

Appendix 18

Whale Tail site-specific geotechnical studies

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SUBJECT: Site Specific Geotechnical Studies

1.0 Introduction

Agnico Eagle Mines (Agnico Eagle) is seeking to extend the life of the Meadowbank Mine by constructing and operating the Whale Tail Pit, which is to be a satellite deposit on the Amaruq property, and will be a continuation of mine operations and milling at the Meadowbank Mine.

Since 2015, many field investigations have been carried out at the Whale Tail Pit Project in order to characterize the field conditions (types of soils encountered, overburden thicknesses, rock quality, etc.).

This memorandum outlines the geotechnical studies conducted at four (4) specific locations:

- > WRSF and WRSF Dike,
- > Quarry;
- > Mammoth Dike;
- > Whale Tail Dike.

These locations are presented in Figure 1 presented below.

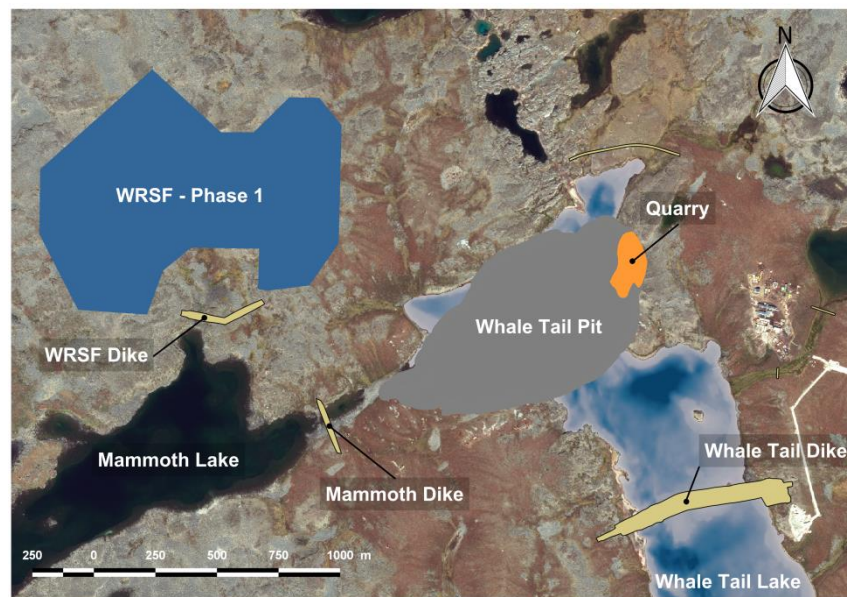


Figure 1: General location of the infrastructures at the Amaruq property



The site specific geotechnical studies at those four (4) locations are summarized in Section 2.0. The investigation results to consider for construction are discussed in Section 3.0. Finally, a conclusion is presented in Section 4.0.

This technical memo is completed in accordance with the requirements of the Whale Tail Project Certificate N.008, condition 9, stating that site-specific geotechnical investigations required to identify sensitive land features and to inform final engineering design prior to the construction of project components such as the waste rock storage facility and quarries shall be undertaken. Results from these studies should be submitted to the Nunavut Impact Review Board at least 30 days prior to the start of construction of these facilities, with results or updates submitted annually thereafter as applicable.

1.1 Objective

The main objective of this memorandum is to gather and summarize the available geotechnical data for the WRSF/quarry area and for the Whale Tail Dike (WTD) area, and to refer to the appropriate documents if more detailed information is required.

2.0 Summary of Geotechnical Studies

The geotechnical studies carried out at the WRSF, the WRSF dike, the Mammoth Dike and quarry areas are summarized in Section 2.1 to 2.3, and those conducted in the WTD area are summarized in Section 2.4. Finally, a summary of results is presented in Section 2.5.

2.1 WRSF and WRSF Dike

In 2015 and 2016, many diamond drill boreholes were drilled in the WRSF area, which allowed to get information on the depth of bedrock at several locations. The list of boreholes drilled within the footprint of the WRSF – Phase I and the information on overburden thicknesses are summarized in Table 1 presented below.

