RS74A

Appendix F

Barr Technical Memorandum: West Pit Flooding and Flood Routing Dated September 12, 2008

Internal
Memorandum

To: PolyMet Project File
From: Greg Williams, Miguel Wong
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c:

This memo describes the flooding of the West Pit. Several flooding options were evaluated prior to the selection of the preferred option and are described in this document. This memo also includes a brief description of the East and West Pit outlet structures and XP-SWMM hydraulic/hydrologic analysis performed to estimate flood routing in Post-Closure.

Within this document, the term "Closure" refers to the period beginning in Mine Year 21 and extending until the West Pit is flooded. The term "Post-Closure" refers to the period beginning when the West Pit is completely flooded and overflow to the Partridge River begins. The analysis presented in this memo was originally performed for the Mine Site-Proposed Action. Except where specified, the information presented for the Mine Site-Proposed Action is applicable to the Mine Site-Reasonable Alternative 1.

1.0 Removal of Dewatering System

During operation, precipitation runoff and groundwater inflow to the pits will be directed to low cells in the pits where it will be collected in sumps and pumped to the surface (these dewatering systems are described in RS22). The East and Central Pits will be backfilled and their primary dewatering systems removed prior to Closure; however some temporary pumps may remain in these pits for selected dewatering that will need to be performed during flooding. Because the East and Central Pits ultimately merge into one pit, they are hereinafter referred to as the East Pit.

All power lines, substations, pumps, hoses, pipes and appurtenances used for dewatering the pits will be removed and the pits will be allowed to fill with water. The pipes from the pits to the Central Pumping Station (CPS) and the Wastewater Treatment Facility (WWTF) will also be removed, with the exceptions of the pipe between the WWTF and the East Pit that will be used in Closure and Post-Closure to route treated water to the East Pit and the pipe from the West Pit to the WWTF which may be used to convey overflow from the WWTF to the West Pit in Closure.

2.0 East and West Pit Overflow Elevations

In order to determine whether outlet structures will be needed for the pits, natural overflow locations and elevations were determined and potential steady-state water levels for the East and West Pits were predicted.

An evaluation of the surface topography along the pit rims was conducted to determine where and at what elevation natural overflow from the pits would occur. Evaluations were conducted using the available maps with 2-foot contours.

- The low point in the ground surface along the rim of the East Pit is approximately 1,596 feet above mean sea level (ft-MSL), located in the northeast corner of the pit. Water leaving the pit at this location would overflow toward the Partridge River to the southeast. Three other low points occur on the ground surface between elevations 1,598 and 1,600 ft-MSL along the rim of the East Pit.
- The low point in the ground surface along the rim of the West Pit is approximately 1,581 ft-MSL, located near the southwest corner of the pit. Water leaving the pit at this location would overflow toward the south. The next low point on the ground surface along the rim of the West Pit is at elevation 1,588 ft-MSL.

The potential future steady-state water levels for the pit lakes are dependent on the pre-mining groundwater elevations in the bedrock and the surficial deposits, as well as the transmissivities of these units. The groundwater model that was used to determine groundwater flow rates during mine operations (RS22) was also used to predict the steady-state water levels in each of the pits assuming no surface overflow outlet was available. The water level in both the East and West Pits was predicted to stabilize above the natural outflow elevations for each pit. The steady-state water level in the East Pit is above the elevation of the rock wall separating the East and Central pits; therefore, these pits would be connected and act as a single body of water.

Because the predicted maximum water levels for both the East and West Pits were higher than the natural overflow elevations, both of these pits are predicted to have a net outflow to surface water. The actual steady-state water levels in the East and West Pits after Year 20 will therefore be established by outlet structures that will be used to route surface overflows from the East Pit into the West Pit, and from the West Pit to a final discharge location in the Partridge River. The water level in the East Pit was designed to stabilize at an elevation of 1,592 ft-MSL to provide an adequate buffer between the overflow to the West Pit (1,592 ft-MSL) and the natural overflow elevation of 1,596 ft-MSL. The West Pit was designed to stabilize at an elevation of 1,581 ft-MSL, which is the natural overflow elevation of the West Pit.

3.0 East Pit Flooding

As indicated in RS22 Draft-02, mining activities will be completed in the East and Central Pit by Mine Year 11 to 13, respectively, prior to the scheduled completion of mining activities in the West Pit by

Mine Year 20. Category 1/2 waste rock and water will be used to fill the East Pit, beginning immediately after mining activities have ceased in each pit. More specifically, all Category 1/2 waste rock mined after Mine Year 14 plus approximately half of the total Category 1/2 waste rock from Mine Years 12, 13 and 14 will be placed in the East Pit.

Sources of water for East Pit flooding include net precipitation and drainage/runoff from the pit footprint, pumping from the Central Pumping Station (CPS) when needed, and liner leakage from the Category 1/2 stockpile. Approximately 5 percent of the total liner leakage from the Category 1/2 stockpile drains to the East Pit in Closure and Post-Closure. Because the waste rock fills approximately 69 percent of the pit capacity, the rate of East Pit flooding is dictated by the schedule of the waste rock input to the pit. The water level in the East Pit will be maintained within five feet of the rock surface during flooding. Based on the Category 1/2 waste rock schedule and average climate conditions, this will result in net pumping to the pit in some years, and net pumping from the pit in other years. The flooding operation has been designed for completion at the end of Mine Year 20 with construction of a treatment wetland over the top of the backfilled rock immediately following the completion of the backfilling operation. The updated sources of water and schedule for East Pit flooding are presented in Table 4-26 of RS74A – Draft02.

Stockpile drainage will continue to require treatment after Mine Year 20 and will continue to be pumped to the WWTF (see RS52). In addition, leachate from the Hydrometallurgical Residue Facility at the Plant Site will no longer be routed back to the hydrometallurgical operations at in Closure and will also require treatment (see RS65). Treatment of these flows will be accomplished using the existing WWTF as the primary treatment mechanism with additional treatment when routed through the constructed wetland treatment system built within the backfilled East Pit prior to the East Pit overflowing to the West Pit.

3.1 East Pit Flooding – Reasonable Alternative 1

The Mine Site-RA1 plan for East Pit flooding varies minimally from the Mine Site-Proposed Action. The type of rock and/or lean ore used for backfilling is different than that described for the Mine Site-Proposed Action. Additionally, the amount of water routed from the WWTF to the East Pit differs from the Mine Site-Proposed Action both during East Pit flooding, in Closure, and Post-Closure. The sources of water and schedule for East Pit flooding under the Mine Site-RA1 are presented in Table 4-54of RS74A – Draft02. All other hydrologic aspects of East Pit flooding and flood routing for the Mine Site-RA1 are identical to those presented for the Mine Site-Proposed Action.

