APPENDIX H
Process Water Discharge Alternatives
(West Range Site)

(Note: Color versions of figures in this Appendix are included in the file posted at the DOE NEPA website: http://www.eh.doe.gov/nepa/docs/deis/deis.html)

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Environmental Analysis of Alternative Discharge Arrangements:

I. **Increased Discharge to Holman Lake and Reduced or Eliminated Discharge to Canisteo Mine Pit**

II. **Relocation of the Holman Lake Outfall to the Swan River**

III. **Zero Liquid Discharge Treatment**

Prepared by Excelsior Energy Inc.
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Introduction

Excelsior has analyzed the environmental impacts of three alternative discharge arrangements for cooling tower blowdown ("CTB") from the West Range Site. These represent potential mitigation alternatives to the base case that was proposed in Excelsior's National Pollution Discharge Elimination System ("NPDES") permit application. The mitigation alternatives are not necessarily mutually exclusive. Since the East Range Site's placement within the Lake Superior watershed requires complete zero liquid discharge treatment of all water, no alternatives analysis was performed for that Site.

Discharge Alternative 1: Increased Discharge to Holman Lake and Reduced or Eliminated Discharge to Canisteo Mine Pit

Description

An alternative discharge arrangement to that proposed in Excelsior's application for a NPDES permit would be to discharge a greater portion of the IGCC Power Station's cooling tower blowdown ("CTB") to Holman Lake, thereby significantly reducing or eliminating such discharges to the Canisteo Mine Pit ("CMP") under normal operating conditions. Excelsior is exploring this option, the execution of which will be subject to discussions with the Minnesota Pollution Control Agency ("MPCA"). To examine the full effects possible under this alternative, Excelsior has assumed that 100% of the CTB can be discharged to Holman Lake and that the discharge to the CMP can be eliminated. The ultimate allocation may fall between this case and the one presented in Section 4.5 of the Environmental Impact Statement ("EIS"), and the environmental impacts can be interpolated accordingly.

Water Management Plan

Implementing this alternative would require modest adjustments to the water management plan. These adjustments are the result of the reduction of the appropriation for Phase II by 1,700 gpm (based on five cycles of concentration of CTB rather than three) and a reduction of 300-3,100 gpm of availability from the CMP since its water would no longer be replenished by CTB discharge.

In Phase I operations, the 300 gpm lost from the CMP can be replaced, for example by reducing the discharge from the Hill Annex Mine Pit ("HAMP") Complex to Upper Panasa Lake compared to the base case. The adjusted water management plan is shown in Figure 1. In Phase II, a total of up to 1,400 gpm must be replaced due to the factors mentioned above. The sustainable flows modeled in Excelsior's Water Appropriation Permit application, reproduced in Table 1 below, represent only one possible scenario and were selected to show appropriation from each potential source. An equally likely scenario for Mesaba One and Mesaba Two would be to operate the CMP and HAMP Complex at lower elevations (to obtain flows closer to the maximum estimated flow available) and supplement flows as necessary with water from the Lind

Mine Pit and Prairie River.

