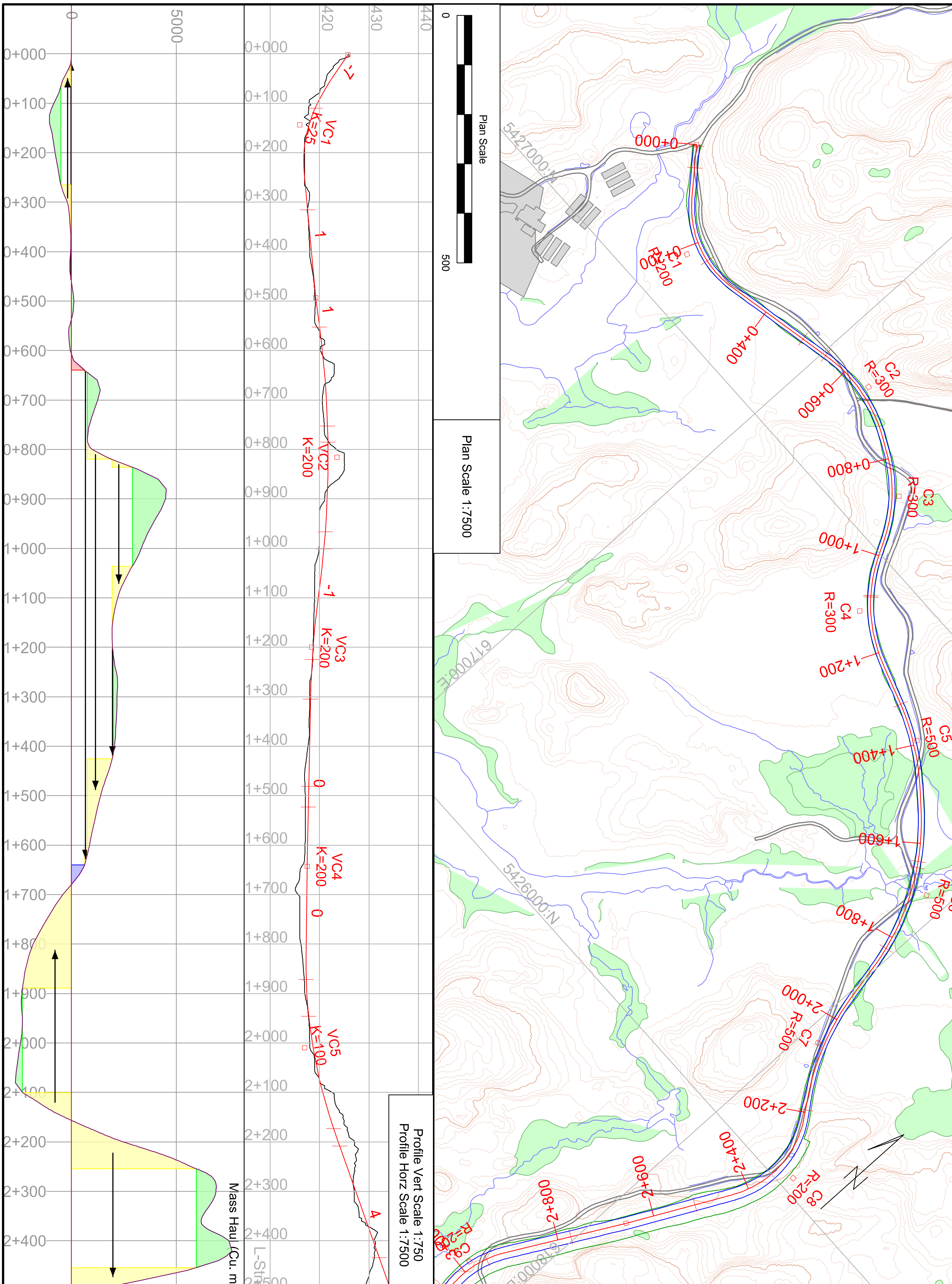
APPENDIX A



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STRIPPING	No stripping
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	CUT: 1:1 BULKING FACTOR 1.000 (BANK m3)