4.0 West Pit Flooding

Upon completion of mining operations at the end of Year 20 and after pit dewatering systems are removed, the West Pit will begin to fill naturally with water from groundwater inflows, precipitation and stormwater runoff from the tributary watershed. The East Pit will also fill naturally to the outlet structure elevation and begin overflowing into the West Pit in approximately Year 21. These sources would fill the West Pit approximately 53 years after dewatering ceases.

Water may also be diverted from other sources to expedite West Pit flooding. The reasons for evaluating such diversions are related to the potential increase of rock oxidation, acid generation, and metal leaching from the walls of the West Pit. Expedited pit flooding may reduce the potential for oxidation of the material exposed in the pit walls and could therefore minimize the aforementioned risk of generating acid waters from the West Pit in Closure.

This section presents the data and assumptions used to quantify the potential sources of water for the West Pit flooding. This section also describes the duration of flooding and impacts on the flow regime of the affected watersheds. After considering the potential impacts of using the various sources and the pit water chemistry resulting from not using some of these additional sources, PolyMet decided to only use, direct groundwater inflows, surface runoff/stockpile drainage collected from the Mine Site, and seepage from the Hydrometallurgical Residue Cells (routed through the WWTF) to fill the West Pit. This results in flooding the West Pit in 45 years.

4.1 Potential Sources of Water for West Pit Flooding

In general, there are seven potential sources of water to fill the West Pit: A) direct groundwater inflows to the West Pit; B) surface runoff and stockpile drainage at the Mine Site; C) seepage collected from the Hydrometallurgical Residue Cells; D) excess water from the Tailings Basin pond; E) dewatering discharges from Peter Mitchell taconite pits; F) high flows from three locations along the Partridge River (no diversions during baseflow conditions); and G) water pumped from Colby Lake. The conceptual plans for the diversions and an approximation of the available volumes are provided in the following paragraphs for each source.

A. Groundwater Inflows to the West Pit

Figure 1 presents estimates of groundwater inflows to the West Pit as a function of water level in the pit. The groundwater contribution is more significant during the initial stages of the flooding operation, with a estimated maximum groundwater inflow of 1,307 acre-feet per year (810 gallons per minute - gpm) when the pit level is at 920 feet above mean sea level (ft-MSL), and a minimum groundwater inflow of 97 acre-feet per year (60 gpm) when the pit level is at 1,581 ft-MSL. As described in RS22 Appendix B, a range of input parameters were evaluated for the groundwater analyses; the inflow estimates used in this evaluation correspond to average values within a relatively wide range of possible groundwater inflow values.

B. Surface Runoff/Stockpile Drainage Collection from the Mine Site

There are two primary components of the water in this source: surface runoff and stockpile drainage. These sources are located at the Mine Site, and readily available for flooding the West Pit.

- Stormwater runoff from the tributary watershed will be routed into the West Pit though a series of ditches maintained and/or constructed in Closure. The contributing drainage areas include the footprints of the West and East Pits and all other areas within the Mine Site that can be drained by gravity to the pits. This includes stormwater from the tops of reclaimed stockpiles and stormwater from other undisturbed or reclaimed areas.

RS24 describes the assumptions made to quantify the surface runoff volumes within the Mine Site from reclaimed stockpiles. Mean values assumed for the calculations are 29.2 inches of annual precipitation based on precipitation records compiled between 1971 and 2001 from 16 weather stations located within 30 miles from the Mine Site, and 20.0 inches of annual open water evaporation based on pan evaporation records at Hoyt Lakes. For this analysis, the annual runoff from the Category 1/2 stockpile was assumed to be 12.5 percent of annual precipitation and 32.5 percent of annual precipitation for the Category 3 stockpile (runoff from other stockpiles does not contribute to West Pit flooding). Runoff from undisturbed areas was assumed to be 40 percent of annual precipitation based on a comparison of precipitation and flow records for the Partridge River.

Surface runoff to the West Pit from reclaimed stockpiles and undisturbed totals 774 acre-feet per year (480 gpm) based on average precipitation, approximately 75% of which is runoff from non-stockpile areas. Net precipitation falling directly on the East and West Pits contributes another 355 acre-feet per year (220 gpm), while groundwater seepage from the constructed wetland in the East Pit to the underlying bedrock contributes approximately 32 acre-feet per year (20 gpm), as described in RS22 Appendix B. Surface runoff and net precipitation to the East Pit will outflow to the West Pit through the East Pit outlet structure and constructed channel.

- Stockpile drainage includes water that infiltrates uncovered or covered stockpiles and reaches the stockpile liner system. This volume of water is referred to as liner yield. A portion of liner yield is collected, routed to the Wastewater Treatment Facility (WWTF), and pumped to the East Pit. The remainder of liner yield passes through the liner system as liner leakage. Only liner leakage from the Category 1/2 Waste Rock Stockpile drains to the East Pit or West Pit; 20% of the total liner leakage drains to the East Pit during Mine Years 1 to 20, and 5% of the total liner leakage drains to the East Pit in Closure and Post-Closure. Sixty percent of the total liner leakage from the Category 1/2 Stockpile drains to the West Pit during Mine Years 1 to 20, and 75% of the total liner leakage drains to the West Pit during Closure and Post-Closure. The total process water routed to the East Pit is 328 acre-feet per year. This value is assumed to remain constant throughout Closure and Post-Closure.

The total flow routed to the West Pit from surface runoff and stockpile drainage within the Mine Site, net precipitation falling over the pits, and groundwater loss from the East Pit is 1,490 acre-feet per year (924 gpm) throughout Closure and Post-Closure.

C. Hydrometallurgical Residue Cell Seepage

Seepage collected from the Hydrometallurgical Residue Cells may be treated by the WWTF at the Mine Site and routed to the East Pit to accelerate West Pit Flooding. The collected seepage would decrease over time, eventually stopping. The estimated seepage rate decreases from an average initial rate of 348 acre-feet per year (215 gpm) in Year 21 to zero after Year 34.

D. Tailings Basin Pond Surplus

At the end of mining operations in Mine Year 20, the Tailings Basin will hold approximately 19,000 acre-feet of water in the combined basin 1E/2E. This surplus water volume would be pumped from the Tailings Basin (located in the Embarrass River watershed) to the West Pit (located in the Partridge River watershed) to facilitate closure activities as soon as the Process Plant stops mineral processing.