Figure 1: Phase I Water Operations Flow Rates: West Range IGCC Power Station

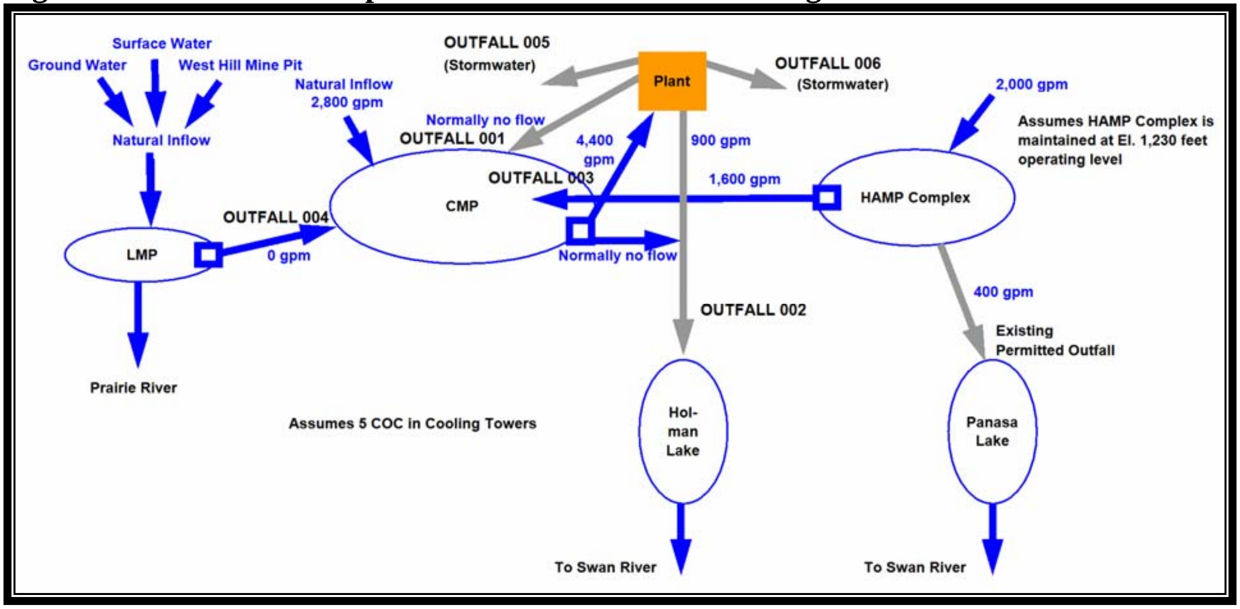


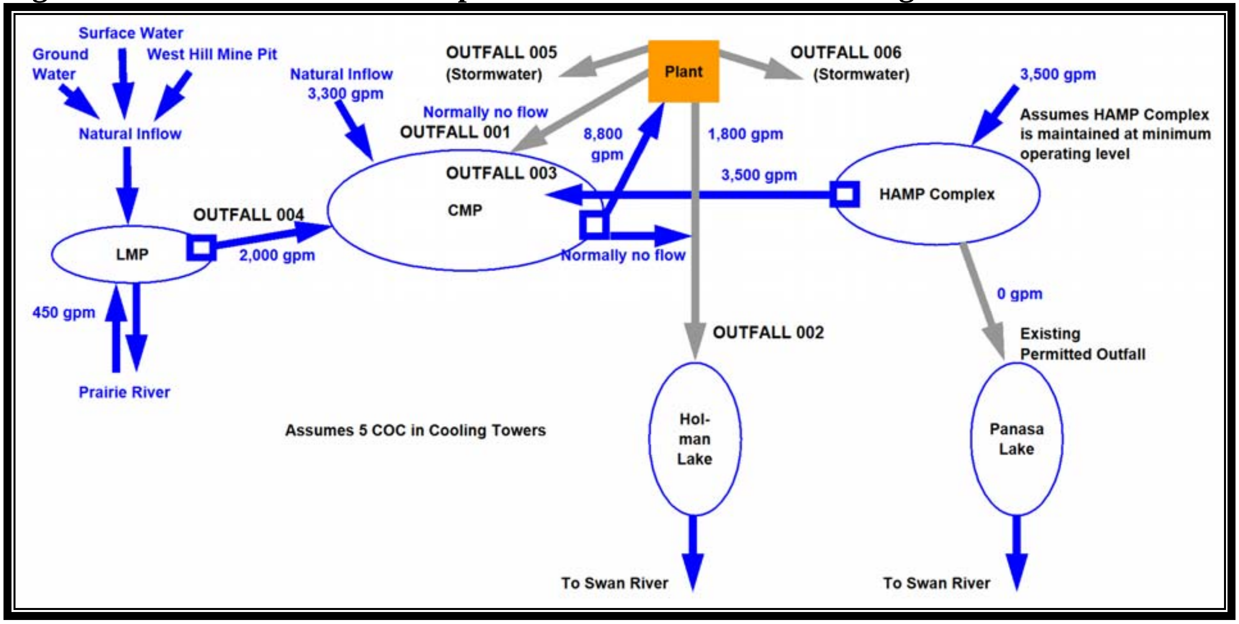
Table 1: Sustainable Flows Modeled in Excelsior's Water Appropriation Permit Application

Water Source	Est. Range of Flow (gpm)	Sustainable Flow for Water Appropriation Modeling (gpm)
Canisteo Mine Pit	810-4,190	2,800
Hill-Annex Mine Pit Complex	1,600-4,030[a]	2,000[b]
Lind Mine Pit	1,600-2,000	1,800[c]
Prairie River	0-2,470[d]	2,470[d]
Discharge from IGCC Power Station	0-3,500	Varies

Notes:
[a]Maximum flow occurs at minimum operating elevation
[b]At an operating elevation of 1,230 ft msl
[c]Based on one summer flow measurement at the LMP outlet and one winter and one summer flow measurement taken at the West Hill Mine Pit outlet
[d]Based on 25% of 7Q10

Figure 2 shows a possible water management plan that could serve Mesaba One and Mesaba Two under the scenario where CTB discharges would be eliminated. In the event that mine pit yields are significantly lower than expected, or during times of extended drought, the option would exist to revert back to the originally proposed arrangement with discharge into the CMP.

Figure 2: Phase I and II Water Operations Flow Rates: West Range IGCC Power Station



Water Quality

The most direct environmental impact associated with this alternative is that by eliminating CTB discharges to the CMP, the water quality of the CMP would remain relatively constant, avoiding the gradual increase in the concentration of pre-existing constituents due to the evaporation of cooling water. Additionally, the water quality of the CTB would no longer escalate as the source water quality would remain relatively constant. This would allow the cooling towers to operate at five cycles of concentration rather than three as specified in the base case. Table 2 shows the estimated concentration of chemical constituents in the CTB discharge for this case. See the section below entitled "Swan River" for further discussion of water quality impacts that would result from water quality trading.

