Minnesota Pollution Control Agency

Review of Minnesota Power's Arrowhead Regional Emission Abatement (AREA) Project

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MPCA Review of Minnesota Power's

Arrowhead Regional Emission Abatement Proposal (AREA)

1.0 Introduction

On October 14, 2005, Minnesota Power submitted an emission reduction proposal, the Arrowhead Regional Emission Abatement Proposal (AREA) and accompanying rate rider, pursuant to Minn. Stat. § 216B.1692. The proposal identified emission reduction options at two plants located in the Arrowhead region of northern Minnesota.

- **Syl Laskin, Aurora**: Replace existing coal burners with low nitrogen dioxide (NOx) burners and overfire air systems on both Laskin coal-fired generating units. Overfire air systems feature additional air ports as well as software that tracks combustion conditions and automatically modifies fuel/air input to more completely burn fuel. These improvements reduce NOx emissions from coal-burning. The proposal includes no increase in capacity at this 100 MW generating station.

- **Taconite Harbor, Schroeder**: Install Mobotec multipollutant control technology on each of the three 75 MW coal-fired units. The company will install equipment within the combustion chamber of each boiler to modify combustion conditions and inject chemicals to reduce NOx, sulfur dioxide (SO_2) and mercury pollution. The proposal includes no increase in capacity at this 225 MW generating station.

Table 1 shows that this project, if implemented as proposed, would result in considerable reduction in key pollutant emissions from these two facilities. The project could reduce emissions of SO_2 by 66 percent, NOx by 50 percent, and mercury by perhaps more than 70 percent.

Table 1. Comparison of annual overall emissions for Syl Laskin and Taconite Harbor plants before and after proposed changes

	SO_2	NO_X	PM	PM_{10}	Mercury (lbs)
Current annual emissions from the two plants (in tons per year—average 2003 to 2004)	7,138	5,694	398	443	94
Emissions after retrofits complete (in tons per year)	3,589	1,949	398	443	25.8
Percent reduction	50%	66%	None	None	72%

In this report, the Minnesota Pollution Control Agency (MPCA) provides the analysis of Minnesota Power's proposal that is required under the emission reduction statute, based on its expertise in evaluating pollution control projects as part of its long-standing air quality regulatory programs. Specifically, Minn. Stat. § 216B.1692, Subd. 4 asks the MPCA to advise the Minnesota Public Utilities Commission (PUC) on three points:

- Verification that the emission reductions project qualifies under Minn. Stat. § 216B.1692, Subd. 1;
- A description of the projected environmental benefits of the proposed project; and
- The MPCA's assessment of the appropriateness of the proposed AREA project.

In addition to addressing these points in this report, the MPCA is also to provide the PUC with answers to two questions posed under Minn. Stat. § 216B.1692 Subd.5(c):

- Whether the project is needed to comply with new state or federal air quality standards; and
- Whether the emission reduction project is required as a corrective action as part of any state or federal enforcement action.

2.0 Summary

The MPCA has reviewed Minnesota Power's proposal to determine whether the proposal qualifies under Minn. Stat. § 216B.1692. The MPCA has also projected the environmental benefits from the implementation of this project.

2.1 Qualifying Projects

The proposed project affects two existing large electric generating plants and does not increase generating capacity. The project reduces emission rates of air pollutants released by Syl Laskin and Taconite Harbor to either levels substantially lower than New Source Performance Standards (NSPS) and/or the most cost-effective level of control.

In making this determination, the MPCA has met its statutory requirement to determine whether the emissions reductions proposed meet applicable new source review standards, emit air contaminants at levels substantially lower than allowed by new source performance standards or reduce air pollutants to their lowest-cost effective level [Minn. Stat. §216B.1692, Subd. 4 (1)].

The MPCA has also determined that the proposed project is not needed to meet state or federal air quality standards nor is it required as a corrective measure as part of any state or federal enforcement action.

Therefore, the MPCA concludes that this is a qualifying project under the statute.

2.2 Project Costs

The MPCA reviewed project costs to determine if they are within a reasonable range. The MPCA believes that the capital and operating costs prepared by Minnesota Power for the selected retrofit technologies are a reasonable estimate. Minnesota Power is not likely to have under-estimated the cost of implementing either project.

2.3 Projected Environmental Benefits

The MPCA must describe the environmental benefits that result from the implementation of this project [Minn. Stat. §216B. 1692, Subd. 4 (2)].

Reducing SO_2 and mercury emissions is critical to improving our water resources in Minnesota and throughout the U.S. Evidence shows that further SO_2 reductions are needed to reverse the ecological damage from acid rain. Sulfur dioxide converts to sulfates which, when deposited as acid rain, may enable lake bacteria to convert mercury to methylate mercury. Methylate mercury can concentrate in fish. This proposal would reduce contributions of both SO_2 and mercury, thereby reducing factors that contribute to mercury contamination in the environment.

Inhalation of fine particulates, some of which are formed by emissions of both SO_2 and NOx, strongly correlates with increased health problems, including early death from cardiopulmonary disease and lung cancer. Researchers have not yet identified a threshold concentration where these health impacts disappear. Fine particulate health effects extend even down to background levels.

Minnesota Power's estimate, using just the PUC's "externality values," shows that environmental benefits

are considerably less than costs. Externality values have been adopted by the PUC to estimate health and environmental damage caused by the emission of some pollutants by electricity generation.

The gap between costs and benefits can be explained by noting that the PUC's externality values are somewhat dated and do not fully quantify all of the benefits associated with this project.

The MPCA has recalculated benefits more comprehensively, in a manner similar to its recalculation of benefits when reviewing Xcel's Metropolitan Emissions Reduction Project (MERP)[1]. The MPCA's recalculation incorporates information from recent federal benefit estimates for Clean Air Act reduction programs, and indicates that, to the extent benefits are quantifiable, it is more likely that AREA's benefits approximate (and most likely exceed) the projected costs.

This benefit estimate does not attempt to quantify fully all health issues associated with fine particulates. It also does not quantify the benefits of the reduction in mercury, regional haze, acid rain, or ground-level ozone.

