TECHNICAL MEMORANDUM

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CONTINGENCY MEASURES TO ELIMINATE WATER TAKING FROM MARMION RESERVOIR DURING LOW WATER LEVEL AND OUTFLOW PERIODS AT RAFT LAKE DAM – HAMMOND REEF GOLD PROJECT

1.0 INTRODUCTION

1.1 Objective

This technical memorandum has been prepared in response to an information request from the Ontario Ministry of Natural Resources (MNRF#4 submitted in mid-August 2015) and the Ontario Environmental Assessment and Approvals Branch (EAB #10 submitted in September 2015) with respect to contingency measures that will be put in place to eliminate water taking from Marmion Reservoir during low water level and outflow periods at Raft Lake Dam. The Ontario Ministry of the Environment and Climate Change supported this request during a teleconference at the end of September 2015. This memorandum describes a water management option for onsite storage facilities that are already described in the Environmental Impact Statement/Environmental Assessment (EIS/EA) Report that will provide contingency storage without significant design changes or additional capital costs.

1.2 Below Normal Water Level and Outflow Conditions at Raft Lake Dam

The operating water levels and outflows specified for Raft Lake Dam in the Seine River Water Management are intended to guide the management of the water control structure under normal water level and outflow conditions. However, there are conditions beyond the control of the operator that may result in the specified water levels and outflows not being achieved. The Seine River Water Management Plan defines the lower compliance level as occurring when outflows are at the minimum values specified and water levels are below the minimum specified elevation for that day. Both conditions must exist at the same time. Below normal conditions are occurring when water levels and outflows fall below the lower compliance level.

A review of the available water level and outflow data for Raft Lake Dam between 2004 and 2012 indicated that below normal conditions occurred twice during that period: from Sep 6 to Nov 1, 2006 (29 days) and from Apr 26 to Aug 7, 2010 (104 days).

1.3 Project Water Demands and Supply Sources Proposed in the EIS/EA Report

Table 1 summarizes the water demands for the Project and the supply sources included as part of the mine water balance presented in the EIS/EA Report. Water requirements for ore processing (i.e. water for reagent mixing and process make-up water in **Table 1**) account for 91% of the total water demand. Note that the mine will be designed and operated to maximize the re-use of process water. Marmion Reservoir is the preferred source for potable water and water for reagent mixing for water quality reasons.

Table 1: Project Water Demands and Supply Sources

Water Demand	Average Daily Rate (m^3/d)	Supply Sources
Potable water at the accommodation camp	300	■ Water taking from Marmion Reservoir
Potable water at the process plant	35	■ Water taking from Marmion Reservoir
Water for reagent mixing	7,200	■ Water taking from Marmion Reservoir
Process make-up water	27,698	■ Reclaimed water from the Tailings Management Facility (TMF) ■ Runoff intercepted within the Project footprint ■ Groundwater seepage into the open pits ■ Treated sewage from the process plant site ■ Water taking from Marmion Reservoir (if required)
Water for dust control	1,947	■ Runoff intercepted within the Project footprint
TOTAL	37,180	

1.4 Onsite Storage Facilities Included in the Current Project Description

1.4.1 Process Plant Collecting Pond

The Process Plant Collecting Pond (PPCP) will be located in the southwest corner of the process plant site. The pond will be divided into two cells:

- A runoff cell collecting dewatering flows from the open pits, runoff from the area surrounding the pond, the overburden stockpile, waste rock stockpile, and low grade ore stockpile, and treated sewage from the process plant site. Water collecting in the runoff cell will be used to satisfy process make-up water and dust control water requirements, and any excess will be treated (if required) and discharged to the reservoir.
- An emergency spill cell providing passive containment in the event of a spill from failure of a process plant vessel.

An emergency spillway will be provided on the south side of the runoff cell in order to discharge excess flows into the West Pit. The runoff cell will have a water storage capacity of 400,000 m^3 to the spillway invert. However, the maximum operating volume will be 350,000 m^3 to provide 50,000 m^3 of surplus capacity to ensure that discharges via the emergency spillway only occur during extreme flood events. The operating volume within the pond below the spillway invert will be controlled by pumping.

