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TECHNICAL MEMORANDUM
PolyMet NorthMet Project Financial Assurance

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I have reviewed the recent submittals to Polymet Northmet's Permit to Mine Application concerning the Reclamation, Closure and Postclosure Plan (Appendix 14) and Financial Assurance (Appendix 15).

Polymet has provided three estimates based on the activities described in the Reclamation, Closure and Postclosure Plan:

- Construction Year 1 Contingency Reclamation Estimate,
- Construction Year 2 Projected Financial Assurance Estimate,
- Mine Year 1 Projected Financial Assurance Estimate.

In addition, they have provided a document titled "Estimating Methodology for Northmet Closure in Mine Years Beyond Mine Year 1."

It is important to note that this review has not included a critique of or recommendations addressing the adequacy of the Reclamation, Closure and Post-Closure Plan submitted by the proponent. It also does not include address of various contingencies relative to the success of those plans that might be necessary to ensure the ultimate adequacy of the estimates, but are not typically part of present regulatory financial assurance ("FA") programs such as Minnesota's.

The review and comments provided are based on more than 35 years of professional experience in mining and environmental issues with a particular emphasis on FA aspects that has resulted in a high degree of knowledge and expertise with respect to FA regulations, guidance, cost estimation, administration and implementation.

<u>Summary comments addressing the key aspects of the Polymet FA estimate</u>

- Overall the financial assurance estimate was conducted in a manner consistent with professional engineering practice and represents an accurate representation of the cost based on the assumptions that were used.

- The involvement of SRK and use of the SRCE (Standard Reclamation Cost Estimator) Excel spreadsheet program to generate the estimate, together with a Minnesota specific cost database, ensures that the estimate has been conducted in a transparent and typically accurate manner.

- The cost estimate appears to accurately reflect the tasks that are described in the reclamation and closure plan. The earthwork and water treatment direct costs are a reasonably accurate depiction of the costs that might be incurred were those activities to be conducted by a third party on behalf of the State of Minnesota.

- The estimate includes costs for "worst-case" conditions by including estimates for closure in Year 11 (highest cost) and at other critical junctures. This is often a point of dispute, and the identification of, and estimate for the worst-case situation as a foundation of FA is particularly important. This is even more important for the proposed project given that the Reclamation and Closure Plan (RCP) depends on significant movement of potentially acid generating waste rock piles as backfill into the previously mined pits. If the mine were to close prematurely it would require more backfill in Year 11 than at any other time, so establishing that as the worst-case situation is highly logical and consistent with best practice in FA estimation.

- FA estimation includes both direct costs, which are the actual capital and operating costs for implementing the RCP, and indirect costs, which are the additional or overhead costs associated with the direct costs and typically include mobilization and demobilization, engineering design/ redesign, contingency, contractor profit and overhead, agency contract administration and project management, and agency indirect activities. The major points of issue are not in the estimate of direct costs as discussed in the prior comments, but instead with respect to indirect costs, and how the total costs are used to estimate the net present value for the establishment of long-term FA.

    - The estimate only includes indirect costs of 5% as a factor of the capital and operating costs, or direct costs. This means the estimate is not consistent with FA requirements which account for a myriad of additional costs. As evidenced by the information contained within MINE CLOSURE AND RECLAMATION COST ESTIMATION GUIDELINES: INDIRECT COST CATEGORIES prepared in 2015 for the Alaska Department of Natural Resources.[1], indirect costs range from a low of 29% to a high of +80%, but in no case at the 5% used in this estimate.

    - The estimate uses a 1.1% inflation rate and an 8% discount rate. The discount rate is typically based on the interest earned for a trust fund. To obtain an earnings rate of 8% it would have to be assumed that the FA was in the form of an investment in the stock market with the inherent risks, which is atypical for FA investment practice. The resulting net discount rate of 6.9% is incredibly high, and not consistent with most state and federal regulatory practice or precedents, which typically use a net discount rate that ranges from 2.8% to 5%.