2.4 Appropriateness of the Project

Both the Syl Laskin and Taconite Harbor plants are older coal-fired generating stations located in northeastern Minnesota, near important natural resources. The AREA project will result in significant emission reduction — including mercury and the precursors to fine particulate matter and regional haze — at both of these plants within the next few years. Given the emission reduction that would be achieved and the low costs of the proposal, the MPCA believes it is appropriate to allow cost recovery for this project, as specified by the statute.

Minnesota Power's implementation of the AREA project will not preclude retrofitting with more traditional means of NOx, SO_2 or mercury controls if, in the future, larger reductions become necessary.

[1] MPCA, Review of Xcel's Metropolitan Emissions Reduction Proposal, December 30, 2002. www.pca.state.mn.us/publications/reports/xcelenergy-metroemissionproposal.pdf

3.0 Qualifying Projects

Under Minn. Stat. § 216B.1692, Minnesota Power has proposed emission reduction projects at two power plants.

- **Syl Laskin, Aurora**—Minnesota Power proposes to lower nitrogen oxide emissions (NOx) by replacing existing burners in the combustion chamber, and installing software to monitor combustion conditions.

- **Taconite Harbor, Schroeder** — Minnesota Power proposes to install Mobotec multipollutant control technology on each of the three 75 MW coal-fired units. The company will install equipment within the combustion chamber of each boiler to modify combustion conditions and inject chemicals to reduce NOx, sulfur dioxide (SO_2) and mercury pollution. Minnesota Power will also be improving particulate matter control devices to ensure that there is no increase in PM emissions after installing the Mobotec technology. However, the costs associated with PM control improvements are not a part of this emission-reduction rider request.

The MPCA is charged with determining whether these proposals "qualify" for the cost recovery that is allowed under Minn. Stat. § 216B.1692. This section first describes how the MPCA considered the statutory requirements, and then evaluated each plant proposal to determine if it qualified.

3.1 Minn. Stat. § 216B.1692 Subd. 1. Qualifying Projects

Projects that may be approved for the emissions reduction rate rider under this section must:

1) be installed on existing large electric generating power plants as defined under Minn. Stat. § 216B.2421 subd. 2(1), that are located in the state and not subject to emission limitations for new power plants under the federal Clean Air Act;

The definition of a large power plant under Minn. Stat. § 216B. 2421 includes the following:

"Large energy facility" means any electric power generating plant or combination of plants at a single site with a combined capacity of 50 MW or more and transmission lines directly associated with the plant that are necessary to connect the plant to the transmission system;"

2) not increase capacity by more than 10 percent or 100 MW, whichever is greater; This is a straightforward calculation of increased capacity over current facility generating capacity.

3) result in the existing power plant either:

> i) complying with applicable New Source Review (NSR) standards under the federal Clean Air Act;
> ii) emitting air contaminants at levels substantially lower than allowed for new facilities by the applicable NSPS standards under the federal Clean Air Act; or,
> iii) reducing emissions from current levels at a unit to the lowest cost-effective level when, due to the age or condition of the generating unit, the public utility demonstrates that it would not be cost effective to reduce emissions to the levels in item (i) or (ii).

Under Minn. Stat. § 216B.1692, subd. 1(3), a project qualifies if it meets NSR requirements (i) (above), if it would make emissions "substantially lower" than the NSPS would require (ii), or if the project makes "cost-effective" reductions (iii). We discuss our considerations of each condition below.

3.1.1 New Source Review

New Source Review (NSR) is a federally mandated air quality program that was established in the 1977 Clean Air Act Amendments. It is designed to improve the quality of the air in areas that have poor quality air. These are called "non-attainment" areas because they do not meet the National Ambient Air Quality Standards (NAAQS). In attainment areas that do meet the NAAQS, NSR protects the quality of the air from significant deterioration. In non-attainment areas, NSR requires the use of technology with the Lowest Achievable Emission Rate (LAER). In attainment areas, Best Available Control Technology (BACT) is required. BACT, unlike LAER, includes an assessment and consideration of costs and other factors. Northeastern Minnesota is an attainment area so NSR there would require BACT.

3.1.2 New Source Performance Standards

The New Source Performance Standards (NSPS) program was established in the 1970 Clean Air Act. Under NSPS, generation facilities built after 1972 are required to meet certain minimum performance standards with regard to emissions of several pollutants. Generation facilities that were built before 1972 are exempt from NSPS.

NSPS have been revised several times, and different standards apply to plants depending on the year the plant was constructed. NSPS have become progressively more stringent, so control requirements at newer plants are more stringent than older NSPS requirements.

3.1.3 Cost Effectiveness

The MPCA views the statute's requirement for the "lowest cost-effective level" to mean the least-cost project for controlling emissions (when the cost of achieving either NSR levels or NSPS cannot be justified).

Minnesota Power acted on the advice of the MPCA and analyzed alternatives that would likely achieve BACT-level and NSPS-level controls, as well as potential alternatives that would not achieve those levels. In this way, control strategies "better than" or "worse than" an alternative were evaluated to demonstrate whether a selected alternative is the most cost-effective. Cost-effectiveness is discussed separately for each plant, because of the difference in the projects.

3.2 Do the Projects Qualify Under 216B.1692 Subd 1?

3.2.1 Syl Laskin

Is it an existing large electric generating power plant as defined under Minn. Stat. § 216B.2421 subd. 2 that is located in the state and not subject to emission limitations for new power plants under the federal Clean Air Act?

The Syl Laskin plant is located in Aurora, Minnesota, and has a net generating capacity of 100 MW. It meets

the definition of a large electric generating power plant because it is larger than 50 MW. The boilers are tangential-fired and now burn sub-bituminous coal. The boilers were constructed in 1951, before the Clean Air Act was passed, and thus before EPA promulgated NSPS for boilers. It is therefore not subject to the NSPS standards for power boilers. The project meets this requirement.

Does it increase capacity by more than 10 percent or more than 100 MW?