Table 2: Expected IGCC Power Station Discharges and Applicable State Numerical Water Quality Standards

Constituent	Units	Class 2 WQ Standard	Anticipated Effluent Water Quality – Phase I & II (5 COC)
Hardness	mg/l	250	1,540
Alkalinity	mg/l	n/a	--
Bicarbonate	mg/l	n/a	869
Calcium	mg/l	n/a	--
Magnesium	mg/l	n/a	--
Iron	mg/l	n/a	--
Manganese	mg/l	n/a	--
Chloride	mg/l	230	26
Sulfate	mg/l	n/a	487
TDS	mg/l	700	1,685
pH	mg/l	6 - 9	6 - 9
Aluminum	ug/l	125	50
Arsenic	ug/l	53	--
Barium	ug/l	--	--
Cadmium	ug/l	2.0[1]	Note 3
Chromium (6+)	ug/l	32[1]	Note 3
Copper	ug/l	15[1]	Note 3
Fluoride	mg/l	n/a	--
Mercury	ng/l	6.9	4.5
Nickel	ug/l	283[1]	25
Potassium	mg/l	n/a	20
Selenium	ug/l	5	Note 3
Sodium	mg/l	--	--
Specific Conductivity	umhos/cm	1000	2,400[4]
Zinc (3)	ug/l	191[1]	Note 3
Phosphorus	mg/l	1[2]	0.02

[1]Indicates a hardness based standard. It is assumed hardness in the receiving water is >200 mg/L based on available data.
[2]Phosphorus standard is an effluent limit and not a water quality standard.
[3]Results below detection limit.
[4]Values depicted reflect assumed values in the groundwater and LMP

Due to the increased discharge rate of CTB to Holman Lake, concentrations of chemical constituents in Holman Lake would increase, but would not escalate over the long term. Figures 3 and 4 show the modeled concentration of total dissolved solids (TDS) and mercury, respectively, over the life of the project for the base case with CTB discharges to both the CMP and Holman Lake. Figures 5 and 6 show the same for the alternative where CTB discharge to the CMP is eliminated. As in the base case, a variance for hardness and TDS, the standards for which are based on aesthetic rather than health-related concerns, may be necessary.

Figure 3: Water Quality (TDS) of Receiving Waters for Base Case: Discharge to Holman Lake and Canisteo Mine Pit

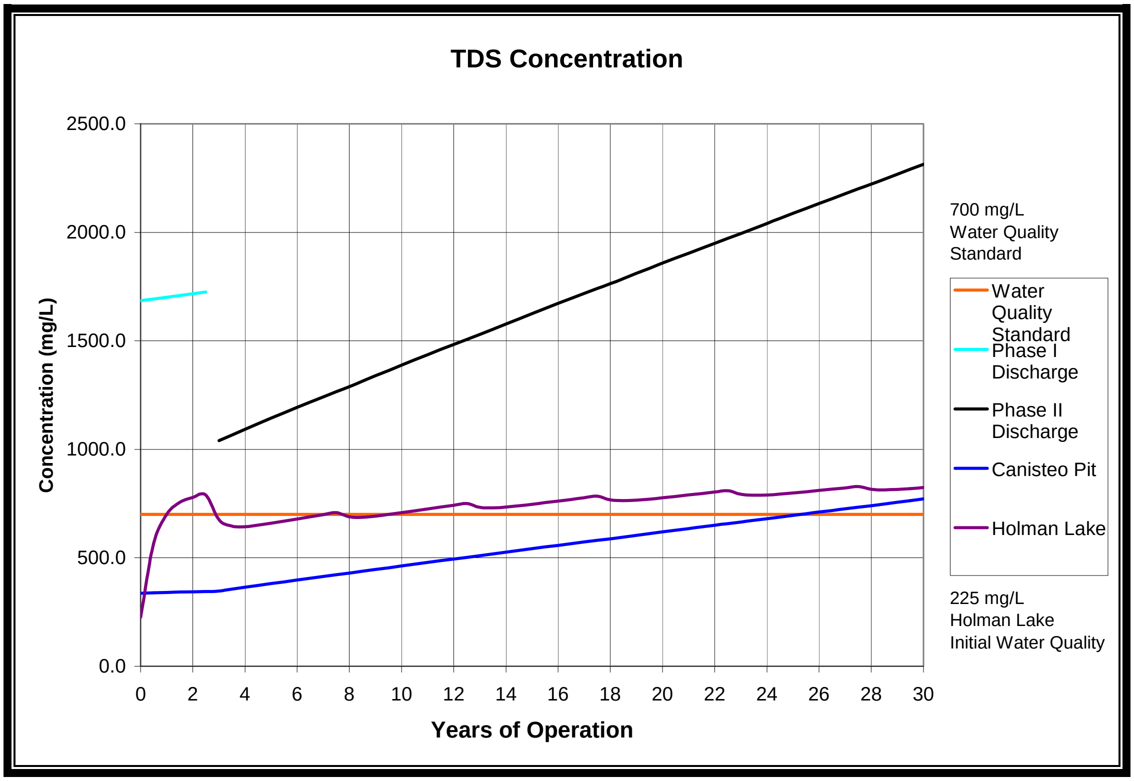


Figure 4: Water Quality (Mercury) of Receiving Waters for Base Case: Discharge to Holman Lake and Canisteo Mine Pit