1.4.2 TMF Reclaim Pond

The Tailings Management Facility (TMF) and its associated Reclaim Pond will be located approximately 8 km northeast of the process plant site, and will be constructed in stages over the mine operating life. Thickened tailings slurry will be delivered to the TMF from the Process Plant. Water released from the deposited tailings due to consolidation/settlement, and runoff from the TMF footprint will be collected in the Reclaim Pond. Water collecting in the pond will be used to satisfy process make-up water requirements and any excess will be treated (if required) and discharged to the reservoir.

An emergency spillway will be provided on the southeast side of the Reclaim Pond in the early years of mine operation to convey excess flows to Lizard Lake. In later years, the spillway will be relocated to the southwest side of the pond to convey excess flows to Sawbill Bay. The Reclaim Pond will have a water storage capacity of 6,200,000 m^3 to the spillway invert at all stages of construction/operation of the TMF. However, the maximum operating volume will be 5,370,000 m^3 to provide 830,000 m^3 of surplus capacity to ensure that discharges via the emergency spillway only occur during extreme flood events. Similar to the PPCP, the operating volume within the pond below the spillway invert will be controlled by pumping.

Due to the natural topography within the TMF and Reclaim Pond footprint, there will be ponding in low points when water levels are low. An allowance was included for 1,800,000 m^3 of dead storage in the Reclaim Pond that cannot be easily accessed, although some of this water could likely be made available under extreme conditions if necessary. Therefore, the effective operating volume of the pond will be 3,570,000 m^3 (5,370,000 m^3 minus 1,800,000 m^3).

1.4.3 Other Holding Ponds

In addition to the PPCP and TMF Reclaim Pond, holding ponds will be located in the northeast corner of the process plant site adjacent to the waste rock stockpile (the Intermediate Collection Pond), at the Emulsion Plant, and at the Detonator Storage Area. The Intermediate Collection Pond (ICP) will collect runoff from the waste rock stockpile which will be pumped to the PPCP and used to satisfy process make-up water requirements in the mill. Runoff from the Emulsion Plant and Detonator Storage Area will be collected in the holding ponds prior to treatment (if required) and discharged to the environment. These holding ponds will have a limited water storage capacity and will be emptied following runoff events.

2.0 PROPOSED WATER MANAGEMENT OPTION

2.1 Normal and High Water Level and Outflow Periods at Raft Lake Dam

During normal and high water level and outflow conditions in Marmion Reservoir, the PPCP and TMF Reclaim Pond will be operated to maintain minimum water storage volumes that can be used during periods when the lower compliance level defined in the Seine River Water Management Plan (**Section 1.2**) is occurring at Raft Lake Dam. The proposed approach is to draw water from the ponds when the storage volumes are above the minimum values (**Section 2.2**), and discharge to the environment when the water accumulating in the ponds exceeds the maximum operating capacities (350,000 m^3 for the PPCP and 5,370,000 m^3 for the TMF Reclaim Pond). The Project is located in a net positive water environment (average precipitation exceeds average evaporation) and there will be a carryover of water accumulating in the ponds during wet periods to dry periods. In months when precipitation and runoff inflows to the ponds cannot satisfy Project water demands and maintain the minimum water storage volumes, the deficit will be met by water taking from Marmion Reservoir provided that water level and flow conditions are above the lower compliance level for Raft Lake Dam. Water taking from

Marmion Reservoir will also be used to satisfy Project water demands for potable water, and water for reagent mixing (**Table 1**).

2.2 Low Water Level and Outflow Periods at Raft Lake Dam

For periods when Raft Lake Dam is operating at the lower compliance level (**Section 1.2**), potable and raw reagent mixing water will be offset by an equivalent discharge from site storage to mitigate potential decreases in water levels and outflows at the Raft Lake Dam resulting from operations.

