TETRA TECH

TECHNICAL MEMO

ISSUED FOR USE

To:	Jennifer Pyliuk, P.Eng., Agnico Eagle	**Date:**	February 18, 2020
c:	Bill Horne, P.Eng., Tetra Tech	**Memo No.:**	001
From:	Guangwen (Gordon) Zhang, P.Eng., Tetra Tech	**File:**	ENG.EARC03140-06
Subject:	Responses to CIRNAC's Comments on CP6 and CP6 Berm Design Report, Meliadine Gold Mine, Nunavut		

1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) was retained by Agnico Eagle Mines Ltd. (Agnico Eagle) to design the CP6 (Water Collection Pond No. 6) and CP6 Berm for the Meliadine Gold Mine, Nunavut, Canada. The design report (Tetra Tech 2020) was submitted to Agnico Eagle on January 24, 2020.

In an email on February 11, 2020, Agnico Eagle forwarded Tetra Tech review comments of Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC) on the CP6 and CP6 Berm design report. Tetra Tech thanks CIRNAC for their comments. This technical memorandum presents Tetra Tech's responses to the comments of CIRNAC.

2.0 TETRA TECH'S RESPONSES TO CIRNAC'S COMMENTS

2.1 Rainfall and Precipitation Data

CIRNAC's Comments:

"Tables 1 and 2 in Section 3.3 of the design report provided surface runoff parameters for a mean precipitation year and a 1/100 wet precipitation year respectively. The values presented in these two tables were adopted from a previous feasibility study (i.e., Tetra Tech EBA 2014). CIRNAC is seeking clarification on which modeling/calculation method was used to determine the rainfall and precipitation data, and if the design parameters have been updated to reflect the current precipitations."

Tetra Tech's Responses:

The rainfall and precipitation data in Tables 1 and 2 were generally adopted from Golder (2013a and 2013b). Tables 1 and 2 below present the values and the associated sources for the data.

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Table 1: Various Parameters for Surface Runoff Estimation for a Mean Precipitation Year

Item	Value	Source or Comment
Total adjusted annual precipitation for a mean precipitation year	412 mm	Golder (2013a)
Total adjusted annual rainfall for a mean precipitation year	210 mm	Golder (2013a)
Total adjusted annual water equivalent snowfall for a mean precipitation year	202 mm	Golder (2013a)
Total estimated snow sublimation	99 mm	Golder (2013a)
Estimated snow melt water equivalent in spring freshet	103 mm	Calculated based on values above
Estimated rainfall runoff coefficient for natural on-land surface for a mean precipitation year	0.7 in June 0.5 in July to October	Estimated based on various sources and experience
Monthly rainfall distribution	16% in June, 21.2% in July 30.8% in August, 24.5% in September 7.5% in October	Golder (2013a)
Annual net runoff on natural on-land surface for a mean precipitation year	215 mm (127 mm in June, 22 mm in July, 32 mm in August, 26 mm in September, and 8 mm in October)	Calculated based on values above
Estimated monthly lake surface evaporation	60 mm in June, 125 mm in July 96 mm in August, 42 mm in September	Golder (2013a)
Annual net runoff on lake surface for a mean precipitation year	-10 mm (76 mm in June, -80 mm in July, -31 mm in August, 9 mm in September, and 16 mm in October)	Calculated based on values above
Estimated monthly natural land surface evapotranspiration	6 mm in June, 14 mm in July 11 mm in August, 5 mm in September	Golder (2013a)
Annual net runoff on disturbed land surface for a mean precipitation year	251 mm (133 mm in June, 36 mm in July, 43 mm in August, 31 mm in September, and 8 mm in October)	Calculated based on values above

Table 2: Various Parameters for Surface Runoff Estimation for a 1 in 100 Extreme Wet Year and Extreme Rainfall

Item	Value	Source or Comment
Total adjusted annual precipitation for a 1 in 100 wet precipitation year	594 mm	Golder (2013a)
Total adjusted annual rainfall for a 1 in 100 wet precipitation year	324 mm	Golder (2013a)
Total adjusted annual water equivalent snowfall for a 1 in 100 wet precipitation year	270 mm	Calculated based on values above
Total estimated snow sublimation	99 mm	Golder (2013a)
Estimated snow melt water equivalent in spring freshet for a 1 in 100 wet precipitation year	171 mm	Calculated based on values above
Assumed natural on-land runoff coefficient for the incremental net rainfall between those for a 1 in 100 wet precipitation year and a mean precipitation year	0.8 in June to October	Assumed

Table 2: Various Parameters for Surface Runoff Estimation for a 1 in 100 Extreme Wet Year and Extreme Rainfall