In addition to the initial volume of water, water collected by the Tailings Basin seepage management system is estimated to provide an average of 1,236 additional acre-feet per year (766 gpm) which would be pumped to the West Pit for a period of up to 15 years into Closure. After this time, collected seepage would no longer require treatment.

Water from the Tailings Basin pond would be routed through the Treated Water Pipeline between the Central Pumping Station and the Tailings Basin by reversing the flow (see RS22). The approximate distance from the Tailings Basin to the West Pit is 39,000 feet as measured along the pipe. Tailings Basin water is predicted to meet water discharge limits.

E. Dewatering Discharges from Peter Mitchell Pits

There are two inundated pits (Peter Mitchell pits) owned by Northshore Mining Company that are located just north of the Mine Site. The Peter Mitchell pits are located in the Biwabik Iron Formation. Information provided by Northshore Mining Company (email communication from Doug Halverson on December 18, 2006) indicates the total volume of water stored in the Peter Mitchell pits is approximately 20,000 acre-feet (see storage-elevation curves presented in Figures 2 and 3). Furthermore, natural runoff from the watersheds of these two pits during periods of high flows (using the same approach to determine Partridge River diversion flows described under Source F) as well as direct net precipitation onto the two pits represent an additional amount of water that can be pumped from the Peter Mitchell pits and therefore increase the volume of water routed to the West Pit by an average value of approximately 473 acre-feet per year (293 gpm).

The required pumping head was computed assuming the lowest 1,000 acre-feet stored in each pit will not be pumped out to the West Pit due to a potential for high solids concentrations and other unknown conditions. The volume-weighted average static head to pump up to elevation 1,630 ft-MSL (i.e., 5 feet above the approximate pit rim elevations) is 27 feet for the Peter Mitchell - West 1 open pit and 24 feet for the Peter Mitchell - West 2 open pit. The approximate distance from these pits to the West Pit is 9,400 feet. A temporary pipeline would need to be installed across One Hundred Mile Swamp to route the water to the West Pit. This source will demand a high cost and might have potential impacts to One Hundred Mile Swamp. It would also require permits to construct the pipeline and Northshore Mining Company permission to dewater these two pits.

F. High Flows from the Partridge River

Figure 4 shows three locations along the Partridge River that have been identified as potential sites to divert water by gravity and/or pumping to the West Pit. These locations were selected to bracket the feasibility of routing the flows and volumes available from various Partridge River locations near the Mine Site. These diversions would be temporary until the West Pit fills to the overflow elevation.

Flows at these three locations were estimated based on simulations conducted using the XP-SWMM hydrologic/hydraulic model for the Partridge River watershed above Colby Lake and analyzed for the base period of 1978-1988 (see RS73). A conservative approach was used for this analysis, to provide rough volumes that do not overestimate the availability of flows.

Following the nomenclature used in XP-SWMM, the three potential sites on the Partridge River include:

- Location L12, north of the Mine Site, at elevation 1,598 ft-MSL and approximately 5,000 feet from the West Pit. It has a catchment area of about 5,280 acres (excluding the Peter Mitchell - West 1 and West 2 watersheds as per Source E). The hydrologic/hydraulic model predicts a mean annual flow of 4.6 cfs at this location. Water could be diverted by gravity through a 1,400 foot-long open channel to the East Pit with a slope of 0.3%; water from the East Pit will flow by gravity to the West Pit. An outlet structure may be required near the Partridge River to restrict the elevation that flows are allowed to divert.

- Location L15, northeast of the Mine Site, at elevation 1,582 ft-MSL and approximately 11,700 feet from the West Pit. It has a catchment area of about 6,353 acres (excluding the Peter Mitchell - West 1 and West 2 watersheds as per Source E). The hydrologic/hydraulic model predicts a mean annual flow of 5.6 cfs. The water levels in this location are about 15 feet lower than the elevation of the rim of the West Pit. Water could be diverted by pumping from the Partridge River to a 1,700 foot-long open channel with a slope of 0.2%, which would discharge into the East Pit; water from the East Pit will flow by gravity to the West Pit. The static head to pump is 16 feet. A control structure (e.g., a low-head weir) may be required on the Partridge River, to maintain a pool for pumping.

- Location L48, immediately downstream of the confluence of the north and south branches of the Partridge River, at elevation 1,526 ft-MSL and approximately 5,600 feet from the West Pit. It has a catchment area of about 29,452 acres (excluding the Peter Mitchell - West 1 and West 2 watersheds as per Source E). The hydrologic/hydraulic model predicts that the mean annual flow is 26.7 cfs. Water levels in this location are significantly lower than the elevation of the rim of the West Pit. Water could be diverted by pumping from the Partridge River directly to the West Pit. The static head to pump is about 64 feet; therefore pumping costs would be high. A control structure (e.g., a low-head weir) may be required on the Partridge River, to maintain a pool for pumping.

Flows in the Partridge River are highly variable and seasonal, with average daily maximum flows about 15 to 20 times the mean annual flow and nearly 500 times the average daily minimum flows. The computations for available water volume were based on two goals in relation to the potential impacts on the Partridge River flows: (1) minimize the impacts on the base flows in the Partridge River, and (2) minimize the impacts on the sediment transport capacity in the Partridge River. In accordance with these two goals, the following criterion was used in this analysis to determine the flows that could be diverted from any of the three locations (L12, L15 or L48); these flows are henceforth called diversion flows. The diversion flows were defined as 20% of the mean of the flows exceeding the base flow (defined as the average flow over the 30-day period of minimum flows). The diversion flows could be withdrawn during the periods when flows are greater than the corresponding base flows.

With the assumptions listed previously, and averaging the results over 365 days, the diversion flow for site L12 is estimated to be 841 acre-feet per year (521 gpm), for site L15 is 1,024 acre-feet per year (635 gpm), and for site L48 is 4,513 acre-feet per year (2,798 gpm).

The two upstream diversion locations provide minimal flows for West Pit flooding and the control structures would block the flows on the Partridge River which may impact fisheries, alter the natural stream channel and change the downstream sediment load. The L48 diversion location would have high construction and operation costs, and would require a larger control structure that would also block flows on the Partridge River.