Water management operations planned for periods when Raft Lake Dam is operating at the lower compliance level are as follows:

- Water taking from Marmion Reservoir to satisfy demands for potable water, and water for reagent mixing (**Table 1**). It is preferred to draw water from the reservoir to meet these demands rather than use reclaimed water from the process for water quality reasons.
- Draw from the water storage volumes in the PPCP and TMF Reclaim Pond to satisfy demands for process make-up water and dust control water;
- Draw from the water storage volumes in the PPCP and TMF Reclaim Pond for discharge to Marmion Reservoir; and
- Discharge water to Marmion Reservoir to offset water taking, to mitigate potential changes to levels and outflows at Raft Lake Dam during this period.

When normal water level and outflow conditions at Raft Lake Dam recur, the minimum water storage volumes in the PPCP and TMF Reclaim Pond will be recovered by allowing water to accumulate in the ponds and water taking from Marmion Reservoir during wet periods.

3.0 MINIMUM WATER STORAGE VOLUMES

Minimum water storage volumes to be maintained in the PPCP and TMF Reclaim Pond have been selected based on the following:

- The requirement to offset water taking to satisfy demands for potable water and water for reagent mixing;
- The deficit in process make-up water requirements after accounting for reclaimed water from the TMF, groundwater seepage into the open pits, treated sewage from the process plant, and runoff intercepted within the Project footprint.
  - Reclaimed water was calculated as the difference between water in the tailings slurry discharged to the TMF and water retained in the deposited tailings due to consolidation/settlement.
  - Runoff intercepted within the Project footprint will vary depending on the prevailing water conditions. The minimum annual runoff volume obtained from mine water balance modelling over a 90-year period using precipitation, sublimation, and evaporation inputs from 1921 to 2011 was selected as a design value.
- The demand for dust control water;

- The length of the period when water level and outflow conditions at Raft Lake Dam will be at the lower compliance level.
  - As discussed in **Section 1.2**, water levels and outflows at the lower compliance level occurred twice between 2004 and 2012. The longer of the two periods was selected as the design event.
- The water storage capacities in the ponds.

Table 2 summarizes the proposed sources of process make-up water during periods of low water levels and outflows at Raft Lake Dam. The runoff volume of 9,076 m^3/d is the minimum value obtained from the mine water balance modelling. A draw of 5,275 m^3/d from the PPCP and TMF Reclaim Pond reserves will be required to satisfy the deficit in process make-up water requirements.

Table 2: Sources of Process Make-Up Water During Low Water Level and Outflow Periods

Source	Average Daily Rate (m^3/d)
Reclaimed water from TMF	12,579
Groundwater seepage into the open pits	740
Treated sewage from process plant site	28
Runoff intercepted within the Project footprint	9,076
Draw from PPCP and TMF Reclaim Pond Reserves	5,275
TOTAL	27,698

Table 3 provides the total average daily rate of draw from the ponds that will be required during periods of low water levels and outflows at Raft Lake Dam. The largest component will be the amount required to offset water taking from Marmion Reservoir for potable water and water for reagent mixing.

Table 3: Average Daily Draw Rate During Low Water Level and Outflow Periods

Water Demand	Average Daily Rate (m^3/d)
Offset water taking from Marmion Reservoir for potable water and raw (clean) water for reagent mixing	7,535
Satisfy deficit in process make-up requirements for design runoff event	5,275
Satisfy demand for dust control water	1,947
TOTAL	14,757

Table 4 provides the minimum storage volumes to be maintained in the PPCP and TMF Reclaim Pond, together with the number of days of water supply.

Table 4: Minimum Storage Volumes

Facility	Minimum Storage Volume (m^3)	Days of Water Supply
PPCP	206,594	14
TMF Reclaim Pond	1,328,107	90
TOTAL	1,534,701	104

4.0 CLOSING REMARKS

The water management option outlined above can be used as a contingency measure for periods when water level and outflow conditions at Raft Lake Dam are at the lower compliance level described in the Seine River Water Management Plan (Section 1.2). This approach is expected to achieve no net decrease in water flows or levels at the Raft Lake Dam resulting from operations during low water level and outflow periods, while allowing for mine operations to continue during these periods. The proposed option does not include new sources of water or onsite storage facilities and is not expected to require significant design changes or additional capital costs.

We trust the above meets your requirements at this time. Please do not hesitate to contact the undersigned for clarification or further information.

GOLDER ASSOCIATES LTD.

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