HAMMOND REEF GOLD PROJECT, ATIKOKAN, ONTARIO

Mine Access Road Plan and Profile

Golder Associates

		11-1118-0074	FILE No. 11-1118-0074	REV
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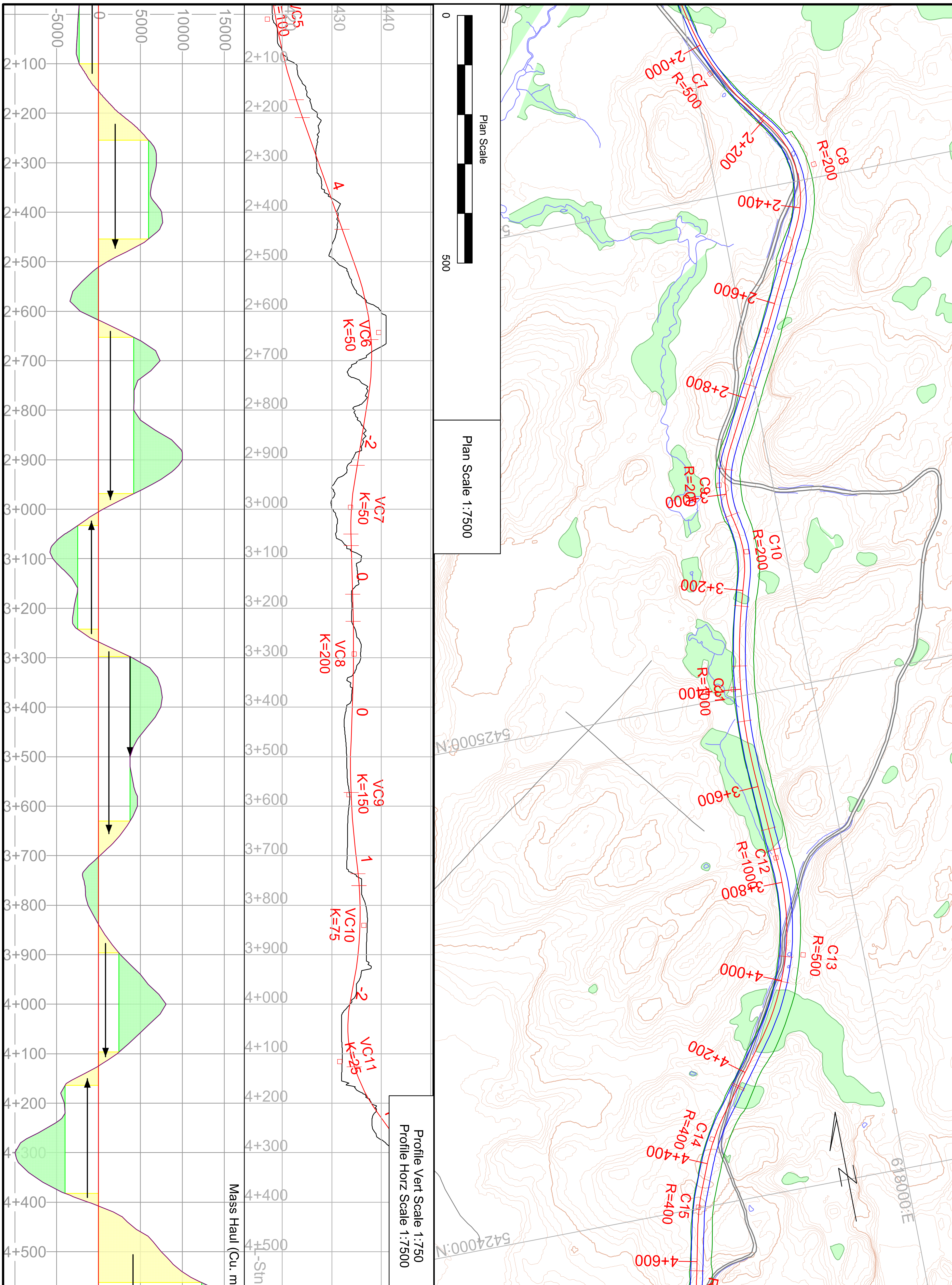