Item	Value	Source or Comment
Monthly rainfall distribution	16% in June, 21.2% in July 30.8% in August, 24.5% in September 7.5% in October	Golder (2013a)
Annual net runoff on natural on-land surface for a 1 in 100 wet precipitation year	430 mm (213 mm in June, 55 mm in July, 80 mm in August, 63 mm in September, and 19 mm in October)	Calculated based on values above
Estimated monthly lake surface evaporation	60 mm in June, 125 mm in July 96 mm in August, 42 mm in September	Golder (2013a)
Annual net runoff on lake surface for a 1 in 100 wet precipitation year	172 mm (163 mm in June, -56 mm in July, 4 mm in August, 37 mm in September, and 24 mm in October)	Calculated based on values above
Estimated monthly natural land surface evapotranspiration	6 mm in June, 14 mm in July 11 mm in August, 5 mm in September	Golder (2013a)
Annual net runoff on disturbed land surface for a 1 in 100 wet precipitation year	466 mm (219 mm in June, 69 mm in July, 91 mm in August, 68 mm in September, and 19 mm in October)	Calculated based on values above
24-hour duration extreme rainfall with a 1 in 100 years of return period	65 mm	Golder (2013a)
24-hour duration extreme rainfall with a 1 in 1000 years of return period	77 mm	Golder (2013b)
24-hour duration PMP (probable maximum precipitation)	259 mm	Golder (2013b)
Runoff coefficient for extreme rainfall	1.0	Assumed

Tetra Tech recently conducted a calibration water balance for the Meliadine site in January 2020, using the measured precipitation data, water collection pond elevations, and operational water pumping volume data in 2019 at the mine site. The calibration water balance findings suggest that the actual net runoff coefficients from the precipitation, especially for the spring freshet, are lower than those used in the feasibility study and subsequent facility designs (including the design for CP6 and CP6 Berm). In another words, the net runoff values used in the facility designs are on the conservative side. To be consistent with other previous facility designs at the mine site and be on the conservative side, the values in Tables 1 and 2 were used in the CP6 and CP6 Berm design.

2.2 Contingency Factor Related to Climate Change

CIRNAC's Comments:

"Also, current industry practices require that additional contingency factor related to climate change be incorporated in pond design. CIRNAC is seeking clarification on whether the CP6 design has taken this additional contingency factor into consideration in deriving the values presented in Tables 1 and 2."

Tetra Tech's Responses:

Most of the values in Tables 1 and 2 were adopted from Golder (2013a and 2013b). An additional contingency factor related to climate change may not be considered when those values were derived. However, the effects of not considering the climate change on the precipitation values and the CP6 and CP6 Berm design are minor due to the following reasons:

- CP6 and CP6 Berm are only required during mine operation and interim closure. After mine closure when the water quality in CP6 meets the direct discharge criteria, CP6 Berm will be breached to restore the natural drainage path of the former lake H19 and CP6 will be no longer operating as a water collection pond. Therefore, the design life of these structures is relatively short (2020 to 2040 or earlier).
- Based on charts presented on the website of Canadian Climate Data and Scenarios of Government of Canada (http://climate-scenarios.canada.ca/?page=download-cmip5), the precipitation increases due to climate change during the periods of 2016 - 2035 and 2046 - 2065 are not significant (see Table 3 below); and
- The Inflow Design Flow (IDF) for the design of CP6 and CP6 Berm is 73 mm (3/7 of equivalent unit runoff during spring freshet for 1 in 100 return wet year). The climate change scenario CMIP5 RCP4.5 (http://climate-scenarios.canada.ca/?page=main) predicts that snow depth will slightly decrease with time in Nunavut. This suggest that the equivalent unit runoff during spring freshet will slightly decrease with time in Nunavut. Therefore, ignoring the climate change effects will be on the conservative side for the design of CP6 and CP6 Berm.

Table 3: Predicted Seasonal and Annual Precipitation Changes by CMIP5 RCP4.5 Scenario for Meliadine Mine Site Area (Government of Canada)

Period	Predicted Seasonal and Annual Precipitation Changes (50th (median) percentiles) from 1986-2005 Baseline under Representative Concentration Pathway (RCP) 4.5 Scenario for Meliadine Mine Site Area (%)				
	Winter	**Spring**	**Summer**	**Autumn**	**Annual Mean**
2016–2035	0 to 10	0 to 10	0 to 10	0 to 10	**0 to 10**
2046–2065	10 to 20	10 to 20	0 to 10	10 to 20	**10 to 20**

The 1 in 100 return 24-hour extreme rainfall of 65 mm was considered in the design of CP6 and CP6 Berm. Assuming 10% increase due to the climate change, the 1 in 100 return 24-hour extreme rainfall may increase to 72 mm, which is still less than the IDF of 73 mm adopted for the design of CP6 and CP6 Berm.

2.3 Storage Capacity for PMP

CIRNAC's Comments:

"CIRNAC also seeks clarification on whether the net effect on the storage amount has been verified, should the PMP (probably maximum precipitation) be used as the governing factor for the CP6 design."

Tetra Tech's Responses:

Sections 4.1 and 4.2 of Tetra Tech (2020) present the classification and consequence of failure of CP6 and CP6 Berm and associated IDF.

The IDF adopted for CP6 and CP6 Berm meets the most critical of the following cases:

- 3/7 of the equivalent unit runoff during spring freshet for a 1 in 100 return wet year; or
- One 1 in 100 return 24-hour extreme rainfall event.