Minnesota Power's proposal does not change the generating capacity of this plant, thus it meets the condition of the statute.

Does the project meet NSR requirements?

The proposal does not meet BACT limits or control technology requirements as would be required by a BACT analysis of new source review, as shown in Table 2 on page 12.

Does the project propose emission levels substantially below the NSPS?

Table 2 on the next page shows the current emission rates at the Laskin plant and the emission rates that would result from Minnesota Power's proposed emission reduction project. Also included are NSPS determinations for similar plants.

Minnesota Power proposes to install low NOx coal burners and overfire air systems including additional air ports and software that is used to track combustion conditions within the boiler to automatically modify fuel/air inputs ("neural network" software). This technology is being widely deployed throughout the utility boiler industry.

Table 2. Comparison of emission data, including recent New Source Review limits, New Source Performance Standards and existing and proposed emission rates for Minnesota Power's Syl Laskin generating station

	Capacity		NOx	SO2	PM	Mercury
	MW	mmbtu/hr	Lb/mmbtu	Lb/mmbtu	Lb/mmbtu	Lb/GMw
Laskin 1 existing emissions	50	660	0.58	0.40	0.033	0.026
Laskin 2 existing emissions	50	660	0.59	0.41	0.033	0.026
BACT median determination[2] (NSR) (Range)			0.09 (0.067 to 0.6)	0.12 (0.068 to 1.17)	0.018 (0.012 to 0.029)	--
New Source Performance Standards[3]		>250	1.6 lb/MWh[4] (0.13 lb/ mmbtu)	1.2	0.03[5]	0.042/0.078[6]
Emissions, Laskin 1, 2 retrofitted (AREA)			0.2	No change	No change	No change

The proposed NOx emission rate for the retrofit of the Laskin plant does not achieve the NSPS NOx emissions rate for new, modified or reconstructed electric generating stations with a heat input capacity of greater than 250 million British thermal units (mmbtu) per hour.

Low NOx burner technologies are being widely deployed, and are being demonstrated in the field to achieve emission rates well below 0.2 lb/mmbtu emissions rate proposed by Minnesota Power. While achieving an emissions rate at or below 0.2 lb/mmbtu represents a considerable reduction in NOx emissions, it does not meet the condition of the statute requiring a "substantial reduction" beyond the NSPS. Emissions of the other regulated pollutants are currently at or below the NSPS. Because proposed emission levels for NOx are not below the NSPS, the MPCA must consider whether the proposal is cost-effective.

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[2] From the RACT/BACT/LAER Clearninghouse (http://cfpub.epa.gov/rblc/htm/bl02.cfm). Emission limits for sub-bituminous coal-fired utility boilers from the past five years were selected.

[3] New Source Performance Standards in 40 CFR 60 Subpart Da (40 CFR 60.40da-60.49da)

[4] A newly constructed unit would be required to meet a 1.6 lb/MWh limit. For Laskin, this translates to a NOx emissions limit on a heat input basis of 0.13 lb/mmbtu.

[5] The NSPS (40 CFR 40.62Da) requires that PM must also be controlled by at least 99%. Because there is a national ambient air quality standard for PM10, limits for PM10 are established during permit preparation of new coal-fired units because the NSPS does not contain emission limits for PM10 from coal-fired units.

[6] EPA amended the NSPS in 2005 to include mercury emission limits for new coal-fired power plants as part of its cap-and-trade program for mercury from coal-fired utility boilers. The standards apply for the first five years of operation, after which the facility must hold sufficient allowances to cover mercury emissions. The dual standard for sub-bituminous coal reflects the difference in the ability to control mercury when scrubbing is in place: the "wet" flue gas desulfurization mercury standard is 0.042 lb/GMw, and "dry" flue gas desulfurization mercury standard is 0.078 lb/GMw.

Does the proposal reduce emissions to the lowest cost-effective level?

The third criterion of the statute allows a project to qualify if the project is the "lowest cost-effective level."

A complete cost-effectiveness study would analyze all possible configurations of every possible design, and then choose the least-cost alternative. Rather than investing significant analysis to identify all options, Minnesota Power acted on the advice of the MPCA and analyzed alternatives that would likely achieve BACT-level and NSPS-level controls, as well as potential alternatives that would not achieve those levels. In this way, control strategies "better than" or "worse than" an alternative would be evaluated to demonstrate whether a selected alternative is the most cost-effective.

Table 3. Cost effectiveness of NOx control alternatives for Minnesota Power's Laskin generating station

Laskin 1, 2		Alternatives		
	AREA (low NOx burners)	A (SNCR)	B (ROFA/ ROTAmix)	C (SCR)
Capital cost	$4,464,000	$3,256,240	$14,722,525	$34,408,000
Annual operations & maintenance	$72,000	$992,000	$825,304	$1,316,000
Annualized total cost	$930,240	$1,749,566	$3,101,037	$8,987,523
Annual NOx reductions (tons)	1,558	1,516	1,558	2,037
$/ton of pollutant removed	$597	$1,154	$1,990	$4,412

For Laskin, Minnesota Power's alternatives included:

- installing low-NOx burners (the selected AREA project),
- implementing selective non-catalytic reduction (SNCR, alternative A above),
- installing Mobotec's rotating overfire air/selective non-catalytic reduction technology (ROFA/ ROTAmix, alternative B above), or
- implementing selective catalytic reduction (SCR,alternative C above).

As discussed in section 5.0, the MPCA reviewed the cost estimate of each alternative, and has concluded that Minnesota Power's estimate of capital and operating costs are reasonable budgetary estimates.

Minnesota Power's proposal appears cost-effective when set alongside its chosen alternatives. Alternative NOx reduction proposals A and B reduce NOx emissions by about the same amount, but cost three times as much, while alternative C achieves an additional 33% improvement in NOx reductions – but at 10 times the cost. At $597 per ton, the AREA configuration costs significantly less than its alternatives, thus meeting the condition of being a cost-effective project.