G. Water Pumped from Colby Lake

The Colby Lake-Whitewater Reservoir system is the farthest downstream location along the Partridge River that would be feasible to withdraw water to divert to the West Pit. Water from this system could be pumped through the existing pipeline that will be used for make-up water for the Process Plant, and then routed to the Tailings Basin and to the West Pit through the Treated Water Pipeline to the Central Pumping Station.

Using a similar criterion to that for the other locations along the Partridge River (described under Source E), the diversion flows from Colby Lake were estimated using data from the Partridge River at the USGS gage located immediately upstream of its confluence with Wyman Creek (approximately 2,000 feet upstream of the discharge into Colby Lake) at 9,884 acre-feet per year (6,128 gpm). However, this is higher than the anticipated maximum annual make-up water demand of 4,400 gpm during mining operations (see RS13). the diversion flows from Colby Lake were assumed to be 8,065 acre-feet per year (5,000 gpm); the static head to pump is about 142 feet.

A diversion flow of 5,000 gpm is equivalent to about 13% of the average daily flow in the Partridge River at the USGS gaging station. Water balance assessments for make-up water demand conducted in response to a request from the Minnesota Department of Natural Resources (MDNR) during a meeting held on June 7, 2007 provide a good comparison. Even in the case of a hypothetical, extreme drought in which inflows to the Colby Lake-Whitewater Reservoir system are reduced by 50% for a 4-year period, the Colby Lake-Whitewater Reservoir system would satisfy a make-up water demand of 5,000 gpm while still complying with the requirements established in Permit 49-135 for water appropriation from Colby Lake. The make-up water would not be needed in Closure or Post-Closure; however this analysis indicates that the 5,000 gpm diversion flow would also not violate the permit conditions. However, the operational costs would be high and it would require adding a section of pipe to connect the Colby Lake line with the Treated Water Pipeline. This would also increase the duration of impacts to Colby Lake-Whitewater Reservoir water level fluctuations.

4.2 Water Management Scenarios for Flooding Operation

This section describes seven scenarios evaluated for pit flooding that use different combinations of the six sources of water described in the previous section. The total storage volume within the West Pit is approximately 108,000 acre-feet at the end of mining at elevation 1581 ft-MSL. Figure 5 presents the predicted flooding rates for each of the following seven scenarios.

1. Local Sources (Groundwater, Surface Runoff/Stockpile Drainage) and Hyrdomet Residue Cell Seepage

The first scenario assumes that only direct groundwater inflows (Source A), surface runoff/stockpile drainage collection from the Mine Site (Source B), and seepage collected from the Hydrometallurgical Residue Cells and routed through the WWTF (Source C) will be available for flooding the West Pit with water during Closure. It would take about 45 years to complete the flooding operation under this first scenario. This scenario was selected as the best option because of the low initial and operating costs, its suitability with the closure options for the Tailings Basin (see Section 4.3.1 of RS74B – Draft02), and because the predicted water quality concentrations of the West Pit overflows result in compliance at the Partridge River with the Minnesota Water Quality Standards (see Section 5.2 of RS74A – Draft02).

2. Local Sources, Hydrometallurgical Residue Cell Seepage, and Tailings Basin Pond Water

In Scenario 2, Tailings Basin pond water (Source D) is pumped to the West Pit at a rate of 4,000 gpm (6,452 acre-feet per year) during the first three years of Closure. Combined with groundwater, surface runoff/stockpile drainage from the Mine Site, and Hydrometallurgical Residue Cell seepage (Sources A, B, and C), it would take approximately 38 years for the West Pit to fill. This scenario was rejected because the accelerated flooding time was not expected to significantly improve West Pit water quality and due to the possible unavailability of Tailings Basin pond water (see Section 4.3.1 of RS74B – Draft02)

3. Local Sources, Hydrometallurgical Residue Cell Seepage, Tailings Basin Pond Water, and Peter Mitchell Open Pits

The third scenario assumes that in addition to Sources A, B, C, and D, water from the Peter Mitchell pits (Source E) will be pumped to the West Pit for seven years at a rate of 2,000 gpm (3,226 acre-feet per year). It would take about 29 years to complete the flooding operation under this third scenario. This scenario was eliminated because of the high costs and potential environmental impacts to One Hundred Mile Swamp and due to the possible unavailability of Tailings Basin pond water (see Section 4.3.1 of

RS74B – Draft02). The expedited pit flooding is also not required to be in compliance at the Partridge River with Minnesota Water Quality Standards (see discussions under Scenario 1 above).

4-6. Local Sources, Hydrometallurgical Residue Cell Seepage, Tailings Basin Pond Water, Peter Mitchell Open Pits, and Partridge River Flows

The fourth, fifth and sixth scenarios build off the third scenario as the base and add water from the Partridge River (Source F) diverted from Location L12 (in Scenario 4), L15 (in Scenario 5), or L48 (in Scenario 6).

The fourth scenario considers that high flows from location L12 in the Partridge River (Source F) will be diverted to the West Pit during the whole time of the flooding operation at an annual-average rate of 521 gpm (841 acre-feet per year). In combination with Sources A, B, C, D, and E, it would take about 21 years to complete the flooding operation under this fourth scenario.

The fifth scenario includes high flows at Location L15 in the Partridge River (Source F) during the whole time of the flooding operation at an annual-average rate of 635 gpm (1,024 acre-feet per year). It would take about 20 years to complete the flooding operation under this scenario. Although the West Pit can be flooded one year sooner in this scenario, pumping from the Partridge River would be required; the shorter flooding time does not necessarily justify the added costs of pumping instead of diverting by gravity as with the fourth scenario.

The sixth scenario considers that high flows from Location L48 in the Partridge River (Source F) will be diverted during the whole time of the flooding operation at an annual-average rate of 2,798 gpm (4,513 acre-feet per year). Combined with Sources A, B, C, D, and E, it would take about 10 years to complete the flooding operation under this scenario. The shorter flooding time (10 years less than with the fourth scenario) may justify the additional costs of pumping if the water quality of the West Pit overflows were significantly improved. However, this expedited flooding is not required to be in compliance at the Partridge River with Minnesota Water Quality Standards (see discussions under Scenario 1 above).

All of these scenarios were eliminated because of the high costs, potential environmental impacts to One Hundred Mile Swamp, the possible unavailability of Tailings Basin pond water (see Section 4.3.1 of RS74B – Draft02), as well as the limited benefits on the West Pit water quality at overflow (see discussion of Scenario 1 above).