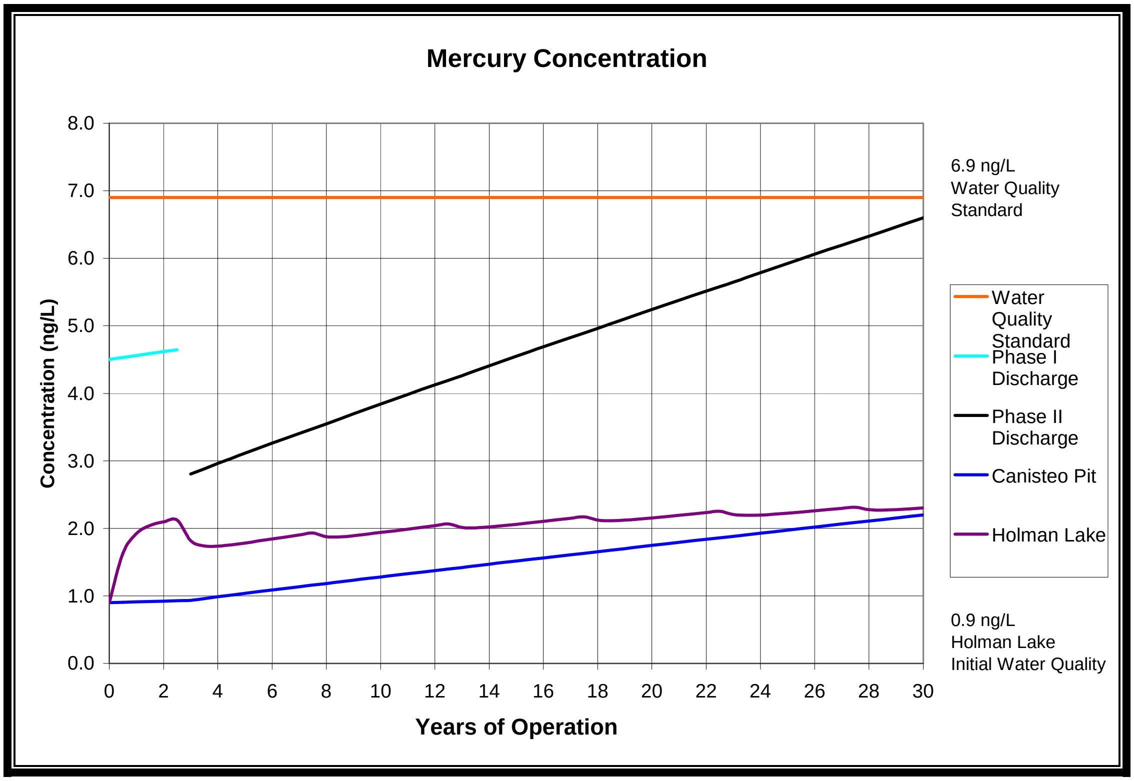


Figure 5: Water Quality (TDS) of Receiving Waters for the Alternative Case: Discharge to Holman Lake Only