Summary

The Syl Laskin proposal meets all three conditions of Minn. Stat. § 216B.1692, subd. 1, and thus is a qualifying project under the statute.

3.2.2 Taconite Harbor

Is it an existing large electric generating power plant as defined under Minn. Stat. § 216B.2421 subd. 2 that is located in the state and not subject to emission limitations for new power plants under the federal Clean Air Act?

The Taconite Harbor generating station consists of three electric generating units, each rated at a net generating capacity of 75 MW.

Because the facility is greater than 50 MW, it is a large generating station. Units 1 and 2 were placed in service in 1957 and unit 3 in 1967. The facility was brought online before the Clean Air Act was passed and before EPA promulgated NSPS for boilers. It is therefore not subject to the NSPS standards for power boilers. The project meets this requirement.

Does it increase capacity by more than 10 percent or more than 100 MW?

The proposed project for this location is to retrofit control technology to lower NOx, SO_2 and mercury emissions. No generating increase is proposed by this project.

Does the project meet NSR requirements?

As shown in Table 4, the proposed project does not meet BACT limits or control technology requirements that would be established through NSR analysis.

Does the project propose "levels substantially below NSPS"?

Table 4 shows the current emission rates at the Taconite Harbor plant and the emission rates that would result from Minnesota Power's proposed emission reduction project. It includes NSR determinations for similar facilities, applicable NSPS, and proposed emission limits for AREA upon completion.

MPCA staff believe that because of the nature of the Taconite Harbor AREA project, a modification of the facility is occurring such that the NSPS for utility boilers applies. Therefore, the NSPS identified in Table 4 below are applicable emission limits for Taconite Harbor. In some instances, these emission limits represent a significant reduction in the current permitted level; the facility currently operates well below its permitted emission limits.

Table 4. Comparison of emission data including recent New Source Review limits, New Source Performance Standards, and existing and proposed emission rates for Minnesota Power's Taconite Harbor generating facility

	Capacity		NOx	SO2	PM	Mercury
	MW	mmbtu/hr	Lb/mmbtu	Lb/mmbtu	Lb/mmbtu	Lb/GMw
Taconite Harbor 1	75	745	0.40	0.67	0.036	0.049
Taconite Harbor 2	75	745	0.41	0.67	0.027	0.049
Taconite Harbor 3	75	745	0.41	0.67	0.033	0.049
BACT median determination[7] (NSR) (Range)			0.09 (0.067 to 0.6)	0.12 (0.068 to 1.17)	0.018 (0.012 to 0.029)	--
New Source Performance Standards[8]			1.6 lb/ MWh (0.16 lb/ mmbtu)[9]	1.2	0.03[10]	0.042/0.078
Emission rate, AREA			0.14	0.24	No change	0.0049

Minnesota Power proposes to install and operate a multipollutant control system owned by the Mobotec USA Company. Mobotec calls their system of controls for NOx "ROFA" and their SO_2 control system "Rotamix/ FSI." Mercury control technology is called "Minplus".

To achieve NOx reductions, Mobotec has developed a "rotating opposed fire air" (ROFA), a combustion control system designed to improve air distribution and mixing within the boiler. The technology has been demonstrated to reduce NOx emissions by up to 65%. "Rotamix/FSI" is a variant of selective non-catalytic reduction (SNCR) for NOx and furnace sorbent injection (FSI) for controlling SO_2. The Rotamix/FSI system will inject into the boiler ammonia to reduce NOx emissions, and limestone to reduce SO_2 emissions. Neither of these methods of reducing the pollutants emissions is new. SNCR was developed to provide a low-cost means of reducing NOx emissions, and is frequently used to meet BACT for NOx at industrial boilers. Furnace sorbent injection of limestone was initially developed to address SO_2 emissions from coal-fired power plants, but fell out of favor with the development of higher removal efficiencies provided by post-combustion flue gas desulfurization systems (50% SO_2 removal with FSI versus 80 to 95% removal with wet or dry scrubbing systems).

The AREA proposal meets emission levels substantially lower than the NSPS for SO_2 and for mercury. Like Laskin, the overall reduction in NOx emissions is substantial (65%), however the proposed emissions rate of 0.14 lb/mmbtu is only 12% lower than the applicable NSPS. NOx emission rates of less than 0.1 lb/mmbtu are being achieved in practice at utility boilers retrofitted with NOx controls. The proposed emissions rate for NOx

[7]From the RACT/BACT/LAER Clearinghouse (http://cfpub.epa.gov/rblc/htm/bl02.cfm). Emission limits for sub-bituminous coal-fired utility boilers from the past five years were selected.

[8]NSPS in 40 CFR 60 Subpart Da (40 CFR 60.40da-60.49da).

[9]A newly constructed unit would be required to meet a 1.6 lb/MWh limit. For Taconite Harbor, this limit translates to about 0.16 lb/ mmbtu on a heat input basis.

[10]The NSPS (40 CFR 40.62Da) restricts emissions of PM (not PM10) from coal-fired units. Because there is a national ambient air quality standard for PM10, permit limits for PM10 must also be established. PM must also be controlled by at least 99%.

is not considered by the MPCA to be substantially below the NSPS for new coal-fired boilers[11].

Adding lime to the combustion chamber via Rotamix/FSI imposes a significant additional particulate matter load to the existing particulate matter control devices. Minnesota Power in its October AREA proposal initially reported that actual PM emissions from the plant would likely double after retrofits. However, the company has acknowledged that emissions will not be allowed to increase, but must meet the NSPS limit, and is considering additional PM controls.

Taconite Harbor boilers are currently emitting PM at rates at or very near the NSPS. Minnesota Power will need to make additional changes to the particulate matter control system to ensure ongoing compliance with the 0.03 lb/mmbtu PM emissions limit within 180 days of restarting the boilers with ROFA/Rotamix/FSI/Minplus in place. Additional PM control can be accomplished in a variety of ways, alone or in combination:

- Rehabilitating current electrostatic precipitators (ESP)
- Adding plates within the ESP
- Lowering flue gas temperature to increase residence time in the ESPs
- Adding conditioning chemicals to increase PM capture in ESP
- Installing "polishing" fabric filters downstream of the ESPs if there is sufficient room
- Replacing ESPs with fabric filters
- Novel PM controls such as replacing portions of the ESP with fabric filters[12].