7. Local Sources, Hydrometallurgical Residue Cell Seepage, Tailings Basin Pond Water, Peter Mitchell Open Pits, and Colby Lake Water

The seventh scenario also builds off the third scenario as the base and considers that water from Colby Lake (Source G) will be diverted during the whole time of the flooding operation at an annual-average rate of 5,000 gpm (8,065 acre-feet per year). Combined with Sources A, B, C, D, and E, it would take about 7 years to complete the flooding operation under this scenario. The shorter flooding time (22 years less than Scenario 3) may justify the additional costs of pumping if there were significant improvement to the water quality of the West Pit overflows. However, this scenario was eliminated because of the high costs and because the expedited flooding is not required to achieve compliance with Minnesota Water Quality Standards in the Partridge River (sees discussions under Scenario 1 above).

4.3 Preferred West Pit Flooding Scenario

Of the seven proposed scenarios for flooding the West Pit previously described, Scenario 1 (including mine site surface runoff, groundwater flows, stockpile drainage, and Hydrometallurgical Residue Cell seeapge) was selected as the preferred option. Seepage from the Hydrometallurgical Residue Cells can be routed to the West Pit via the Treated Water Pipeline and the Central Pumping Station without the construction of a new channel or pipeline across potentially sensitive areas. This scenario has no negative impacts on flows in the Partridge River or the Colby Lake-Whitewater Reservoir system. The contributions of the various water sources utilized in this scenario are shown in Figure 6. This option fills the West Pit approximately 45 years into Closure (in Year 65). Surface water overflow from the West Pit to the Partridge River is expected to begin about 66 years after pit dewatering ceases.

4.4 West Pit Flooding – Reasonable Alternative 1

The Mine Site-RA1 considers the same plan for West Pit flooding as presented in Section 1.4.3. Inputs to the West Pit flooding are identical to those described for the Mine Site-Proposed Action with the sole exception of the volume of water pumped from the WWTF to the East Pit, which is increased relative to the Mine Site-Proposed Action. This increase shortens the time to fill the West Pit by less than a year, and does not appreciably alter the relative contributions of each source to West Pit flooding. The sources of water and schedule for West Pit flooding under the Mine Site-RA1 are presented in Table 4-21a of RS74 – Draft02. All other hydrologic aspects of West Pit flooding and flood routing for the Mine Site-RA1 are identical to those presented for the Mine Site-Proposed Action.

5.0 Outlet Control Structures

5.1 East Pit Outlet Structure and Connection to West Pit

Overflows from the East Pit will be directed to the West Pit through a channel that will be excavated from the southwest corner of the East Pit to the northeast corner of the West Pit. The overflow will be set at elevation 1,592 ft-MSL. Based on available bedrock data, it is anticipated that the East Pit overflow structure will be excavated in bedrock.

The East Pit outlet structure will be formed out of bedrock (assuming bedrock conditions are stable) or a reinforced concrete weir will be cast-in-place; the invert of the outlet will be set at the East Pit overflow elevation previously described. The weir will be 20 feet wide, resulting in a 0.5-foot head over the weir during the 100-year storm event. A 425-foot-long channel with a bottom slope of about 1% will connect the East Pit overflow to the West Pit. The channel will have a 6 foot wide bottom with side slopes of 3H:1V, resulting in a maximum flow velocity of 6 feet per second during the 100-year overflow. Based on available bedrock elevations, it is expected the entire length of the channel will be excavated in bedrock.

The final locations of the intake and discharge of the connection channel will be determined once more detailed investigations of the bedrock topography along the proposed route are completed prior to Closure.

5.2 West Pit Outlet Structure

An outlet structure will be constructed on the southeastern side of the West Pit at elevation 1,581 ft-MSL near the natural overflow location. Based on available bedrock data, it is anticipated that, similar to the channel connecting the East and West Pit, the West Pit overflow structure will be excavated in bedrock. The West Pit outlet structure will be formed out of bedrock (assuming bedrock conditions are stable) or a reinforced concrete weir will be cast-in-place; the weir will be 20 feet wide, able to convey the 100-year, 24-hour storm event with approximately 0.7 feet of head over the weir.

The West Pit outlet structure will direct overflows into an existing wetland that flows towards Dunka Road at Outlet Structure OS-5 and into the Partridge River through an existing natural drainage path. An existing wetland at that location may be altered to provide a final stage of treatment before discharge, if necessary.

6.0 East and West Pit Flood Routing

Average annual overflows from the East and West Pits were estimated based on the inflows summarized in Table 4-21 of RS74 – Draft02. The annual average overflow from the East Pit to the West Pit will vary depending on climate conditions, but is anticipated to decrease from 1.8 cfs at the beginning of Closure to a steady state condition of 1.3 cfs approximately 13 years into Closure. The annual average overflow from the West Pit will be about 2.6 cfs (1,900 acre-feet per year).

An XP-SWMM model representing the Mine Site in Post-Closure was developed to estimate peak discharges from the East and West Pits during storm events. Flood routing was modeled for two precipitation events: the 10-year frequency, 24-hour duration storm event and the 100-year, 24-hour duration storm event. The total precipitation for these events is 3.36 inches and 5.2 inches respectively.

The peak overflow rate from the East Pit outlet structure during the 100-year, 24-hour event was estimated to be 23 cfs. The anticipated peak flow from the West Pit during the 100-year, 24-hour storm event is 33 cfs. Peak flows during the 10-year, 24-hour event are estimated to be 10 cfs and 14 cfs for the East and West Pits, respectively.

This flood routing analysis was performed assuming that the water surface elevations in the East Pit and West Pit are equal to the outlet elevations (see Section 1.2) at the beginning of the storm event. Higher beginning water surface elevations will result in greater maximum discharge rates than those presented in this memo. Water surface elevations below the pit outlets will result in lower maximum discharge rates, as a portion of the total storm volume will remain stored in the pits.

