WATER RESOURCES VOL 2

IMPACT INDICATORS, CONCEPTUAL MODEL AND SIMULATION METHODOLOGY

TWIN METALS MINNESOTA PROJECT

Environmental Review Support Document

Prepared for Twin Metals Minnesota, LLC
Prepared by

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REVISION RECORD

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REVISION NARRATIVE

DISCLAIMER

This document is a working document. This document may change over time because of new information, or further analysis or deliberation.

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LIST OF ABBREVIATIONS, ACRONYMS, AND SYMBOLS

TMM	Twin Metals Minnesota, LLC

1.0 INTRODUCTION

The Twin Metals Minnesota, LLC (TMM) Project (Project) is focused on designing, permitting, constructing, and operating an underground copper, nickel, cobalt, platinum, palladium, gold, and silver mining project. Located approximately nine miles (14 kilometers [km]) southeast of Ely, Minnesota, and 11 miles (18 km) northeast of Babbitt, Minnesota, the Project targets valuable state, federal, and private minerals within the Maturi deposit, which is a part of the Duluth Complex geologic formation.

All potential Project infrastructure locations presented herein are considered preliminary and are undergoing further design and engineering evaluations which will dictate final design and locations. Further information about TMM and the Project is located at http://www.twin-metals.com/.

The purpose of this document is to provide necessary information for the environmental review and permitting process. TMM retained [insert Consultant name] (insert abbreviated Consultant name) to complete [insert text].

2.0 SUMMARY

- Provide a high level summary of what is presented within this report.
- Describe how this report volume relates to the other volumes.
- Describe how the data documented and validated and analyzed to establish baseline condition in the other volumes of the *Water Resources Data Package*, are further utilized to develop a conceptual model of the hydrologic regime at the Project with respect to surface water, groundwater, climate, and the water balance for the Project.
- Describe methodologies designed to analyze, predict, and quantify potential changes to the hydrologic regime as a result of implementation of the Project.
- Describe how the conceptual model and numerical model simulation methodologies presented in this report are to be carried forward into other volumes.
- Reference relevant sections of the FSDD, SEAW, and / or federal documents to remind the reader there is a defined scope that is being followed.

3.0 IMPACT ASSESSMENT CRITERIA

3.1 Areas of Analysis

Areas of analysis will be developed and described. Areas of analysis will be developed accounting for the following:

- Areas of analysis of direct effects will be determined using the construction limits of the proposed action and alternatives that could impact the existing conditions of surface and groundwater resources.
- Areas of analysis of direct and indirect effects to the baseline conditions will be determined using areas where changes in hydrology, changes in groundwater quantity, groundwater quality, surface water flow, surface water quality, or changes due to dust deposition from the proposed action and alternatives could impact the baseline conditions.

3.2 Indicators

The conceptual models should be addressed

3.2.1 Surface Water

- Will the Project design features, operating protocols, and the resulting water balance model confirm that a direct discharge of process water or contact will not be anticipated?
- How will water appropriation, contact water management, non-contact water management, and mine dewatering affect the Birch Lake water level or hydrologic system?
- How will contact water management and non-contact water management affect surface water flows and stream morphology of Keeley and Nokomis Creeks?
- Could the management of process water and contact water result in impacts to water quality in area streams (Keeley and Nokomis Creeks) or Birch Lake and if so, to what extent?
- Could the flooded underground workings in closure result in impacts to water quality in area streams or Birch Lake and if so, to what extent?

3.2.2 Groundwater

- What will be the three dimensional extent of the cone of depressurization over the life of dewatering activities (projected groundwater potentiometric surface maps and cross sections)?
- What will be the timeframe and expected rate to initiate and complete flooding of the mine workings?
- How will contact water management and non-contact water diversion affect groundwater recharge and the potentiometric surface in the shallow groundwater system?
- How will the changes in the potentiometric surfaces affect local streamflow, contribution to Birch Lake and wetlands?
- Will local domestic wells be affected by mining activities?
- Could the management of process water and contact water result in impacts to groundwater quality and if so, to what extent?

- Could the flooded mine workings in closure result in impacts to groundwater quality and if so, to what extent?