In any case, to obtain a permit to implement this project at Taconite Harbor, Minnesota Power will have to accept permit conditions that meet NSPS for PM. In other words, PM emissions cannot substantially increase due to this project. Minnesota Power must yet explain how it plans to address increased PM emissions in comments filed subsequent to this report.

Of special interest in this proposal is the plan to use Mobotec's technology for mercury removal. Mobotec offers a proprietary chemical, Minplus, which is injected into the combustion chamber, where it chemically absorbs mercury at the high combustion chamber temperatures[13]. The Minplus containing the mercury is then removed with particulate matter (PM) in the PM control device. The MPCA has reviewed the performance test data for mercury control from several Mobotech installations in the U.S. While these tests did not run for long periods of time, the data did show substantial reduction in mercury levels.

Minnesota Power plans to test Mobotec control technology first on unit 2, in late 2006, before formally adopting it for use on units 1 and 3.

The MPCA views the application of combustion modifications for NOx control and furnace sorbent injection for SO_2 control as appropriate technology at Taconite Harbor to reduce emissions of these pollutants, and would expect that the Mobotec system should be deployed at all three generating units, irrespective of the success of the mercury control system being offered by Mobotec. If the MPCA determines that additional NOx, SO_2 or mercury control is necessary, the Mobotec technology does not appear to interfere with the ability to select

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[11]The proposed emissions rate is likely to meet the "presumptive Best Available Retrofit Technology" (BART) emissions rate established by EPA for the type of coal fired boilers at Taconite Harbor to achieve regional haze reduction goals. BART might apply to Unit 3. See the discussion of regional haze rules in section 4.0.

[12]The Advanced Hybrid filter was developed by University of North Dakota's Energy and Environment Research Center, and is undergoing full scale demonstration at Otter Tail Power's Big Stone Plant in South Dakota.

[13]Biermann, JP; Higgins, B; Wendt JO; Senior, C; Wang, D; "Mercury Reduction in a Coal Fired Power Plant at over 2000º F using MinPlus Sorbent through Furnace Sorbent Injection" Paper accepted for publication at Electric Utilities Conference (EUEC),Tucson, AZ, January 23-25, 2006.

additional or more traditional control schemes for these pollutants. This includes adding selective catalytic reduction for NOx control, downstream scrubbing for further SO2 control, or the injection of enhanced, activated carbon for mercury removal.

In summary, AREA for Taconite Harbor meets emission levels substantially lower than the NSPS for SO_2 and for mercury, but not for NOx or particulate matter.

Does the proposal reduce emissions to the lowest cost-effective level?

The AREA proposal at Taconite Harbor does not achieve emission levels significantly below the NSPS for NOx or particulate matter. The issue then becomes whether reductions at the facility for these pollutants (and others) are made at the lowest cost-effective level.

The most straight-forward cost-effectiveness analysis would be to generate alternatives that achieve the same project goals, and select the lowest-cost project. In this case, each alternative reduces pollutants, but different pollutants to varying degrees. In practice, it is not possible to select the lowest-cost technology for each pollutant due to the inter-relatedness of the Mobotec multipollutant control technology. Since Mobotec is a multipollutant technology, it makes sense to look at cost-effectiveness in terms of each alternative's ability to control the same pollutants collectively, that is, in a multipollutant fashion.

Table 5 below shows the total cost of the Mobotec proposal for Taconite Harbor and the two alternatives. Total NOx and SO2 reductions are summed and a cost per ton of pollutant calculated. Mercury is not included due its insignificance to the calculation (it is reported in pounds, not tons, and does not affect the calculation) but is discussed separately below. The total cost of the Mobotec project is lower than the total cost of options A and B, and achieves substantial pollutant reductions at the lowest cost for each ton of pollutant reduced.

Table 5. Total project cost-effectiveness for Minnesota Power's Taconite Harbor generating station[14]

	AREA	A	B
Total Capital Cost	$47,993,342	$206,706,765	$77,316,480
Total Annual Cost	$9,065,904	$37,306,574	$16,175,041
Total NOx Reduction (tons)	2,091	2,732	1,720
Total SO2 Reduction (tons)	3,599	4,984	2,492
Total tons reduced	5,690	7,716	4,212
$/ton total tons reduced	$1,593	$4,835	$3,840

The ROFA/Rotamix technology is Mobotec's platform for its multipollutant controls. Once the initial investment in a ROFA/Rotamix system is made, additional capital and annual costs to reduce SO_2 and mercury are both expected to be lower than the capital and annual cost of using furnace sorbent injection or dry scrubbing for SO_2 control. Because both NOx and SO_2 contribute to significant health problems when converted in the atmosphere,

[14] Costs are derived from Minnesota Power's response to MPCA information request number 8. Minnesota Power provided capital and annual cost estimates for each component of the project alternatives, the review of which is described in section 5 of this report. Total annual costs for Table 5 and Table 6 are calculated by summing the annual cost of each technology with the levelized capital recovery factor. Minnesota Power uses a levelized capital recovery factor of 0.14 for Taconite Harbor (Initial filing, p. 14). When preparing this table, the MPCA did not adjust or apply any levelization factors to the annual costs.

the MPCA believes it is appropriate to seek reductions in both of these pollutants whenever possible. Making the initial investment in the ROFA/Rotamix technology allows for a much smaller investment in SO_2 with equal or greater reductions than conventional removal technologies.

Few mercury control technologies have long-term demonstrated track records for controlling utility mercury emissions, and Mobotec's Minplus technology track record is particularly small. However, the technology holds great promise, and if successful, supplies an important additional method of controlling mercury emissions at certain types of utility boilers.

