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Technical Memorandum

To: Erik Carlson
From: Tina Pint
Subject: TetraTech Review of NorthMet GoldSim Models
Date: August 29, 2012
Project: NorthMet SDEIS – 23690862.00 042 002
c: Jim Scott, PolyMet; Steve Donohue, Foth

At the request of PolyMet, Tetra Tech (a subcontractor to Foth) reviewed the Plant Site and Mine Site probabilistic water quality models that have been developed by Barr for the NorthMet Project. The scope of Tetra Tech's review was to check the models with respect to the work plan documents in order to determine if project components and assumptions documented in the work plans were properly entered into the models. This review was conducted using the following versions of the models and work plans:

- Mine Site Water Modeling Work Plan, Version 7 (dated July 2, 2012)
- Mine Site GoldSim model, Version 2.2
- Plant Site Water Modeling Work Plan, Version 6 (dated July 2, 2012)
- Plant Site GoldSim model, Version 2.1

Spreadsheets provided by Tetra Tech and containing the results of their review are attached. A column has been added to the spreadsheets providing the action Barr has taken to remedy the identified issues. Several of the identified problems/issues will require a change to either the models or the work plans. In cases where a change is to be made to the model, the change will be made and identified in the tracking spreadsheet that has been developed for the tracking of model changes resulting from ERM's review. Tetra Tech has independently made the model changes identified and has determined that these model changes do not affect model predictions pertaining to water resource objectives. Changes made to the work plans will be identified in the next submittal of these documents.

Documentation: "Plant Site Water Modeling Work Plan, Version 6" (dated July 2, 2012)					
Item	**Date**	**Model Version**	**Problem / Issue**	**Suggested Corrective Action**	**Barr Action Taken**
1	8/14/2012	PS V2.1	Tt-GEO found that many release rate distributions for both fine and coarse tailings (listed in Tables 1-13 and 1-14) are not modeled as beta distributions but rather as log-normal distributions.	Update documentation to reflect these differences or modify distributions in model (as appropriate). Species in error are: Se, Ag, As, Pb, Tl, V	Work Plan is correct. The release rates for several constituents in the model and work plan tables were modified during the CDF process (CDF052). This CDF was rejected, requiring the work plan tables and model to go back to a state prior to the proposed CDF changes. The work plan tables were changed back (i.e., the means, standard deviations, minimum and maximum values were changed back) but the selected distributions (i.e., Beta vs. Log-Normal) within the model were inadvertantly not changed back. Model changed by CDA on 08/20/12 to use Beta distributions according to the work plan; not Log-Normal.
2	8/14/2012	PS V2.1	Tt-GEO found that the release rates for beryllium from fine and coarse tailings were assumed to be zero (in contrast to the non-zero values in Tables 1-13 and 1-14).	Update indicated tables or modify values in model (as appropriate).	Work Plan is correct. The release rates for beryllium in the model and work plan tables were modified during the CDF process (CDF052, all release of beryllium was non-detects, suggesting zero release). This CDF was rejected, requiring the work plan tables and model to go back to a state prior to the proposed CDF changes. The work plan tables were changed back (i.e., the means, standard deviations, minimum and maximum values were changed back) but the selected distributions (i.e., Beta vs. Discrete) within the model were inadvertantly not changed back. Model changed by CDA on 08/20/12 to use Beta distributions according to the work plan; not Discrete with a value of 0.
3	8/14/2012	PS V2.1	Tt-GEO found that the interception well system (described on page 9 of this document) has been replaced with an interception trench system (until t=35 years). [Note: The interception system is still replaced by a permeable reactive barrier after t=35 years.]	Replace "Interception Wells…" section on page 9 with a detailed description of the trench system. Also remove all other references to interception wells elsewhere in the document (e.g. Figure A and paragraph 3 of page 5).	As a results of the AWMP process, the interception well system has been replaced by a trench system. The model was updated after the July submittal of the work plans, creating the discrepancy. The work plan will be modified to no longer make mention of the interception wells, but instead the trench collection system.
4	8/14/2012	PS V2.1	Paragraph 3 on page 10 misidentifies Table 1-47 as the location of constituent specific PRB efficiency; this information is actually in Table 1-45.	Replace "Table 1-47" with "Table 1-45" in text.	This suggested change will be made.
5	8/14/2012	PS V2.1	Flow from Area 5 is modeled as an uncertain input resampled each month (which is how it is described in Table 1-1), but paragraph 2 on page 12 states that Area 5 flow will be a deterministic input.	Update text to agree with model and Table 1-1.	The model is correct (see Section 5.5.4 of the Water Modeling Data Package Volume 2 - Plant Site, Version 7). Text will be updated to indicate that the concentration effluent from Area 5 is deterministic and the flow is an uncertain input, resampled each month and correlated to the watershed yield.

Documentation: "Mine Site Water Modeling Work Plan, Version 7" (dated July 2, 2012)					
Item	**Date**	**Model Version**	**Problem / Issue**	**Suggested Corrective Action**	**Barr Action Taken**
1	8/15/2012	MS V2.2	Paragraph 2 on page 5 indicates that Category 4 seepage flows into the shallow aquifer, however in the model this seepage ("Cat4SP_Water_Mixed") only goes to the east pit (cells "Sink_EPCP_Sump_water" and "Sink_EPCP_PoreLower_water") and/or the WWTF ("WestPond_Water").	Remove "Category 4" from the statement in this paragraph and (if necessary) add another sentence indicating where Category 4 seepage goes.	The destination for seepage from the Category 4 stockpile is described in the Groundwater Transport Conceptual Model section. The paragraph on page 5 will be edited to read "flows to a groundwater evaluation point or to a dewatered mine pit..."
2	8/16/2012	MS V2.2	Pb and Sb values for "WWTF_Targets_Closure" do not match the values listed in Table 1-34 of the documentation.	Update Table 1-34 to reflect values used in current model version.	Work plan is correct. This is a change due to the AWMP, Section 5, and is implemented correctly in the model via the element "WWTF_Adj_Targets", which needs to be activated/deactivated for AWMP modeling. The model will be updated following AWMP completion to use the listed values in all situations, not just when AWMP Section 5 is active.
3	8/16/2012	MS V2.2	Ni value in the model variable "WP_PRB_Limits" does not match the value in Table 1-34.	Update Table 1-34 to reflect value used in current model version.	Model is correct, and is consistent with AWMP Version 2. Workplan will be updated to use the correct value.
4	8/16/2012	MS V2.2	Entry for Year 11.5 in Table 1-9b is not included in the model input data table (variable WP_Footprint_Area)	The missing entry does not influence model results, so the entry should simply be removed from Table 1-9b in the documentation.	This suggested change will be made.
5	8/16/2012	MS V2.2	"Cat1SP_Geomem_Perc" is not located in the *Stockpile_Hydrology* container, but is rather in the *Model_Controls* container.	The variable's location does not influence model results, but should probably be moved to the "Stockpile Hydrology" container to make ERM's review easier.	This model element, like other AWMP-related inputs, needs to be activated/deactivated for AWMP modeling and is therefore in the "Model_Controls" container. Model will be updated following AWMP completion to incorporate agreed-upon AWMP inputs within the main "Inputs" container.