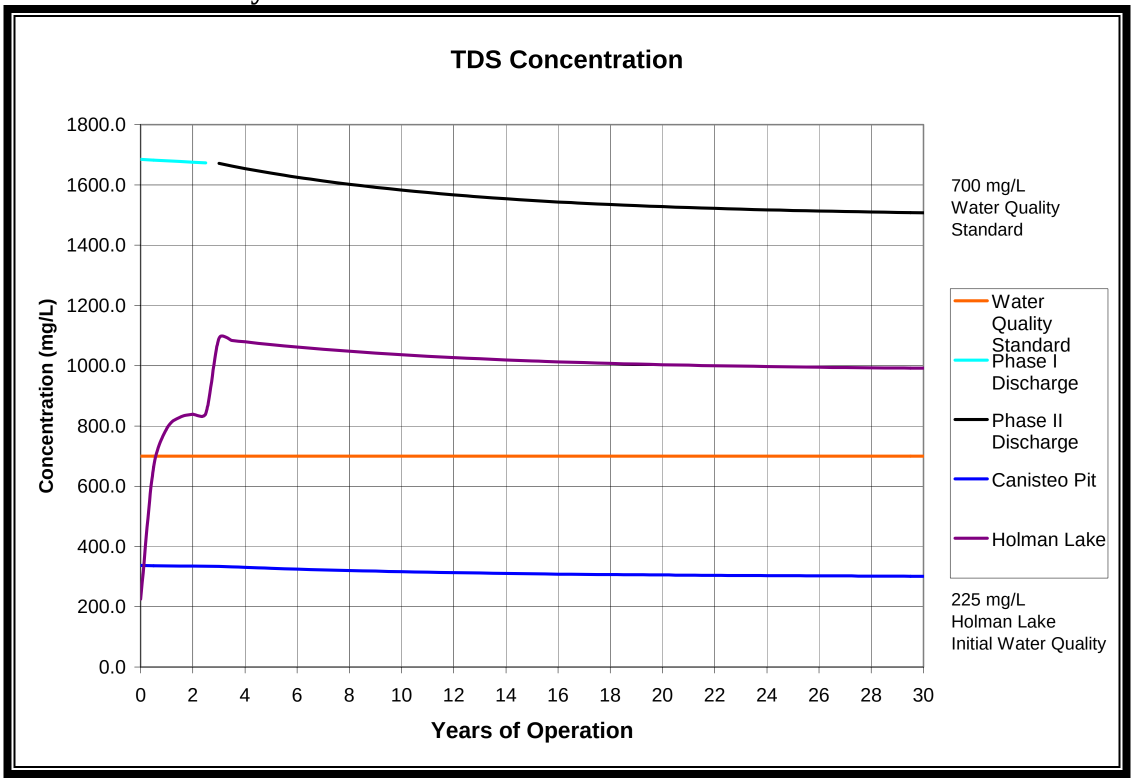
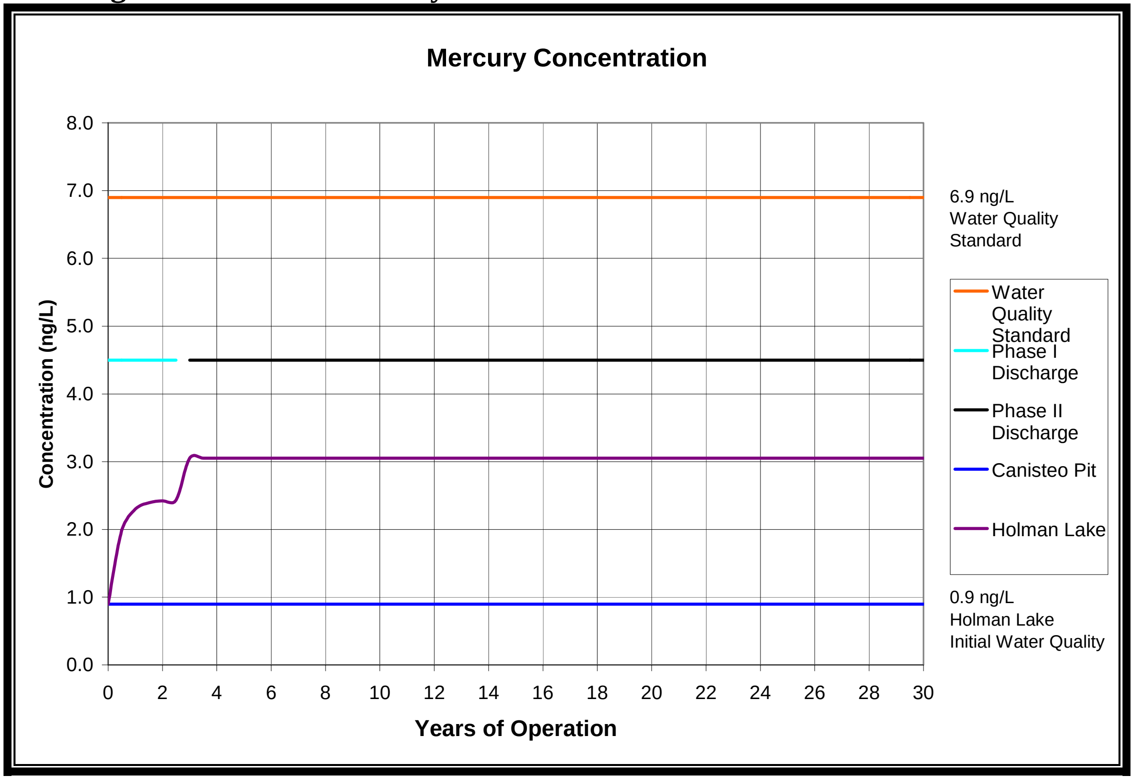


Figure 6: Water Quality (Mercury) of Receiving Waters for the Alternative Case: Discharge to Holman Lake Only



Sulfate

There is currently no water quality standard applicable to sulfate concentrations in the CMP or Holman Lake. However, the MPCA has raised questions regarding the potential relationship between sulfate and the generation of methyl mercury in certain aquatic environments.[1] While it has been demonstrated that the addition of sulfate may stimulate the formation of methyl mercury in peatlands,[2] the relationship may depend on several variables in addition to sulfate. These include organic carbon, the fraction of bioavailable mercury, the presence of adjacent wetlands and peat bogs in particular, and the microbial community structure (not all sulfate reducing bacteria methylate mercury).[3] Therefore, it is unclear at this time whether there would

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[1] May 4, 2006 letter from Minnesota Pollution Control Agency (Richard Sandberg, Manager, Air Quality Permits Section, Industrial Division) to Minnesota Department of Commerce (William Storm, Energy Facility Permitting), page 4. In the letter, the MPCA indicates that increases in sulfate in certain aquatic environments can contribute to the formation of methylmercury in receiving waters.