Table 1: Diamond drill boreholes drilled in the WRSF – Phase I area

Borehole ID	Surface elevation (m)	Bedrock elevation (m)	Bedrock Depth (m)
AMQ16-1065	164.46	160.87	3.59
AMQ15-397	165.85	159.93	5.92
AMQ15-394	162.98	158.72	4.26
AMQ15-386	162.14	157.93	4.21
AMQ15-428	160.68	155.97	4.71
AMQ15-419	155.91	150.34	5.57
AMQ16-980	158.80	149.76	9.04

AMQ15-378	166.48	160.46	6.02
AMQ15-423	158.88	155.90	2.98
AMQ15-373	163.44	152.58	10.86
AMQ15-364	157.21	146.93	10.28
AMQ15-392	158.16	151.77	6.39
AMQ15-396	158.00	151.40	6.60
AMQ15-412	161.32	151.20	10.12
AMQ15-384	161.01	149.33	11.68
AMQ15-407	163.32	155.20	8.12
AMQ15-385	161.19	150.48	10.71
AMQ15-402	167.41	159.29	8.12

The average, minimum and maximum bedrock depth determined during drilling are 7.18 m, 2.98 m and 11.68 m, respectively. The bedrock depth is of great importance for the assessment of the overall stability of a geotechnical infrastructure. This parameter was used in the technical note on the stability analyses for the WRSF (SNC-Lavalin, 2017b).

In February 2018, a field investigation with down-the-hole drill has been carried out in the area of the WRSF Dike to be constructed. The information available on the boreholes is summarized in Table 2.

Table 2: Boreholes drilled in the WRSF Dike area

Borehole ID	Surface Elevation (m)	Bedrock Elevation (m)	Bedrock Depth (m)
L1701	159.16	156.42	2.74
L1702-B*	155.92	154.39	1.53
L1703-B	153.04	145.72	7.32
L1704*	153.61	148.43	5.18
L1705*	155.42	153.89	1.53
L1706*	156.49	154.66	1.83

L1707	156.47	155.55	0.92
L1708*	155.55	154.33	1.22
L1709	155.74	154.07	1.67
L1710*	155.44	153.91	1.53
L1711	156.66	153.31	3.35
L1712*	157.01	155.49	1.52
L1713	157.90	153.02	4.88
L1714	159.75	157.31	2.44

*Borehole located within the footprint of the future WRSF Dike

In the WRSF Dike area, the average, minimum and maximum bedrock depth determined during the investigation campaign are 2.69 m, 0.92 m and 7.32 m, respectively. The overburden is thinner in the WRSF Dike area compared to the waste rock storage facility located north. However, since the boreholes were drilled during the winter, it is harder to determine the exact depth of the bedrock elevation as the ground is in the frozen state. Unlike diamond drilling where soil samples and bedrock cores are recovered, the accuracy of the bedrock depth obtained with this technique relies on the experience of the operator.

In March 2018, SNC-Lavalin carried out a diamond drilling campaign in the WRSF Dike area to confirm the depth of the bedrock obtained in previous field investigations. The geotechnical data are being analysed at the moment; the results of this geotechnical investigation will be presented in a factual report to be issued in June 2018 (SNC-Lavalin, 2018c).

2.2 Quarry Area

As for the quarry area, boreholes have been drilled between 2014 and 2016. The bedrock depth and elevation are summarized in [Table 3](#).

Table 3: Boreholes drilled in the quarry area

Borehole ID	Surface Elevation (m)	Bedrock Elevation (m)	Bedrock Depth (m)
AMQ15-349A	155.30	146.48	8.82
AMQ16-808	155.18	148.25	6.93
AMQ15-277	155.78	152.57	3.21
AMQ15-160	156.68	154.09	2.59

AMQ16-161	157.02	153.03	3.99
AMQ15-270	157.26	152.24	5.02
AMQ15-309	157.63	154.89	2.74
AMQ15-288	158.34	153.06	5.28
AMQ15-285	158.11	152.04	6.07

In the quarry area, the average, minimum and maximum bedrock depth determined during the investigation are 4.96 m, 2.59 m and 8.82 m, respectively. For the quarry and open pit, the geotechnical investigation results support the characterization and quantity estimation of available material for construction, as well as giving important information for the first stage development of the open pit.

2.3 Mammoth Dike Area

Some boreholes were drilled within the Mammoth Dike alignment between 2015 and 2017. Both diamond and down-the-hole drillings methods were used in order to assess the bedrock depth in the Mammoth Dike area, as summarized in [Table 4](#).

