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Technical Memorandum

To: Richard Clark
From: Mike Hansel
Subject: Economic Consequences of meeting 10 mg/L Sulfate Standard
Date: May 31, 2011
Project: 23/69-0B65
c: Jasmine Scheuring, Tom Lutes, Tony Widboom, Lisa Andrews, Keith Hanson

Treatment of process wastewaters to 10 mg/L for sulfates is not technically feasible. In an "**Evaluation of the Mesabi Nugget Variance Application for NPDES/SDS Permit Renewal Permit No. MN0067687"** by John Engesser, P.E., Assistant Director, Minnesota Department of Natural Resources, Division of Lands and Minerals (2010), Mr. Engesser concludes "At the current time there are no technically feasible water treatment technologies that can be used to ensure that all the required discharge limits for alkalinity, TDS, hardness, and specific conductance can be met. There are currently no viable treatment options to treat Pit 1 water to less than 10 mg sulfate per liter." Mr. Engesser notes that nanofiltration is only likely to remove sulfates down to the 250 mg/L level. While reverse osmosis could in theory be used to reduce sulfate to the 10 mg/L level in certain applications, Mr. Engesser notes: "Since no proven method has been developed for disposal of the brines from nanofiltration or RO systems, these treatment methods are currently not viable treatment options for Pit 1 discharge water."

Because such treatment is not technically feasible, the costs of a theoretical wastewater treatment effort are both irrelevant and impossible to determine with any accuracy. While we are not aware of any requirement to estimate costs or the economic consequences for implementing infeasible technology, below is a short discussion of those economic consequences.

The use of membrane treatment (reverse osmosis) is the only technology that could conceivably reduce the concentrations of dissolved solids and especially sulfates to levels approaching the current interpretations of applicable water quality standards. From the ***Area 1 Pit Water Treatment Evaluation in Support of the Non-Degradation Analysis***, Barr, May, 2011, the capital cost of such a system for Area 1 Pit alone was estimated to be $40.6 million (including pilot testing and professional services but not including any amount for contingencies). The annual O&M costs were estimated to be $3.3 million/year. The costs provided in the revised Area 1 Pit Water Treatment Evaluation were based on achieving a 10 mg/L sulfate water quality standard.

The range of accuracy for the costs presented is ±15 to 50 percent. This reflects the uncertainties associated with the unproven application of this technology. This degree of accuracy falls within the level of accuracy suggested for alternatives analysis by the U.S. EPA (U.S. EPA, 2000).

Such systems have only been used at the scale required just for Area 1 Pit in areas where ocean discharge or evaporation ponds are available – options not available in northern Minnesota. A large portion of the cost is in managing the residual brine from the membrane treatment of the water by evaporation and crystallization. Such large scale systems have not been built anywhere in Minnesota, or elsewhere to our knowledge. While others may have proposed to construct such systems, none have in fact been built.

The net present value for a system designed only for Area 1 Pit and achieving a 10 mg/L sulfate water quality standard is estimated at $91.7million for a twenty year operating life.

While the production rate used as the basis for the current AQ permit was 600,000 mt/year of nuggets, it is more realistic to achieve a production rate of 500,000 mt/year given the current equipments' design criteria. Assuming the discharges from Area 1 Pit plus the discharges from Area 2WX and 6 Pits (to supply ore to the nugget process) must be treated to meet the 10 mg/L sulfate standard, this yields an increased operating cost of at least $6.60/mt of nugget produced. Assuming a useful life of equipment of 20 years, and an interest rate of 7%, yields an annualized capital cost of $3.8 million. Adding the annual O&M costs of $3.3 million results in an increased cost of $14.2/mt of nugget produced.

Iron prices are cyclical and can rise and fall rapidly. Figure 1 shows the price of Brazilian Pig Iron export costs (one of the competitors to Mesabi Nugget). Prices over the past decade have ranged from $95/mt to nearly $700/mt, with an average price of $265/mt and a median price of $256/mt. An additional $14.2/mt of operating costs would make the Mesabi Nugget cost 5.5% higher, making Mesabi Nugget product non-competitive half the time.

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With worldwide competition in iron supply, such an increased operating cost would put Mesabi Nugget at a distinct economic disadvantage during all economic cycles and particularly during downturns in demand and world prices for iron like that which occurred in 2009. A facility with higher capital and operating costs cannot be competitive. Spending hundreds of millions on wastewater treatment would jeopardize the entire $300 million dollar investment in the nugget plant and additional investment planned for the mining operation. The potentially groundbreaking technology being developed at Mesabi Nugget would be stifled and future economic development expanding the technology would never occur. For both technical and economic infeasibility reasons, additional treatment of process wastewaters should be ruled out as limit variances are being considered.

Reference: U. S. EPA (2000), *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*, EPA 540-R00-002.