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HAMMOND REEF GOLD PROJECT, ATIKOKAN, ONTARIO

Mine Access Road Plan and Profile

Golder Associates

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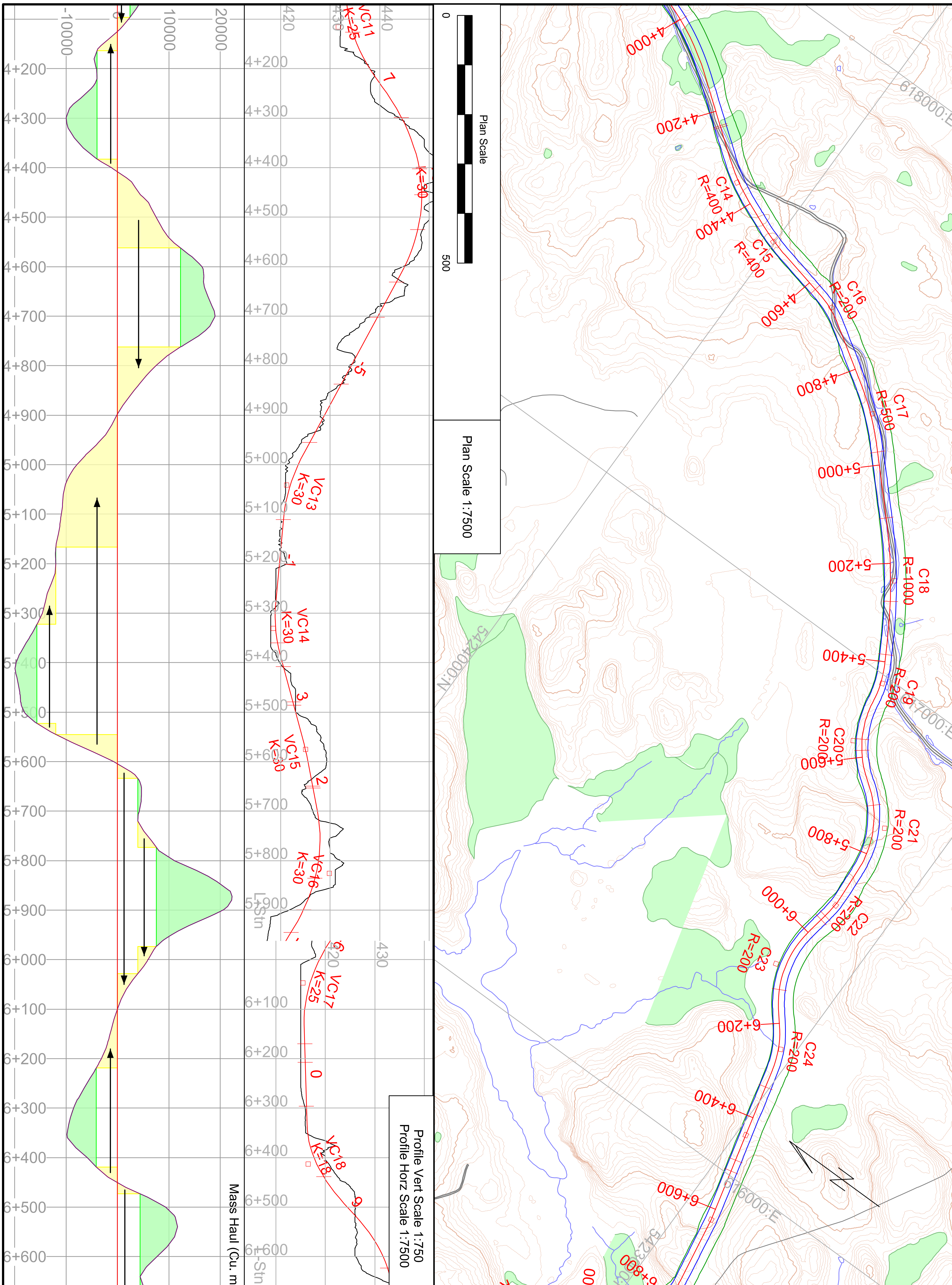