Table 4: Boreholes drilled in the Mammoth Dike area

Borehole ID	Surface Elevation (m)	Bedrock Elevation (m)	Bedrock Depth (m)
AMQ15-492	154.03	145.65	8.38
AMQ15-414	156.75	150.19	6.56
MD-01-2015*	152.75	150.70	2.05
MD-02-2015*	154.03	151.03	3.00
MD-03-2015	152.27	148.67	3.60
AMQ16-718	152.68	148.24	4.44
L1611*	152.83	149.78	3.05
L1612*	153.06	150.47	2.59
L1613*	149.72	147.58	2.14
L1614*	154.17	146.86	7.31



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L1615	155.11	147.80	7.31
AMQ16-722	152.33	147.27	5.06
AMQ16-1051	152.66	148.99	3.67
AMQ16-1050	153.45	145.96	7.49
AMQ16-1049	153.42	146.77	6.65
AMQ15-395	155.23	146.45	8.78

*Borehole located within the footprint of the future Mammoth Dike

In the Mammoth Dike area, the average, minimum and maximum bedrock depth determined during the investigation are 5.13 m, 2.05 m and 8.78 m, respectively. Moreover, the borehole logs from boreholes MD-01-2015 and MD-02-2015 (Agnico Eagle Mines Ltd., 2015a) indicate the presence of a 1-m-thick layer of gravel and cobbles underlain by a till layer (gravel and sand with some silt).

2.4 WTD Area

Several geotechnical investigations were conducted since 2015 in the WTD area. The following investigation reports contain all the information collected from diamond and down-the-hole drilling (with air track drill rig), such as soil collection, bedrock coring, water tests, geo-camera, and thermistors installation:

- › Geotechnical investigation report, 627215-0000-40ER-0002 (Agnico Eagle Mines Ltd., 2015b);
- › Field work 2016, 640387-1000-4GER-0001 (Agnico Eagle Mines Ltd., 2016);
- › 2017 geotechnical investigation, 645003-2000-4GER-0001 (SNC-Lavalin, 2017a).

It should be noted that in March 2018, an additional geotechnical campaign was performed. The information collected during this campaign is being analysed and will be presented in a separate document.

All the available information on the geotechnical investigations carried out at the WTD is presented in the design report of Whale Tail Dike (SNC-Lavalin, 2018b) and summarized below.

The geotechnical investigations (carried out from 2015 to 2018) showed that the subsurface profile generally consists of sand and gravel with cobbles and boulders and/or glacial till overburden overlying weathered bedrock except for the west abutment that presents an esker with sand and gravel.

Based on the water content data from samples collected about 500 m inland east of the WTD and from the latest field investigation, the east abutment presents a layer of ice-rich soil that reaches a depth of 4.0 metres. It is considered that the top of the active layer has low to intermediate ice content, but is underlain by a frozen layer that contains potential segregated ice lenses, under which is ice-poor till. Gradation curves show that the ice-rich till material is silty sand with some gravel and clay. The ice-rich till can be classified as SM material according to the United Soil Classification System (USCS). The ice-poor till material is sandy gravel with some silt, and can be referred to a GW-GM material.



2.5 Summary of Results

The boreholes drilled in the WRSF, Mammoth Dike and quarry areas can provide an order of magnitude of the overburden thicknesses at those locations which are summarized in [Table 5](#).

Table 5: Summary of bedrock depth at the WRSF and quarry areas

Location	Average bedrock depth (m)	Number of boreholes
WRSF - Phase I	7.18	18
WRSF Dike	2.69	14
Mammoth Dike	5.13	16
Quarry	4.96	9

As for the WTD area, the lakebed generally consists of sand and gravel with cobbles and boulders.

3.0 Investigation Results to Consider for Construction

The bedrock depth was considered in the overall design of the facility, as well as in the WRSF stability analyses and in the geometry of the infrastructure. This parameter can have a significant impact on the overall stability.

For the WRSF Dike area, the bedrock surface is much shallower, which reduce the need of excavation for the construction and may have a positive impact on the stability of the structure.

In the Mammoth Dike area, the bedrock surface is deeper compared to the WRSF Dike but still remains relatively shallow, which has a positive impact on the overall stability.

In the quarry area, the investigation supports the pit development and indicates how much borrow material is available for construction.

The potential impacts of the field investigations on the construction of the WTD have been discussed in the design report (SNC-Lavalin, 2018b).

4.0 Conclusion

Field investigation campaigns have been carried out at the WRSF and quarry areas between 2014 and 2016. The information available as of May 2018 indicates that the bedrock depth varies from 7.2 m within the footprint of the WRSF – Phase 1 area (2.7 m within the footprint of the WRSF Dike), 5.1 m in the Mammoth Dike area and 4.9 m in the quarry area, in average. No further geotechnical data are available in these areas, hence no major sensitive land features have been identified at these locations. The design report of the Whale Tail Dike (SNC-Lavalin, 2018b) contains all the required information on the field investigations carried out at the WTD, and should be referred to for all the implications of geotechnical investigations for construction.

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5.0 References

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