This design criteria are consistent with the design criteria for similar water collection ponds and berms (CP3, CP3 Berm, CP4, and CP4 Berm) that have been designed (Tetra Tech 2018) and constructed (2018 to 2019) at the Meliadine mine site.

Design of CP6 and CP6 Berm to accommodate for the PMP (probably maximum precipitation) is desired but not necessary based on their classification and consequence of failure.

Under an emergency (rainfall) event, CP6 can temporarily store an ultimate water volume of 105,380 m^3 at a pond water elevation of 64.36 m, which is the lowest natural ground surface elevation at the saddle on the east side of the CP6 catchment area.

The catchment area for CP6 is approximately 447,885 m^2. With the ultimate storage capacity of 105,380 m^3, this is equivalent to a net unit area runoff of 235 mm, which is slightly less than the 24-hour duration PMP (probable maximum precipitation) of 259 mm provided by Golder (2013b).

2.4 Factor of Safety in Stability

CIRNAC's Comments:

“It is stated in Section 4.8 Stability Analysis that "the calculated factors of safety for the pond and berm meet or exceed the minimum factors of safety, as suggested by CDA (2007) and CGS (2006)". It is not clear what the values of the calculated factors of safety for the pond and berm are and how they compare with the minimum values suggested by CDA and CGS. CIRNAC recommends that the values of the calculated and the minimum factors of safety be presented in a table so that they can be compared directly.”

Tetra Tech's Responses:

Table 4 summarizes the required (design) and calculated minimum factors of safety for CP6 and CP6 Berm.

Table 4: Required and Calculated Minimum Factors of Safety for CP6 and CP6 Berm

Loading Conditions	Required (Design) Minimum Factor of Safety	Calculated Minimum Factor of Safety for CP6	Calculated Minimum Factor of Safety for CP6 Berm
During construction and after end of construction but before pond filling	1.3	2.45	1.55
After pond water filling, static loading, normal operation	1.5	1.55	1.55
Seismic loading (pseudo-static), long-term, normal water level	1.1	1.37	1.40
Long-term, static loading, sensitivity cases with pond water levels higher than the normal water level	1.4	1.55	1.55

3.0 CLOSURE

Use of this memo is subject to Tetra Tech's Limitations on Use of this Document which are attached in Appendix A. We trust this technical memo meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

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Feb 18, 2020

FILE: ENG.EARC03140-06
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TETRA TECH CANADA INC.

Signature ________________

Date Feb 18, 2020

PERMIT NUMBER: P 018
NT/NU Association of Professional Engineers and Geoscientists

REFRENCES

Golder, 2013a. SD 2-6 Surface Water Management Plan. Final Report submitted to Agnico Eagle Mines Limited., Project No. Doc 232-1013730076, January 2013.

Golder, 2013b. Email from Dan R. Walker of Golder Associate to Agnico Eagle Mines Limited on June 11, 2013.

Tetra Tech EBA, 2014. Tailings, Waste, and Water Management for Feasibility Level Study, Meliadine Project, Nunavut. Technical report submitted to Agnico Eagle Mines Limited by Tetra Tech EBA, EBA File: E14103188-01, Agnico Eagle Report Number: 6509-REP-05, December 2014.

Tetra Tech, 2018. Design Report for CP3, CP4 CP Berms, Berm2, Channel3, and Channle4, Meliadine Project, Nunavut. A technical report submitted to Agnico Eagle Mines Ltd. by Tetra Tech Canada Inc., Agnico Eagle Report Number: 6515-E-132-007-132-REP-017, June 2018.

Tetra Tech, 2020. Design Report for CP6 and CP6 Berm, Meliadine Project, Nunavut. A technical report submitted to Agnico Eagle Mines Ltd. by Tetra Tech Canada Inc., January 24, 2020.

APPENDIX A

TETRA TECH'S LIMITATIONS ON USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

GEOTECHNICAL

1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the “Professional Document”).

The Professional Document is intended for the sole use of TETRA TECH’s Client (the “Client”) as specifically identified in the TETRA TECH Services Agreement or other Contractual Agreement entered into with the Client (either of which is termed the “Contract” herein). TETRA TECH does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Professional Document when it is used or relied upon by any party other than the Client, unless authorized in writing by TETRA TECH.

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Both electronic file and/or hard copy versions of TETRA TECH’s Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH’s Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client’s current or future software and hardware systems.

1.3 STANDARD OF CARE

Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by persons other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this report, at or on the development proposed as of the date of the Professional Document requires a supplementary investigation and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, TETRA TECH has not been retained to investigate, address or consider and has not investigated, addressed or considered any environmental or regulatory issues associated with development on the subject site.

1.8 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems and methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. TETRA TECH does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

1.9 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

1.10 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historic environment. TETRA TECH does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional investigation and review may be necessary.

1.11 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

1.12 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

1.13 INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known.

1.14 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, as well as the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

1.15 DRAINAGE SYSTEMS

Where temporary or permanent drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function.

1.16 BEARING CAPACITY

Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions assumed in this report in fact exist at the site.

1.17 SAMPLES

TETRA TECH will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.