    - The estimate also uses a 50-year time period for long-term costs and not a more typical 100 to 500-year time frame.

- The information provided for the long-term cost estimate was summarized and did not provide the necessary details required to allow for accurate evaluation by a third-party. The application should not be considered complete until a more detailed long-term cost estimate is provided and an opportunity allowed for review of that information.

- Based on the information and assumptions discussed above, including the use of a 6.9% net discount rate, Polymet Northmet has estimated the FA for the maximum cost year 11 to be a NPV

[1] http://dnr.alaska.gov/mlw/mining/largemine/rcindirects_dowlreport20150407.pdf

of $332M through year 50. Using a 2.8% net discount rate we estimate the FA on a 500-year basis to be a NPV of $515M, and using a 1.5% net discount rate on a 500-year basis to be a NPV of $755M. This does not include an increase in indirect costs from 5% to 30% which if using the 1.5% net discount rate would further increase the value of the recommended FA for the Polymet Northmet project to a NPV of approximately $934M.

Minnesota Financial Assurance Requirements and Guidance

Minnesota's financial assurance regulations applicable to the Polymet Northmet Project are contained in the Revised Statutes of Minnesota (RSM) for Nonferrous Metallic Mineral Mining Chapter 6132.1200 Financial Assurance. The key requirements follow:

6132.1200 FINANCIAL ASSURANCE
Subp. 2. ***Contingency reclamation cost estimates.*** *Persons intending to conduct a mining operation shall submit, as part of the application for a permit to mine, a documented estimate of costs necessary to implement the contingency reclamation plan under part 6132.1300, subpart 4. This estimate shall include closure and postclosure maintenance activities required if operations cease within the first calendar year.*

A. The permittee shall annually adjust the contingency reclamation cost estimate under part 6132.1300, subpart 4.

B. Cost estimates shall be based on the following:

(1) current dollar value at the time of the estimate; and

(2) the cost to the commissioner of administering and hiring a third party to implement the contingency reclamation plan.

C. No salvage value attributed to the sale of wastes, facility structures, equipment, land, or other assets shall be used for estimating purposes.

6132.1300 ANNUAL REPORT.
Subp. 4. ***Contingency reclamation plan.*** *A contingency reclamation plan including closure and postclosure maintenance shall be submitted with the annual report to identify reclamation activities that would be implemented by the permittee if operations cease in the upcoming calendar year. The plan shall include the following:*

A. methods, sequence, and schedule of reclamation that address the goals and meet the requirements of parts 6132.2000 to 6132.3200;

B. maps and cross sections at a scale approved by the commissioner that depict the construction, including shape, extent, and content, and reclamation, including contouring, covering, vegetation, closure, and postclosure maintenance, of each area affected by mining; and

C. cost estimates and financial mechanisms under part 6132.1200 necessary to implement the contingency reclamation plan if operations cease in the upcoming calendar year.

Minnesota's regulations require a detailed review of all of the costs of reclamation and closure annually, and adjusts the financial assurance cost estimate accordingly. Most states and federal agencies conduct reviews on a three to five-year basis and in some cases are not required to account for post closure costs.

No guidance for financial assurance cost estimation were identified for either the Minnesota Department of Natural Resources or Pollution Control Agency.

I have obtained and reviewed the currently available financial assurance cost estimates for mines in Minnesota administered under highly similar ferrous minerals regulations. The cost estimate basis and methodology used were highly inconsistent and not typical to the level of cost estimates performed in

most other states. The estimates did not appear to be updated on an annual basis as required. The estimates in most cases did not identify post-closure activities or associated costs.