Figure 1 **Estimates of groundwater inflow rates to the West Pit**

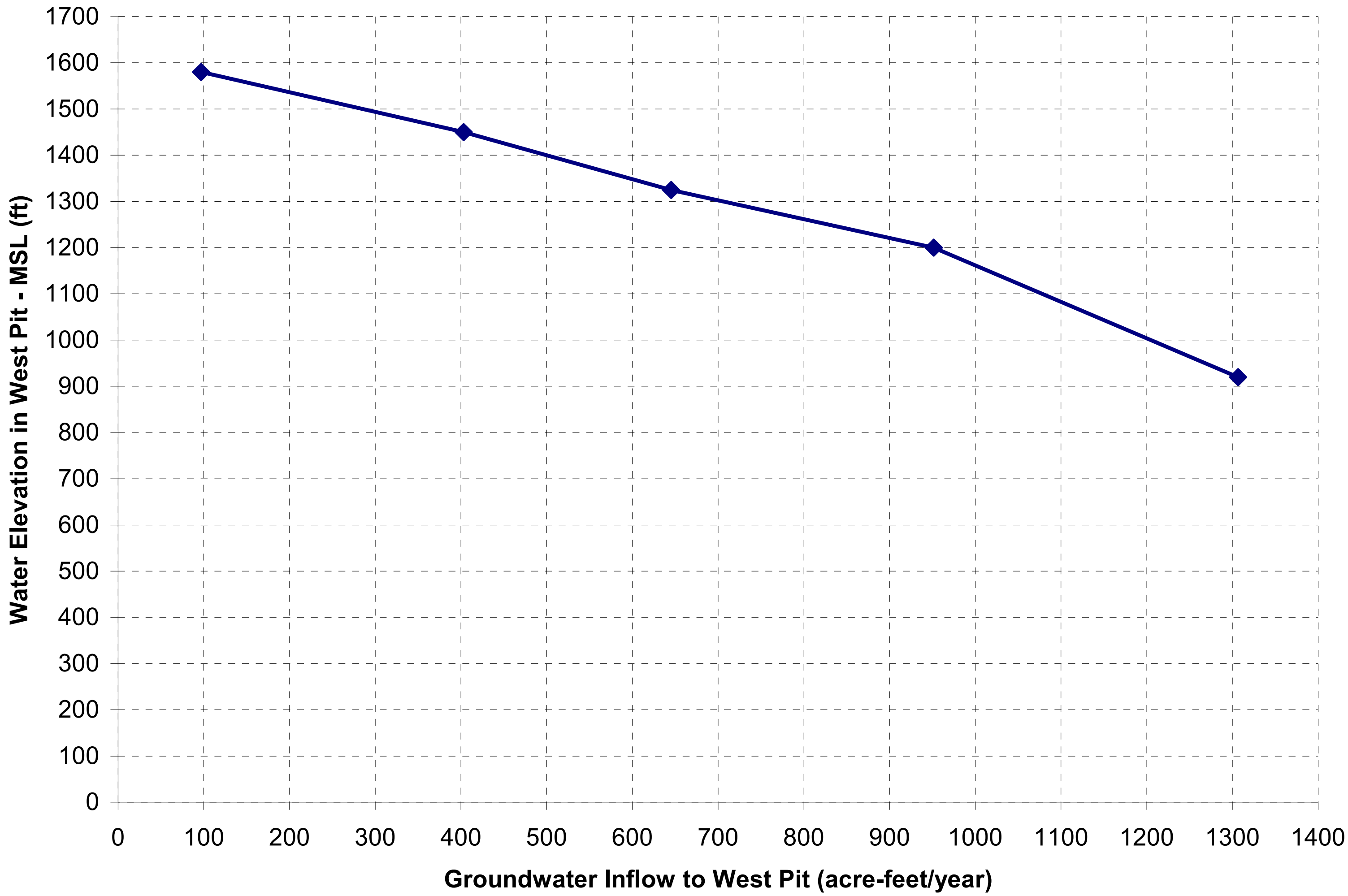

Figure 2 **Storage-elevation curve for Peter Mitchell Open Pit (West 1)**

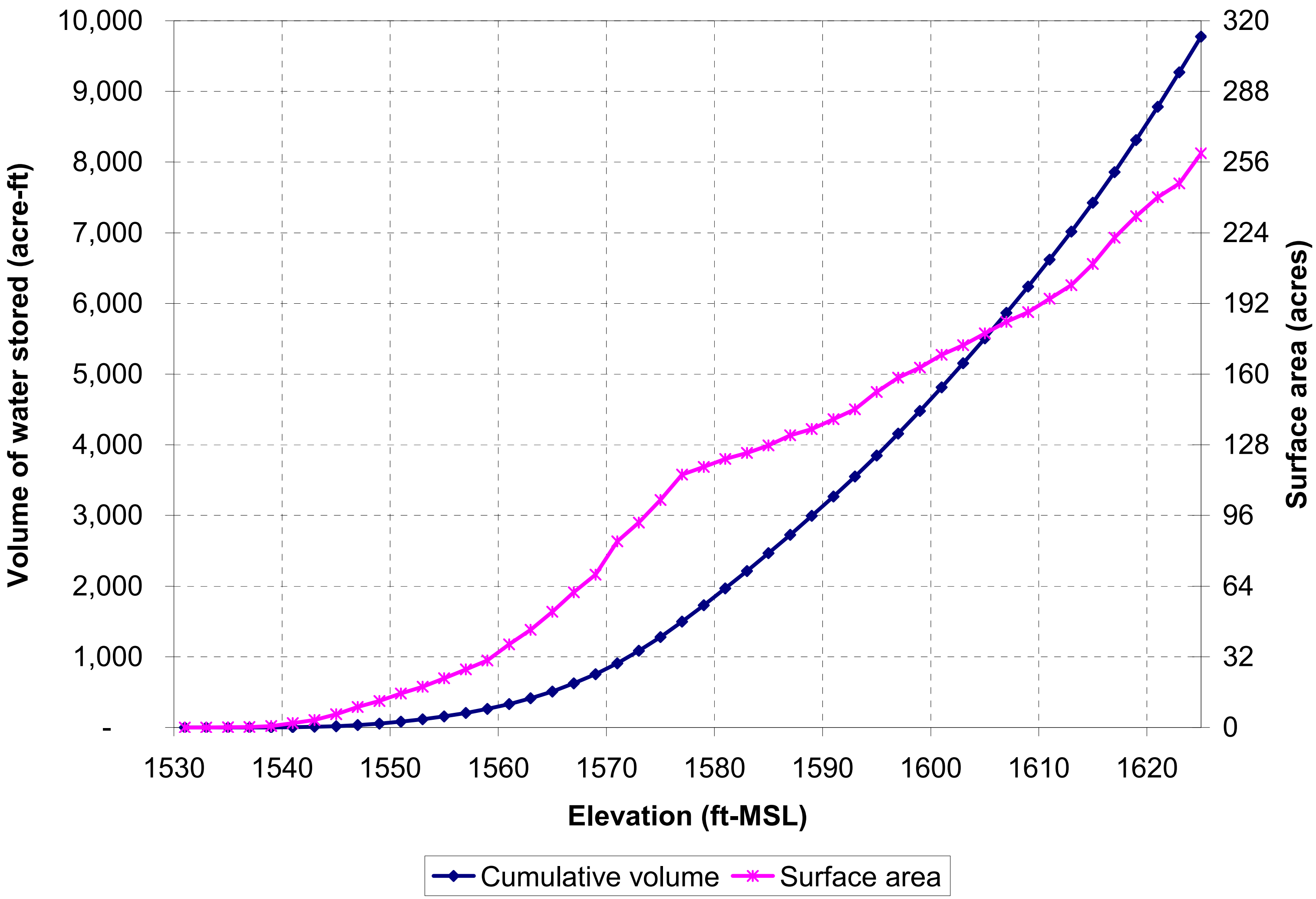