[2] Branfireun BA, Roulet NT, Kelly CA & Rudd JWM (1999) In situ sulphate stimulation of mercury methylation in a boreal peatland: toward a link between acid rain and methylmercury contamination in remote environments. Global Geochemical Cycles 13: 743-750. Branfireun BA, Bishop K, Roulet NT, Granberg G & Nilsson M (2001) Mercury cycling in boreal ecosystems: The long-term effect of acid rain constituents on peatland pore water methylmercury concentrations. Geophys. Res. Lett. 28: 1227-1230.

[3] Macalady JL, Mack EE & Scow KM (2000) Sediment Microbial Community Structure and Mercury Methylation in Mercury-Polluted Clear Lake, California. Appl. Environ. Microbiol. 66: 1479. Porvari P & Verta M (1995)

be any impact associated with sulfate discharged to Holman Lake via the CTB from Mesaba One and Mesaba Two. To the extent appropriate, this matter will be addressed during the National Pollutant Discharge Elimination System permitting process.

Thermal impacts are expected to be minimal. The thermal modeling presented in the Environmental Supplement, which showed negligible impacts, was based upon a 2,400 gpm flow, which exceeds any flow into Holman Lake that is considered in the base case or this alternative case.

Outflow from Holman Lake

Water flows through Holman Lake and into the Swan River would increase compared to the base case. Table 3 summarizes the conservatively modeled existing flow and the increase in both scenarios. While the relative increase appears large, Holman Lake has historically experienced large fluctuations in flows caused by dewatering flows from nearby mining activity and beaver dam management. Therefore, historical outflows from Holman Lake have far exceeded those that will result from full CTB discharge, and scouring of the outflow from the lake is not likely to be of concern.

Table 3: Water Flows through Holman Lake

	Existing Flow	Maximum CTB Discharge	Total Outflow
Base Case	**1,215 gpm**	**825 gpm**	**2,040 gpm**
Alternative Case	**1,215 gpm**	**1,800 gpm**	**3,015 gpm**

Swan River

The headwaters of the Swan River are located about nine river-miles upstream of Holman Lake. At the outlet of Swan Lake, the origin of the Swan River, the average flow is approximately 28,000 gpm.[4] No forks in the Swan River occur between its origin and Holman Lake and, within that stretch, three streams from named lakes empty therein (these streams emanate from Snowball Lake, Lower Panasa Lake, and Twin Lakes); therefore, the flow rate at the point at which Mesaba's discharge enters the Swan River is expected to be minimal in relation to the existing flow except during periods of extremely low flow in the Swan River.

The Swan River is impaired for mercury and dissolved oxygen (for which phosphorus is the surrogate chemical of concern). Excelsior anticipates that water quality trading – that is, reducing mercury and phosphorus emissions via contractual arrangements with nearby sources in order to offset Mesaba's discharges – will be a valid approach to addressing these regulatory concerns. The MPCA is developing water quality trading rules, but has already issued NPDES

Methylmercury production In flooded soils - a laboratory study. Water, Air, and Soil Poll. 80: 765-773.

[4] Minnesota Steel Project Draft Environmental Impact Statement. p. 4-50. Feb. 2007 (*see* http://files.dnr.state.mn.us/input/environmentalreview/minnsteel/deis/deis_1.pdf).

permits in the past that featured such trading.[5]

Based on preliminary discussions with nearby sources in the watershed, trading opportunities do exist, since additional controls and improved operating practices could reduce their emissions. It is anticipated that under MPCA oversight, Excelsior could enter into agreements with these nearby sources to ensure that the reductions would take place and to compensate the sources for the cost of the reductions. Trading would occur at a ratio of greater than 1:1, thereby reducing the mass loading of mercury and phosphorus to the Swan River. Therefore, under a water quality trading arrangement, the impairment to the Swan River and downstream waters would decrease.

Air Quality

Particulate matter emissions due to cooling tower drift would decrease slightly due to the water quality of the Canisteo Mine Pit remaining relatively constant. Instead of 39 tons/year for Mesaba One and Mesaba Two, worst case emissions would be expected to decrease to 35 tons/year.

Discharge Alternative 2: Relocation of the Holman Lake Outfall to the Swan River

Description

An alternative discharge arrangement to that proposed in Excelsior's application for a NPDES permit would be to relocate the outfall currently proposed into Holman Lake to instead discharge to the Swan River. This alternative could occur independently of or in conjunction with Discharge Alternative 1 as discussed above. It would reduce the concern of localized impacts associated with discharge into a relatively small lake, and may expand the options for water quality trading mentioned in Alternative 1. Environmental impacts associated with the blowdown pipeline alignment could be minimized by following the proposed HVTL and natural gas pipeline corridors for approximately 4.5 miles to where they cross the Swan River. This crossing is less than half a mile upstream from the confluence of Holman Lake's discharge and the Swan River. While the currently proposed pipeline from the plant to Holman Lake could be eliminated, it may be necessary to maintain the proposed tie-in linking the CMP to Holman Lake in order to manage water levels in the CMP.