Detailed Comments on Long-Term Cost Estimation

1. The federal and state agencies have recognized the inadequacy of approaches to FA that are not specific to hardrock mining. The primary federal land management regulatory agencies, the U.S. Department of Interior, Bureau of Land Management (BLM) and U.S. Department of Agriculture, Forest Service (USFS), and a number of states including Alaska, Montana, Nevada and New Mexico, have developed guidance for the determination of long-term cost estimation for financial assurance purposes.
    a. BLM's 3809 Handbook[2] extensively addresses long-term tasks and costs as well as acceptable mechanisms. Nevada BLM has issued guidance (Appendix A) on long-term costs based on their regulatory authority under 43 CFR § 3809.552(c)[3] recommending the use of a 500-yr period to simulate "perpetuity" since present value approaches $0, and a trust fund as the most appropriate FA mechanism for this purpose.
    b. The USFS Training Guide for Reclamation Bond Estimation and Administration[4] recommends that the costs be discounted over a minimum of 100 years to arrive at the initial estimation of a trust fund amount.
    c. Alaska has typically dealt with long-term monitoring and O&M activities by requiring at least a 100-year duration for costs together with a conservative approach to the determination of discount rates. As reflected by the recent Donlin Gold EIS Appendix A: Financial Assurance[5] estimate a "Costs for long-term post closure activities were estimated out to 200 years after closure of the operation. The 200-year time period is sufficient to demonstrate that the post-closure trust fund can be self-sustaining in perpetuity, should long term water management be required post closure." The estimate used an inflation factor of 2.16% and 5.00% interest or a net discount rate of 2.84%.
    d. Montana's Department of Environmental Quality (DEQ) was the first regulatory agency in the U.S. to recognize long-term water management and treatment requirements at the Golden Sunlight mine related to mine influenced water and costs in mine site closure and financial assurance cost estimation beginning in 1997. Montana has consistently applied a 100-year duration for long-term cost estimates together with a requirement for a cash trust fund.
    e. Although not specifically identified in New Mexico's Mining and Mineral Division (MMD) Guidance for Calculating Reclamation Costs in Net Present Value, the suggestion for water treatment is for a duration of 100-years (p. 3). Where long-term water management and treatment costs have been applied in past FA calculation in New Mexico, a 100-year basis has consistently been applied including for the Questa site as well as the Chino and Tyrone Mine sites, all of which are similarly expected to require perpetual care and maintenance.

2. There is little or no precedence for the use of a 50-year period in financial assurance cost estimation. Given the significance of the water management and treatment requirements for the Polymet Northmet site in terms of both cost and duration together with the numerous precedents available, the

[2] H – 3809-1 – Surface Management, Release 3-336, 09/17/2012.
[3] 43 CFR 3809.552(c)- When BLM identifies a need for it, you must establish a trust fund or other funding mechanism to ensure the continuation of long-term treatment to achieve water quality standards and for other long-term post-mining maintenance requirements.
[4] For Mineral Plans of Operation authorized and administered under 36 CFR 228A, USDA – Forest Service, APRIL 2004.
[5] http://www.donlingoldeis.com/Documents/17%20Appendix%20A%20to%20Appendix%20B.pdf

FA representing those tasks should be calculated for a period of a minimum of 100 years, and preferably for at least 200 or ideally 500 years as recommended by BLM.

3. The U.S. Office of Management and Budget (OMB) has issued guidance for discount rates that should be considered by the Minnesota Department of Natural Resources. It is a more conservative approach than that suggested by the project proponent and in our professional experience more consistent with other federal and state agencies. 2016 Discount Rates for OMB Circular No. A-94[6] recommends that a "real" discount rate be used for discounting constant-dollar flows, and specifies a current 30-year rate of 1.5% suggesting that programs with durations longer than 30 years use the 30-year interest rate. Given the significance of the Polymet Northmet site FA requirements, together with precedent for a similar conservative approach in determination of long-term FA, a net (e.g. real interest rate) discount rate of at a minimum 2.84%, and preferably using a rate of 1.5% should be used in determining the net present value of the Polymet Northmet site long-term monitoring and O&M FA.