3.3 Conceptual Site Model

3.3.1 Existing Conditions

A conceptual model of the hydrologic system illustrating pre-project (baseline) conditions will be developed to include the interactions between the following components:

- Climatic processes that add or remove water to the Project
- Surface water hydrology
- Surface water quality
- Groundwater flow and levels
- Groundwater quality
- Wetland hydrology
- Man-made structures that exert controls on groundwater and surface water

3.3.2 Future Conditions

A conceptual model will be developed to represent future conditions and incorporate the following into the pre-project conceptual model:

- Addition of Project processes during the mine operations.
    - Mine water inflow
    - Groundwater drawdowns and other hydrologic stresses induced by mine dewatering
    - Tailings storage
    - Backfill operations
    - Changes in recharge from mine related above ground facilities
    - Stormwater routing
    - Land cover changes and topographic modifications
    - Withdrawals of water from Birch Lake Reservoir
      Discharges to the environment
- Mine closure and post-closure processes
    - Flooding of underground workings
    - Transition of flooded mine from functioning as a terminal sink during initial stage of inflow to a flow—through feature during later stages and post closure
    - Land use changes and restoration to pre-project conditions
    - Management of tailings storage
    - Termination of surface water withdrawals and discharges related to mine operations

3.4 Simulation Methodology

Numerical Models – Model Methodology

Based on the conceptual models developed for the hydrologic systems, numerical models will be developed to simulate existing baseline (pre-project) hydrologic conditions and simulate the future response of the baseline conditions as a result of implementation of the Project. The numerical models will use combination of deterministic and stochastic / probabilistic approaches to prediction of potential outcomes.

The following modeling activities will be performed:

- Groundwater Flow Model
- Groundwater Quality Model
- Tailings Storage (DSF) Hydrology Model
- Surface Water Hydrology Model
- Surface Water Quality Model
- Water and Mass Balance Model
- Geochemical Model of Underground Mine Water Quality and Mass Loading

A description and graphical representation illustrating how the various models function together to simulate the baseline conditions and predict future responses will be provided. Details will be provided regarding the assumptions for the various models, the handoffs of inputs and outputs between the models, the impact categories assessed, types of impacts, and impact evaluation criteria, end points and timeframes.

Using the defined areas of analysis, pre-project conditions and future conditions will be modeled using specific procedures that will be described within this section in detail. A generalized approach is presented below:

3.4.1 Existing Conditions

- Pre-project conditions models will use available information through Q2 2020 for preliminary modeling.
- Final modeling will include data collected after Q2 2020 as necessary. For example, the DSF hydrology model will be updated with data through at least Q4, 2020 since some of the associated data streams are not available at the end of Q2 2020.
- Pre-project models will be calibrated to a selected target data-set(s) to verify that it adequately represents the existing hydrologic system prior to use in making future predictions.
- For each model, calibration target error thresholds will be identified.

- Each model will undergo sensitivity analysis to identify the model inputs it is most sensitive to and to rank the model input parameters by the degree of model sensitivity.
- Uncertainty analysis will be performed and presented for each model.
- Groundwater hydrological and water quality models will be developed for the Project area and adjacent watershed(s).
- Groundwater modeling will be coupled with Precipitation-Runoff Modeling using an integrator such as GSFLOW.
- A series of stochastic models will be developed to predict climatic conditions using the following approach:
    - Based on local National Oceanic and Atmospheric Administration (NOAA) meteorological data and historical data from meteorological stations in Ely, MN, and Babbitt, MN.
    - Generate a range of expected climatic conditions.
    - Support surface water modeling, GSFLOW, and water balance models.
- Surface water hydrological and water quality models will be developed for the Project area and the watershed(s) adjacent to the Project area.
- Surface water models will use site-specific watershed characteristics and the stochastic climate generator to simulate surface water discharge and storage conditions.
- Surface water models will be calibrated to local USGS gaging station data as wells TMM collected data. These locations include:
    - DMSW3-North Nokomis Creek
    - DMSW12-Birch Lake Outlet
    - DMSW13-Kawishiwi River
    - DMSW15-Keeley Creek
    - DMSW23-Filson Creek
      SW28-South Nokomis Creek
- Surface water models will consider the 7Q10 flow (7-day, 10-year low flow conditions) in the water bodies as a scenario among others in the range of flow conditions simulated.
- The Project water balance model will be developed to define and quantify operational interactions as they are influenced by varying climatic conditions and interactions with local water resources.
- Finally, all of the interacting Project, climatological, and hydrological interactions will be integrated and applied to predefined analysis points.

3.4.2 Future Conditions

- Future conditions models will use the calibrated baseline conditions models and then predict changes to the baseline conditions based on operational characteristics for the mine and the DSF.
- The same models and processes will be used with the exception of additional emphasis on mine inflows, DSF hydrology models and geochemical modeling of underground mine water quality and mass loading.
- Future conditions models will make predictions on a transient basis over the mine period of operations and post closure phases.
- Each model will undergo sensitivity analysis to identify the model inputs it is most sensitive to and to rank the model input parameters by the degree of model sensitivity.
- Uncertainty analysis will be performed and presented for each model.
- The models will be integrated and applied to the analysis points predefined for the pre-project baseline models.
- The models will predict conditions as influenced by the Project to determine potential impacts to the hydrologic system.

4.0 REFERENCES

TABLES

FIGURES

APPENDICES

APPENDIX [#A, B, C, D]

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