Two related alternatives include discharge to the Mississippi River and the Prairie River. The large distance to the Mississippi River (approximately 13 miles) rules it out as a reasonable alternative, even though the larger flow would alleviate some other concerns. The Prairie River has larger flows than the Swan River, but not large enough to dismiss the fundamental

[5] NPDES permits for Southern Minnesota Beet Sugar Cooperative (2004) and Rahr Malting (1997) both included water quality trading.

environmental concerns associated with blowdown discharge such as the need for variances and mercury impairment. Also, it is anticipated that there would be fewer trading partners available in the Prairie River watershed than the Swan River. Finally, the Prairie River empties into Prairie Lake approximately 13 river miles downstream of the potential discharge point. This lake appears to have many residential property owners located on its shoreline and is impaired for fish consumption due to mercury, adding significant uncertainty regarding the practicality of obtaining the necessary discharge permit.

Water Quality

The most direct environmental impacts of this alternative are associated with the water quality of Holman Lake and Swan River. Because Holman Lake flows into the Swan River, the mass load on the watershed of chemicals of concern, such as phosphorus and mercury, would not change under this alternative. However, the allocation of localized impact between Holman Lake and Swan River would be affected.

Under this alternative, impacts to the water quality of Holman Lake as illustrated in Figures 3-6 would be avoided – i.e, concentrations of TDS, hardness, phosphate, mercury, etc. within the lake would remain at background levels. On the other hand, impacts to the Swan River's water quality would be somewhat magnified, as this alternative bypasses the dilutive effect of discharging into Holman Lake. As discussed in Alternative 1, the average flow of Swan River is at least 28,000 gpm, while the maximum discharge to the Swan River would be 1,800 gpm. Therefore, the impact to water quality during normal flow conditions would be modest. However, because the 7Q10 flow of the Swan River is just 800 gpm,[6] the river could consist primarily of CTB during conditions of extremely low flows. While flow augmentation during such periods could be considered a positive effect, the TDS and hardness concentrations would be relatively high. The maximum possible discharge concentrations would be the same as those identified in Table 2, and the allowable mixing zone of 25% of the 7Q10 flow (200 gpm) would do little to dilute those concentrations. As with the base case, a variance request for TDS and hardness, the standards for which are based on aesthetic rather than health-related concerns, may be necessary.

Thermal Impacts

As with water quality, because the blowdown discharge flow would be approximately 6% of the river flow, this alternative would have minimal thermal impacts during average flow conditions. However, the impact could become very significant during low flows, and would most likely introduce the need for a variance for the temperature of the discharge. During worst-case conditions, blowdown water would leave the plant at approximately 86°F during peak summer temperatures,[7] which just meets absolute state water quality standards, but would exceed the relative limit of 3°F above ambient water temperatures (Minn. R. 7050.0220 subp. 5). Cooling

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[6] United States Geological Survey. Low Flow Application for the Swan River near Calumet, MN. Available: http://gisdmnspl.cr.usgs.gov/lowflow/contData/logPearson/p05216860.pdf.

[7] Excelsior Energy. Appendix E to the Mesaba Energy Project NPDES Permit. Submitted to the MPCA June 2006.

ponds of sufficient size may be able to mitigate thermal concerns. Otherwise, due to the low 7Q10 value for the Swan River, it is unlikely that this standard could be met without a variance.

Sulfate and Other Localized Concerns

The possibility of localized impacts, such as the impact of sulfate on the formation of methyl mercury and concerns surrounding the outflow of Holman Lake, would be reduced. While the possibility of methyl mercury formation would not be completely eliminated, some factors that are suggested to be involved with its formation would be diminished. There would generally be less contact with adjacent wetlands under this alternative, and sulfate would be more fully diluted under normal flow conditions. While some localized impact to the Swan River near the point of discharge is possible (see variance discussions above), they are of lesser concern in a flowing river than in a lake.

Pipeline Alignment Impacts

While this alternative would increase the total miles of blowdown pipeline by approximately two miles, it would be along existing corridors, preventing any impacts associated with new pipeline corridors. A 150-ft right-of-way ("ROW") is proposed where HVTL and natural gas pipelines share a corridor. The corridor may be able to accommodate the blowdown pipeline as proposed, or slight additional widening may be necessary. Therefore, while such widening may cause additional wetland and land use impacts, the impacts would be very small, and would be minimized by combining infrastructure corridors to the maximum extent possible.