4. The significance of these recommendations can be demonstrated by two modified estimates that have been conducted for this purpose. First, an Excel spreadsheet was developed incorporating the cost estimate values used in the Polymet Northmet estimate. The information provided by Northmet Polymet did not provide the necessary details to exactly emulate their approach[7], and instead the data was applied to a simplified spreadsheet estimating a NPV using Polymet Northmet's assumptions for direct and indirect costs totaling $612.1M. The simplified spreadsheet I developed calculated a NPV of $332.0M, as compared to a NPV of $365.5M estimated by Northmet Polymet. Modified estimates were then performed with the following changes to the assumptions:

    a. Modification #1 used a duration of 500 years instead of the 50 years used by Polymet with no change to the net discount rate (e.g. 6.9%). The costs used by Polymet Northmet were extended from a 50-yr period to a total project period of 500-years where applicable. Water Treatment Plant capital cost replacement, which was not identified in the Polymet Northmet estimate, was based on a total estimated cost of $10M with 20% replacement intervals for moving equipment of 10 years, 20% replacement intervals for stationary equipment of 20 years, and total replacement every 100 years. The results are summarized in Table 1 which show that over the 500-yr period approximately $4.0B in costs would be estimated and based on a net discount rate of 6.9% a NPV of $339.2M is estimated as compared to our initial estimate of $332.0M, or an increase in NPV of $7.2M for 500-year duration as compared to a 50-year duration. The small change is largely due to the high discount rate as demonstrated in the following section.
    b. Modifications #2 and #3 used a duration of 500 years and also included changes to the net discount rate using 2.8% and 1.5% respectively. The results are summarized in Table 1 which show that for a net discount rate of 2.8% the NPV would increase to $515M and for a net discount rate of 1.5% would increase to $755M. This is further demonstrated in Figure 2 which shows the cumulative FA for the various net discount rates for 500-year period applied to the Polymet Northmet FA data. As indicated by the figure, the duration period is more sensitive as the discount rate is lowered, and in the case of a 1.5% discount rate the total amount of FA necessary increases until approximately 300 years.

[6] https://www.whitehouse.gov/sites/default/files/omb/memoranda/2016/m-16-05_0.pdf

[7] The complete information to support the FA costs for the additional mine years should be requested and provided. Additional explanation needs to be provided on the methodology used to determine NPV based on the approach which identifies "variable" and "fixed" costs and adjustments for water treatment and why these methods, which are not typical, were used in the calculations.

5. The Polymet Northmet FA is inconsistent with federal and state guidance for indirect costs and cost escalation. At a minimum, the FA costs should include indirect costs in conformance with existing practice in other states and by the BLM and USFS. It is also recommended that consideration be given to developing guidance relative to indirect costs. The rationale for this recommendation is contained in the recent 2015 publication titled MINE CLOSURE AND RECLAMATION COST ESTIMATION GUIDELINES: INDIRECT COST CATEGORIES prepared for the Alaska Department of Natural Resources.[8] As noted by the report, "Estimation of a mine's direct R&C costs is a relatively straight-forward exercise; however, estimating indirect costs presents a greater challenge. Each category of indirect costs – contractor profit, contractor overhead, performance and payment bonds, liability insurance, contract administration, engineering redesign, and contingency – exhibits a degree of variability." As evidenced by the material within the report, indirect cost category ranges by agency were from a low of 29% to a high of +80%, but in no case at the 5% total proposed by Polymet Northmet. Our modifications #4 to Polymet Northmet's estimate used a duration of 500 years and also included changes to the net discount rate using 1.5% and indirect costs using 30% instead of 5%. The results are summarized in Table 1 which show that based on these assumptions, which we recommend be used, increase the FA to $934M.