Figure 3 **Storage-elevation curve for Peter Mitchell Open Pit (West 2)**

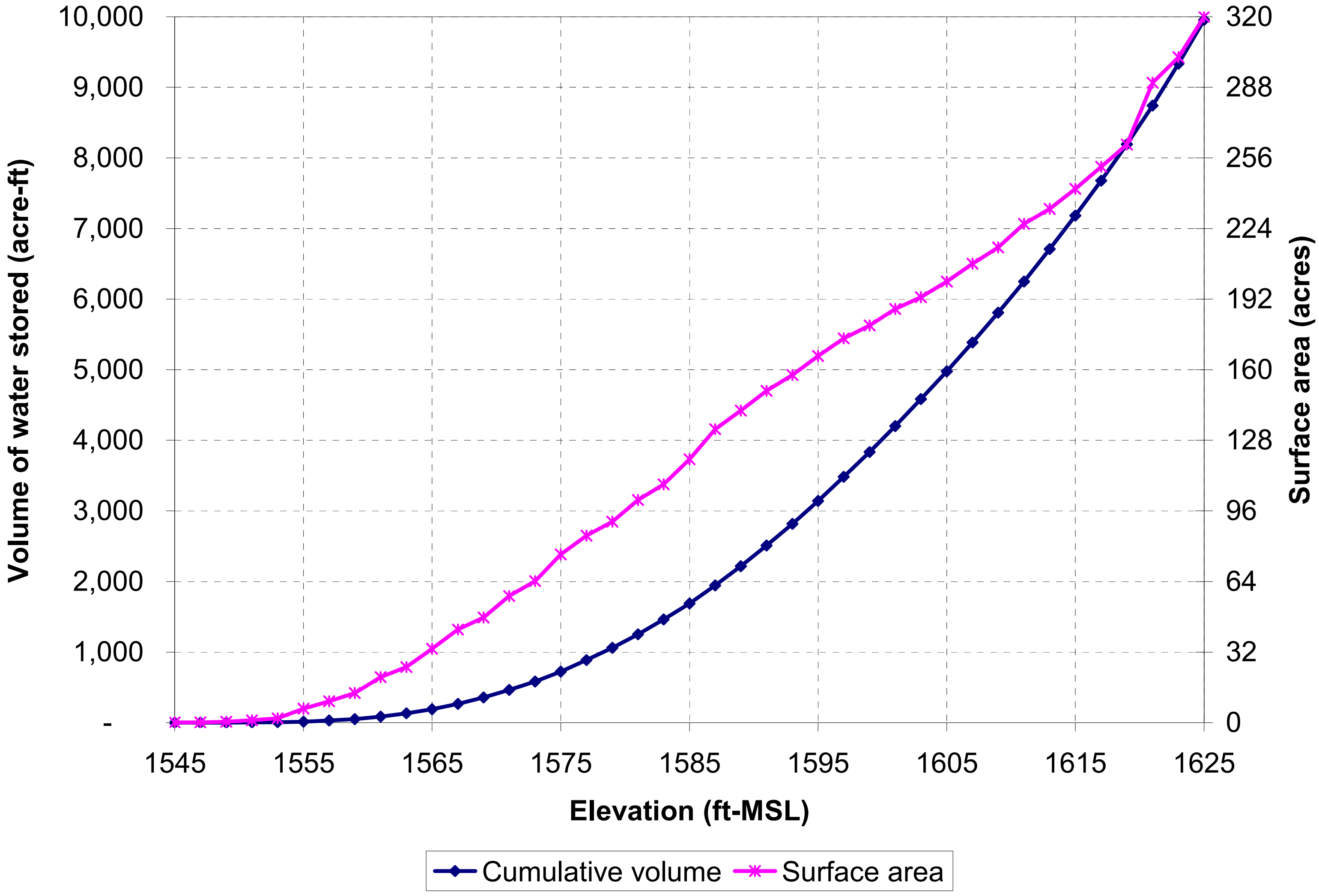

Figure 4 **Locations of potential flow diversions from the Partridge River for West Pit flooding**