To determine the cost-effectiveness of the use of Minplus, the MPCA separately compared the cost-per-pound of mercury removed by the mercury control alternatives. As Table 6, below, shows, the Minplus technology has the potential to be a lower-cost method for controlling mercury over the alternative of using activated carbon injection with a fabric filter, the technology proposed in alternatives A and B, because the cost-per-pound of mercury removed by Minplus is lower than the other alternatives.

Table 6. Cost effectiveness of mercury control alternatives for Minnesota Power's Taconite Harbor generating station

	AREA	A	B
Mercury Reduction	Mobotec/Minplus	Sorbent Injection	Sorbent Injection
Capital cost of component	$1,530,000	$1,380,000	$1,380,000
Annual operation & maintenance	$1,650,000	$1,969,920	$1,969,920
Total Annual Cost	$1,864,200	$2,163,120	$2,163,120
Annual mercury reductions (pounds)	69.3	69.3	69.3[15]
$/pound mercury removed	$26,900	$31,214	$31,214

Given that the Mobotec technology is the most cost effective as compared with the alternative technology considered, and given the desirability associated with reducing NOx, SO_2 and mercury with one technology application, the MPCA views the selection of the Mobotec technology as a cost-effective reduction strategy for Taconite Harbor and meets the requirements of the statute.

Summary

The Taconite Harbor retrofit project meets the conditions of Minn. Stat. 216B.1692, subd 1, lowering emission rates of regulations pollutants to substantially lower than applicable NSPS for SO_2 and mercury and at an overall cost-effective level for all pollutants. No change in PM emissions will occur with implementation of this project.

[15] In the original filing, mercury removal was reported at 40% for this alternative, an appropriate assumption if the existing hot-side ESPs were being relied upon solely for particulate matter control. However, the cost estimates for this alternative include the installation of fabric filters downstream of the ESPs, similar to the fabric filters included in alternative A. Expected mercury removal performance for this alternative is therefore assumed to be the same as alternative A, that is 69.3 pounds, or a 90% reduction.

4.0 Other Questions the PUC Must Consider

Minn. Stat. § 216B.1692, subd. 5 requires the PUC to evaluate whether:

1. the emission reduction project is needed to comply with new state or federal air quality standards; or
2. the emission reduction project is required as a corrective action as part of any state or federal enforcement action.

The MPCA has evaluated both of these questions and has concluded the following:

1. Neither of the proposed projects are currently needed to meet any new state or federal air quality standards; and
2. Neither of the proposed projects are currently required as a corrective action as part of any state or federal enforcement action. There are no pending state or federal enforcement actions that would affect emissions at these facilities.

There are three federal regulations that we reviewed in making these determinations and that relate to further regulation of emissions from electric generating units (EGUs). These have the potential to effect emissions from these two Minnesota Power plants, and they include the Regional Haze Rule, the Clean Air Interstate Rule and the Clean Air Mercury Rule.

4.1 Regional Haze Rule

In 1999 EPA promulgated rules to implement regional haze requirements specified in the federal Clean Air Act. Those rules require states to develop plans to meet goals to improve visibility impairment in National Parks and Wilderness Areas. The rules also require Best Available Retrofit Technology (BART) to be installed on certain EGUs built between 1962 and 1977. Taconite Harbor Unit 3 is a BART-eligible unit because construction of the unit began in 1970. It is possible that the implementation of the Regional Haze Rule will impact other Minnesota Power plants due to their proximity to Voyageurs National Park, Isle Royale National Park and the Boundary Waters Canoe Area Wilderness. The initial emission reductions that may be required to meet this rule must be in place by 2018.

However, it is not possible at this time to determine whether emission reductions at either Taconite Harbor or Syl Laskin will be required to comply with the Regional Haze Rule. First, the MPCA has not yet completed its analysis of regional haze to know what emission reductions will ultimately be required in the State Implementation Plan (SIP) due to EPA in late 2007. While it is possible that the SIP may target these two plants for reductions, that is not clear, and regional haze goals could be met by targeting other plants in the region.

Second, while Taconite Harbor Unit 3 is considered to be BART eligible, there is additional analysis that must be done to determine if actual emission reductions would be required of the unit. That additional work will not be completed until late in 2006. Therefore, at this time, it is not possible to conclude that the AREA projects would be required to meet the Regional Haze Rule.

4.2 Clean Air Interstate Rule (CAIR)

EPA promulgated its Clean Air Interstate Rule (CAIR) in 2005 to address interstate air emissions. This rule affects 28 states, including Minnesota, in the eastern half of the country.

The rule establishes a regional cap on the emissions of SO_2 and NOx from power plants and sets state-specific emission budgets for the pollutants in two phases. The final phase of the cap begins in 2015. An allowance can be considered as a license to emit a ton of the pollutant. A state distributes an initial set of allowances, and after that an EGU must: a) use available allowances to cover emissions and bank or sell any surplus, b) reduce emissions if available allowances are less than emissions, or c) buy allowances to cover excess emissions. Options b and c can be combined to cover excesses.

Since this is a cap and trade approach, the rule does not require any specific reduction of any specific unit or plant. The MPCA is now considering how to allocate NOx allowances. Final rules governing how Minnesota distributes allowances will not be promulgated until 2007.

Finally, EPA has recently said it will take additional comments and information on whether or not Minnesota should be included under the CAIR. Therefore, it is not possible to determine at this time whether the AREA projects would be needed to comply with the CAIR. Furthermore, since CAIR is a cap and trade program, no specific plant or unit is required to do anything other than have enough allowances to cover emissions, even though total emissions in the control region will be reduced by about 70%.

4.3 Clean Air Mercury Rule (CAMR)

In 2005, EPA promulgated CAMR to reduce mercury emissions by 70% from EGUs in the US. CAMR, like CAIR, is a cap and trade approach, and is implemented within a state in the same way: the state can simply accept all conditions established by EPA in its state-level program, or it can make adjustments to address state-level concerns. Unlike CAIR, CAMR applies in all states.