[8] http://dnr.alaska.gov/mlw/mining/largemine/rcindirects_dowlreport20150407.pdf

Table 1

Polymet Northmet FA Summary

Item	Polymet Base Case Mine Year 11	Modified Estimates			
		#1	#2	#3	#4
Capital Costs					
Category 2/3 Waste Rock Pile	$61,458,842	$61,458,842	$61,458,842	$61,458,842	$61,458,842
Category 4 Waste Rock Stockpile	$45,566,470	$45,566,470	$45,566,470	$45,566,470	$45,566,470
Category 1 Waste Rock Stockpile	$0	$0	$0	$0	$0
Open Pits	$156,544	$156,544	$156,544	$156,544	$156,544
Flotation TSF	$38,837,611	$38,837,611	$38,837,611	$38,837,611	$38,837,611
Sub-Total	$146,019,467	$146,019,467	$146,019,467	$146,019,467	$146,019,467
Long-Term Monitoring and O&M Costs					
Duration, years	30	500	500	500	500
WWTF Pit Flushing	$75,612,990	$75,612,990	$75,612,990	$75,612,990	$75,612,990
WWTP	$338,113,846	$3,387,900,737	$3,387,900,737	$3,387,900,737	$3,387,900,737
WWTP Capital Replacement	$0	$210,000,000	$210,000,000	$210,000,000	$210,000,000
Phase 2	$23,238,499	$23,238,499	$23,238,499	$23,238,499	$23,238,499
Sub-Total	$436,965,335	$3,696,752,226	$3,696,752,226	$3,696,752,226	$3,696,752,226
Total Direct Costs	$582,984,802	$3,842,771,693	$3,842,771,693	$3,842,771,693	$3,842,771,693
Indirect Costs					
% of Direct Costs	5%	5%	5%	5%	30%
Indirect Cost	$29,149,240	$192,138,585	$192,138,585	$192,138,585	$1,152,831,508
Total Direct + Indirect Costs	$612,134,042	$4,034,910,278	$4,034,910,278	$4,034,910,278	$4,995,603,201
Net Present Value					
Inflation	1.10%	1.10%			
Interest	8.00%	8.00%			
Net Discount Rate	6.90%	6.90%	2.80%	1.50%	1.50%
NPV (2016$)	$332,029,460	$339,189,924	$514,638,906	$754,516,546	$934,163,343

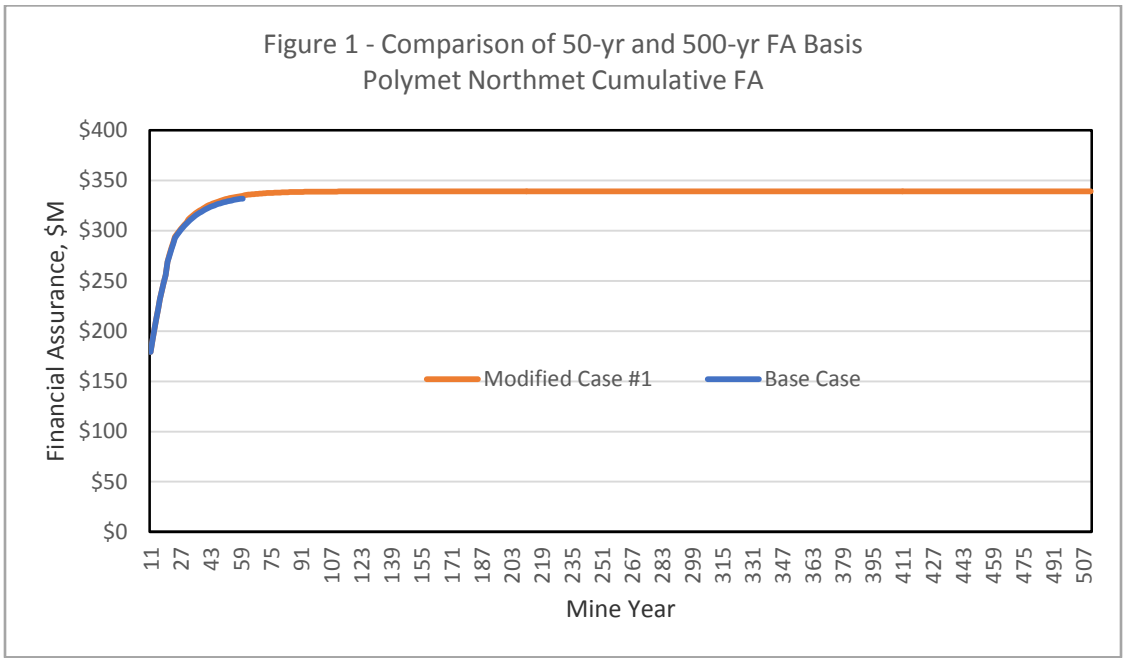
Figure 1 - Comparison of 50-yr and 500-yr FA Basis
Polymet Northmet Cumulative FA
Financial Assurance, $M
$400
$350
$300
$250
$200
$150
$100
$50
$0
Modified Case #1
Base Case
11 27 43 59 75 91 107 123 139 155 171 187 203 219 235 251 267 283 299 315 331 347 363 379 395 411 427 443 459 475 491 507
Mine Year