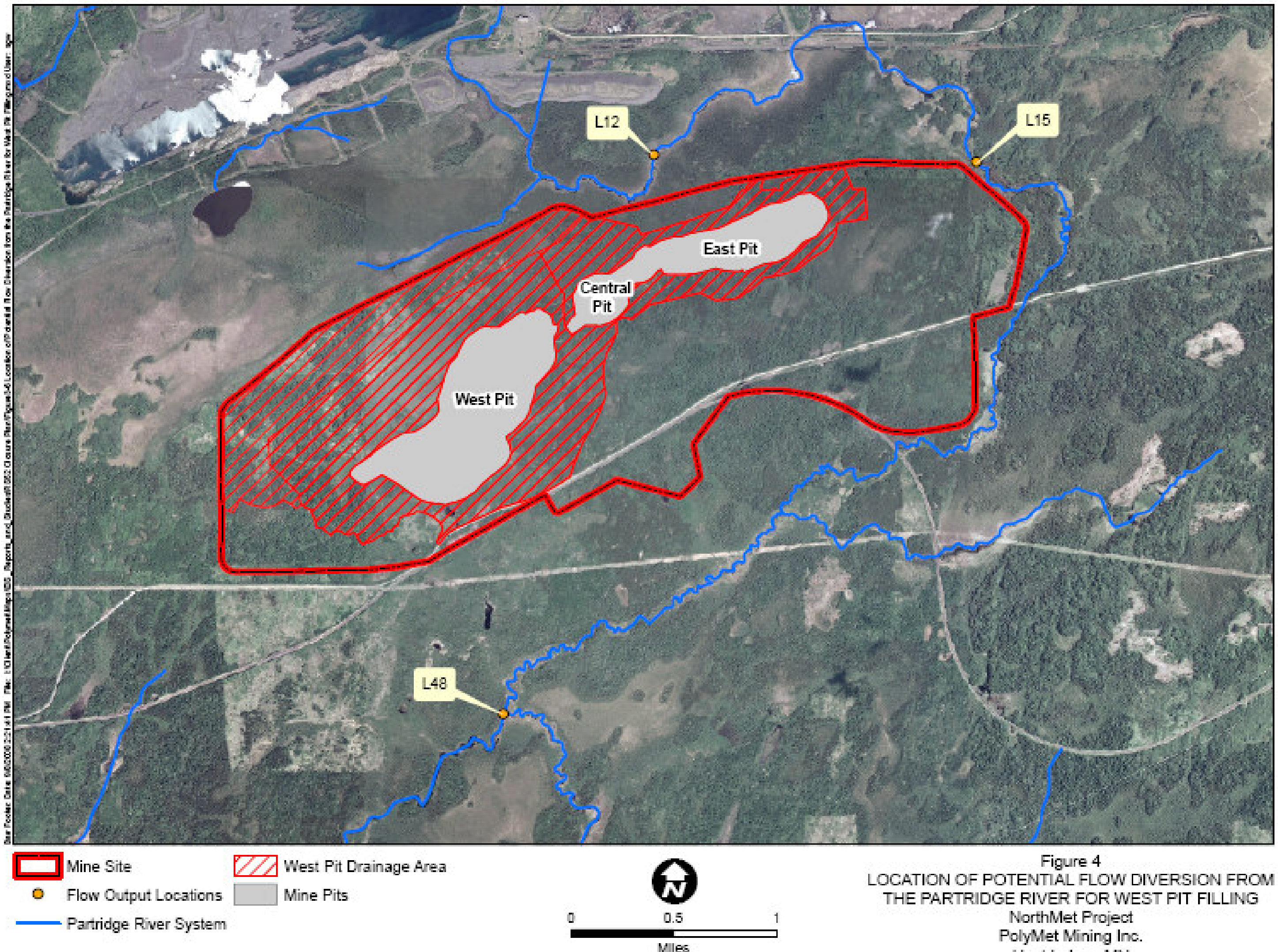

Figure 4
LOCATION OF POTENTIAL FLOW DIVERSION FROM THE PARTRIDGE RIVER FOR WEST PIT FILLING
NorthMet Project
PolyMet Mining Inc.
Hoyt Lakes, MN

Figure 5 **Rates of West Pit flooding presented for different combinations or source water**

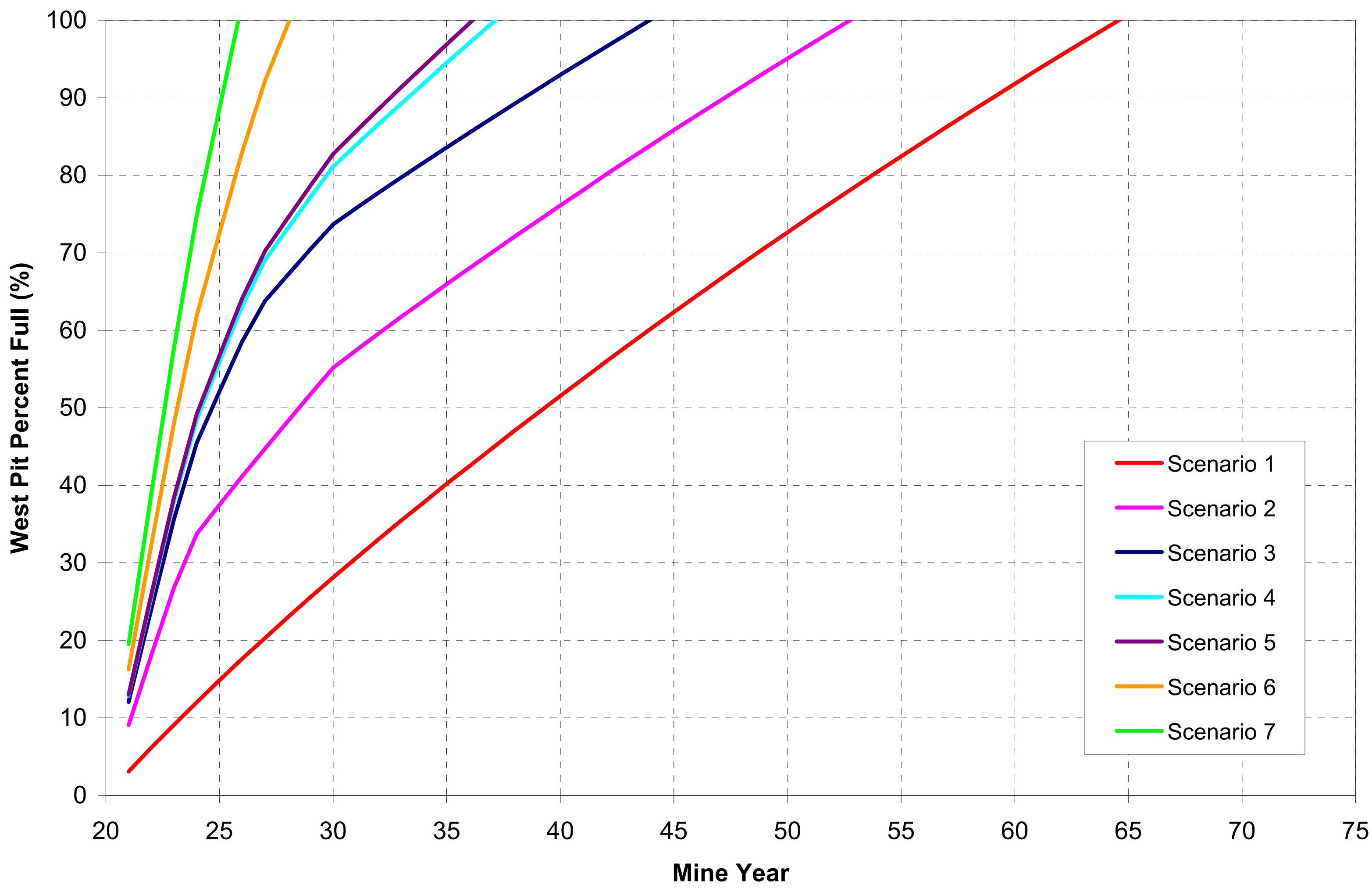

Figure 6 Breakdown of sources for West Pit flooding – Preferred Option