The final cap for CAMR is in place in 2018. While EPA has promulgated the regulations setting up the foundations of the trading program, it has not yet proposed model rules that states can use to design their state programs. As a result the MPCA has not started considering how it would propose to allocate allowances to the EGUs in the state.

Further, the CAMR is being reconsidered by EPA and could change. Therefore, it is not possible to determine at this time whether the AREA projects would be needed to comply with CAMR. Also, as with CAIR, by definition, under CAMR, no specific plant or unit is required to reduce mercury emissions.

5.0 Estimated Capital Cost of the Proposal

The MPCA analyzed the cost of the proposed project to determine whether the estimated costs are reasonable because they are used to calculate cost-effectiveness and to compare with the estimated benefits of the project. The MPCA has reviewed the construction costs of the proposals to determine whether they are within an expected reasonable range of costs.

The MPCA's experience in assessing the cost of projects has developed from its reviews of cost estimate of emission units and air pollution control equipment when assessing economic impacts of air pollution control policies and rules, and specifically from its experience reviewing and approving "best available control technology" (BACT) determinations used for air permitting.

5.1 Method of analysis

Minnesota Power reports that cost estimates were prepared on Minnesota Power's behalf by its engineering consultant Burns and McDonnell. The consultant relied on two sets of data to generate estimates for Minnesota Power: its database of projects it was involved in, as well as EPA's cost estimating spreadsheet CUECost[16]. The MPCA is very familiar with CUECost, having used it in its assessment of BACT analyses as well as in the assessment of costs in Xcel's Metropolitan Emissions Reduction Project. Documentation for CUECost describes its estimating accuracy as a rough order of magnitude estimated with an accuracy of +/- 30%, and can be refined with site-specific information.

Minnesota Power has reported that appropriately pricing steel in all alternatives has been difficult, and represented a considerable area of uncertainty in estimating project costs. Steel costs have risen considerably in the past several years, and will likely continue to fluctuate over the expected time period of this proposed project[17].

Minnesota Power reports that project costs have taken into account this considerable area of uncertainty. The MPCA believes that cost estimates should be considered conservative — that is, Minnesota Power is unlikely to underestimate the actual costs of the proposed projects.

5.2 Assessment of Syl Laskin Cost Estimate

Minnesota Power provided a budgetary estimate for the Laskin project, that is, within +/- 30%. The cost of the project will be refined by Minnesota Power as specific design and procurement activities occur. Estimates were derived from Burns and McDonnell's own project database, Mobotec's quote for Laskin, and EPA's CUECost.

Given the considerable recent industry investment in NOx control projects and current rapid increases in the price of energy and steel, the MPCA believes it is appropriate for Minnesota Power to rely on Burns and McDonnell's database of actual project costs. This database was used to estimate the total annual costs of

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[16] CUECost is an Excel spreadsheet used by regulators and utilities to generate rough order of magnitude cost estimates for air pollution control projects on power boilers. Because it is designed for estimating costs for EGUs with generating capacities greater than 100 MW, Minnesota Power's consultant appropriately included a capacity-scaling factor to account for the increased cost of projects at small boilers. (MN Power response to MPCA comment 1, December 19, 2005)

[17] Engineering News Record, October 24, 2005. Vol. 255 No. 16. National steel prices in October 2005 are 43% higher than 2003 prices.

alternatives rather than relying on EPA spreadsheets that do not reflect the current market conditions.

The source of the estimated capital costs are described in Table 9. The MPCA finds that Minnesota Power's estimated capital and annual operating cost of the selected alternative appears to be a reasonable estimate that does not under-predict the actual cost of the project.

Table 9. Cost of emission reduction alternatives at Syl Laskin

	Alternative	Capital $2005	$/KW	Annual $/yr	Source of estimate
LNB, OFA, NN	AERA	4,464,000	45	72,000	Burns and McDonnell database
SNCR	A	3,256,240	33	992,202	EPA CUECost
Mobotec ROFA	B	14,722,525	147	825,304	Vendor Quote + MP estimate
SCR	C	34,408,000	344	1,316,000	Burns and McDonnell database

5.3 Assessment of Taconite Harbor Estimated Costs

Capital and operating cost estimates for the alternatives considered at Taconite Harbor came from several different sources. The estimates of the alternatives are broken down below by project component in order to understand the various costs involved. Minnesota Power also reports that Mobotec provided an extremely attractive proposal for ROFA/Rotamix/FSI/Minplus.

Table 10. Cost of emission reduction alternatives at Taconite Harbor

Taconite Harbor Alternative Components	Alternative	Capital $2005	$/ KW	Annual $/yr	Source of estimate
LNB/OFA,SCR, DSI, FF, ACI	A	208,086,765	925	10,337,547	See below
Mobotec ROFA/Rotamix/ FSI/Minplus	AERA	49,523,342	220	3,996,836	Vendor Quote + MP estimate
LNB/OFA, FSI, FF, ACI	B	78,696,450	350	7,320,654	See below
Component Estimates					
Low NOx Burners/Overfire Air (LNB/OFA)		8,745,720	39	141,000	Burns and McDonnell database
Furnace Sorbent Injection (FSI)		31,328,397	139	3,417,000	EPA IAPCS
Fabric Filter for FSI (FF)		37,242,363	166	1,792,734	EPA CUECost
Activated Carbon Injection (ACI)		1,380,000	6	1,969,920	MP estimate
Selective Catalytic Reduction (SCR)		66,858,321	297	2,244,000	Burns and McDonnell database
Semi-dry FGD and ductwork (DSI)		90,684,621	403	4,446,198	EPA CUECost
Fabric Filters (FF) for DSI		40,418,103	180	1,536,429	EPA CUECost

Construction cost estimates for retrofitting this facility appropriately reflect the constraints of the site. The generating units sit very close to one another; electrostatic precipitators retrofitted at the plant have reduced the available space for adding additional equipment. Additionally, retrofitting this facility involves installing three control devices on fairly small utility boilers, hence there is little economy of scale.