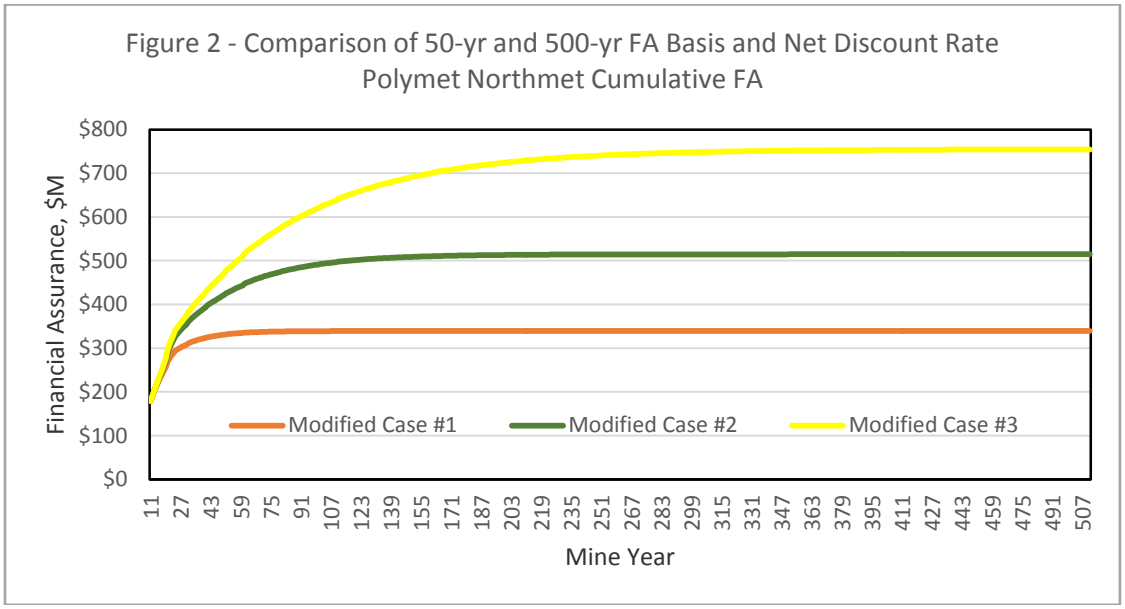
Figure 2 - Comparison of 50-yr and 500-yr FA Basis and Net Discount Rate
Polymet Northmet Cumulative FA
Financial Assurance, $M
$800
$700
$600
$500
$400
$300
$200
$100
$0
Modified Case #1
Modified Case #2
Modified Case #3
11 27 43 59 75 91 107 123 139 155 171 187 203 219 235 251 267 283 299 315 331 347 363 379 395 411 427 443 459 475 491 507
Mine Year