Discharge Alternative 3: Zero Liquid Discharge Treatment

Description

An alternative to the discharge proposed in Excelsior's NPDES permit application would be to eliminate all CTB discharge through the use of Zero Liquid Discharge ("ZLD") treatment. A ZLD system on the West Range would be implemented as described for the East Range Site in Section 4.5.4 of the EIS. Outside of the Great Lakes watershed and extremely arid regions, ZLD treatment of power plant cooling water is a nearly unprecedented level of treatment. This alternative would eliminate all CTB blowdown discharge and associated pipelines from the facility and would reduce the facility's water appropriation needs. ZLD treatment would incur significant capital and O&M costs, reduce plant efficiency and output, and produce additional solid waste and cooling tower drift. It is possible that this alternative could be combined with either of the first two by using ZLD treatment of a slipstream of the CTB, although such an arrangement may be even less cost effective than ZLD alone.

Water Management Plan

Compared to the base case from the permit application, maximum water appropriation needs for two Mesaba phases under this alternative would decrease from 10,300 gpm to 7,000 gpm.[8] However, the proposed CTB discharge from the plant to the CMP of 2,675 gpm (for Mesaba One and Two) would also be eliminated. Overall, the water needs are up to 625 gpm less than the base case, and up to 1,800 gpm less than required under Alternative 1.

Water Quality

As all direct discharges from the plant would be eliminated, water quality impacts to Holman Lake and the CMP as identified in Figures 3-6 would be avoided – i.e., concentrations of TDS, hardness, phosphate, mercury, etc. within the lake would remain at background levels. There would also be no direct water quality impact to the Swan River. The possibility of localized impacts identified for the base case and other alternatives would also be eliminated.

Solid Waste Disposal

The ZLD system for treating CTB would produce significant amounts of non-hazardous salts that must be transported from the site and landfilled. On the East Range, Mesaba One and Two could produce up to 24,000 tons/year of solid waste from this treatment based on the worst-case source water quality, which has a TDS of up to 1800 mg/L.[9] Because the source water quality on the West Range is much better (approximately 340 mg/L TDS[10]), the maximum salt production from ZLD treatment of the CTB would be less than 5,000 tons/year for Mesaba One and Two.

Plant Capacity and Efficiency

Operation of the ZLD system would consume electricity, adding to the parasitic load within the facility, which has two closely connected effects. First, it reduces the net output capacity of the plant. Second, it reduces the efficiency of the plant proportionately to this reduction in capacity. On the East Range Site, plant capacity could be reduced by up to 2 MW (approximately 0.3%), and the corresponding heat rate increase would be 31 Btu/kWh. As mentioned above, the source water quality at the West Range Site is superior, which is likely to reduce the parasitic load of ZLD treatment versus the East Range Site. Therefore, a 2 MW reduction in plant capacity and 31 Btu/kWh increase in heat rate are likely to overestimate this effect for the West Range Site. However, to the degree that efficiency is reduced, air emissions on a per megawatt hour basis will increase (by a maximum of about 0.3%).

Air Quality

The ZLD system will increase particular matter emissions due to cooling tower drift, as the cycles of concentration at which cooling towers operate would likely be increased. If this figure were doubled, particulate emissions due to drift would increase from 39 tons/year to 78

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[8] Excelsior Energy. Appendix D to the Mesaba Energy Project NPDES Permit. Submitted to the MPCA, June 2006.
[9] Excelsior Energy. Environmental Supplement to the Joint Permit Application. Submitted to the MN Public Utilities Commission, June 2006. p. I-155.
[10] *Ibid.*

tons/year, resulting in facility wide particulate emissions of 532 tons/year instead of 493 tons/yr.

Pipeline Alignment Impacts

Under this alternative, all blowdown pipelines from the plant could be eliminated. While most pipelines share corridors with other infrastructure, the approximately two mile blowdown pipeline to Canisteo Mine Pit represents corridor that could be completely eliminated. Wetland impacts may be reduced by up to 17 acres, and land use impacts would be reduced as well.

Summary

The quantifiable differences between the alternatives are tabulated below. Note that Alternative 2 reflects the base case with the Holman Lake discharge diverted to the Swan River. This alternative could be combined with Alternative 1, which would produce the results shown for that alternative. As described in the analysis, Alternative 1 involves a range of possible flow allocations, and it was assumed for the purposes of this summary that all discharge was redirected from the CMP to Holman Lake. The figures below represent maximum values.

Table 4: Quantitative Impact Comparison across Alternatives

Parameter	Base Case		Alt. 1		Alt. 2	
Number of Phases	1	2	1	2	1	2
Discharge to CMP (gpm)	300	2,675	0	0	300	2,675
Discharge to Swan River Watershed (gpm)	600	825	900	1,800	600	825
Net Water Needed (gpm)	4,100	7,625	4,400	8,800	4,100	7,625
Cycles of Concentration	5	3	5	5	5	3
PM Emissions from Drift (tons/yr)	20	39	18	35	20	39

Table 4 (con't)

Parameter	Alt. 1 & 2		Alt. 3	
Number of Phases	1	2	1	2
Discharge to CMP (gpm)	0	0	0	0
Discharge to Swan River Watershed (gpm)	900	1,800	0	0
Net Water Needed (gpm)	4,400	8,800	3,500	7,000
Cycles of Concentration	5	5	≥10	≥10
PM Emissions from Drift (tons/yr)	18	35	39	78