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HAMMOND REEF GOLD PROJECT, ATIKOKAN, ONTARIO

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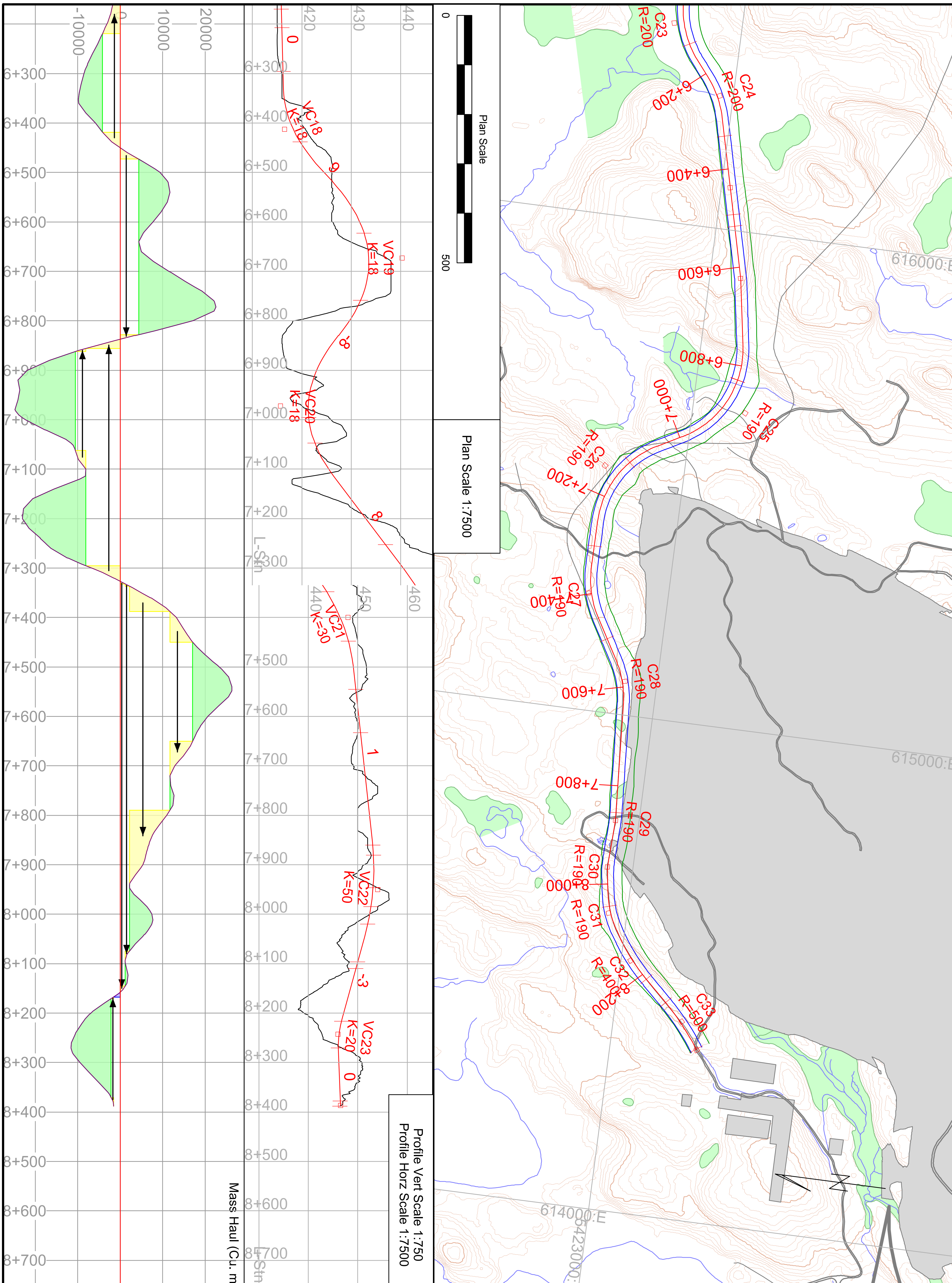

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HAMMOND REEF GOLD PROJECT, ATIKOKAN, ONTARIO

Mine Access Road Plan and Profile

Golder Associates

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