The lack of economy is quite apparent when comparing the 2002 estimated retrofit cost of a semi-dry FGD system, ductwork and fabric filters to the single 600 MW generating unit at the AS King generating plant; the King estimate was $189/kW, compared to this estimate of $685/kW (semi-dry FGD and ductwork + FF from Table 7) to retrofit the same equipment at three 75 MW Taconite Harbor generating units. Installation at Taconite Harbor of furnace sorbent injection (FSI), while a less-efficient SO_2 control method, is much less complicated and falls to $305/kW (furnace sorbent injection + fabric filter from Table 7), and is more costly than the ROFA/Rotamix/FSI/Minplus option.

NOx controls are subject to similar influences. The cost of SCR installation at King was $161/kW, compared to the SCR estimate here of $297/kW. The MPCA believes the estimate for the SCRs at Taconite Harbor to

be a conservative estimate, and likely appropriate given facility space constraints, and current industry and construction conditions.

The cost estimate provided by Minnesota Power appear reasonable given the constraints of the facility, the lack of economies of scale, and the attractive pricing offered by Mobotec to Minnesota Power.

5.4 Present Value of Total Project Costs

The project is planned to begin in late 2006 and completed in late 2008. The life expectancies of the proposed changes, and the two plants themselves, differ. Laskin's changes are planned to last eleven years. The Taconite Harbor changes will last for 21 years.

Minnesota Power has estimated costs so that they are scheduled in equal annual amounts over the full term for both projects. However, Minnesota Power did not provide a present value estimate of the total cost of both projects. If we sum the costs without discounting them, the total comes to $262 million. Minnesota Power chooses separate discount rates for costs. They discount capital costs at 9 per cent. They use a 7.75% discount rate for operations and maintenance costs. When discounted accordingly, total costs stated in present value terms are $210 million. So it is this total project cost estimate of $210 million that will later be compared with estimated benefits.

5.5 Summary

Construction and operating cost estimates for the Syl Laskin and Taconite Harbor project prepared by Minnesota Power and their consultant appear to be reasonable estimates. Estimates were generated using reliable data sources and standard estimating procedures and tools. The estimates take into account potential site limitations and anticipate potential material supply cost issues. The MPCA is confident that Minnesota Power's estimated capital and operating costs for these pollution control projects are not underestimated, that they reasonably estimate the costs of the projects.

6.0 Assessment of Benefits of the Proposed Project

6.1 Emission Estimate of the Proposal

The MPCA has independently calculated likely annual reductions in air emissions under Minnesota Power's proposal, presented in tables 11 and 12 below. Current emissions are shown in Table 11.

Table 11. Annual emissions for Minnesota Power generating stations

	SO_2 (tpy)	NO_X (tpy)	PM (tpy)	PM_{10} (tpy)	Mercury (pounds)
Laskin 1	792	1,141	65	77	
Laskin 2	816	1,183	70	75	18 [18]
Taconite Harbor 1	1,778	1,069	96	102	27
Taconite Harbor 2	1,815	1,109	73	85	27
Taconite Harbor 3	1,937	1,192	95	104	22
Total Annual Emissions	7,138	5,694	398	443	94

Annual emissions from Laskin and Taconite Harbor are taken from Minnesota Power's annual emission inventory reports to the MPCA. The emissions were averaged over the years 2002 to 2004 for Laskin, and 2003 to 2004 for Taconite Harbor, because this facility ran only a portion of 2002.

Table 12. Annual emissions after the proposed changes

	SO_2	NO_X	PM	PM_{10}	Mercury (pounds)
Laskin 1	795	394	65	77	
Laskin 2	814	401	70	75	18[18]
Taconite Harbor 1	635	370	96	102	2.7
Taconite Harbor 2	651	379	73	85	2.7
Taconite Harbor 3	690	402	95	104	2.2
Total Annual Emissions	3,589	1,949	398	443	25.6
Emissions change (tpy)	-3,552	-3,745	0	0	-64.4

6.2 Impacts of Power Plant Emissions

Electrical utility power plants are a major source of air pollution. In Minnesota, power plants are major

[18] Estimate for Laskin is for entire plant.

contributors to the emissions of SO_2, NOx, mercury, and other metals. Power plant emissions of NOx contribute to ozone pollution; emissions of SO_2 and NOx contribute to fine particulate formation, visibility impairment or regional haze and acid rain; and the emissions of mercury contribute to fish consumption advisories and water quality impairment. The MPCA issues air pollution alerts throughout the year when levels of fine particulate matter and ozone reach unhealthy levels.

Of highest concern today is the health effects associated with the contribution of power plant emissions to the amount of fine particulate matter ($PM_{2.5}$) found in the air. Fine particles can be directly emitted, but many, if not most are formed in the air from chemical reactions of nitrogen oxides, sulfur oxides, organic compounds, and ammonia.

Power plant emissions contribute to local and regional levels of fine particulate matter. Fine particles are associated with a range of adverse health effects such as coughing, shortness of breath; aggravation of existing respiratory conditions such as asthma and chronic bronchitis; increased susceptibility to respiratory infections; and heightened risk premature death from heart attacks and respiratory conditions. EPA's concern about the health effects of fine particulates has resulted in their recent proposal to tighten air quality standards.

Another important problem to note is the contribution of power plant emissions to visibility impairment, or regional haze. The federal Clean Air Act requires states to reduce haze and protect visibility in national parks and wilderness areas. Visibility in Voyageurs National Park and the Boundary Waters Canoe Area Wilderness is impaired and the MPCA is actively working to develop a plan for improving visibility in those important resources.

Finally, we have an important concern about the role power plant emissions play in the accumulation of mercury in fish tissue, necessitating fish consumption advisories for water bodies. Currently, the MPCA's 2004 impaired waters list identifies 419 river reaches and 820 lakes[19] in Minnesota that are considered to be impaired because the fish are contaminated with mercury. While much has been done in Minnesota and nationally to reduce mercury emissions, coal-burning power plants remain a major contributor to environmental mercury contamination.

6.3 Estimate of Quantifiable Benefits from AREA

Minnesota Power conducted a limited analysis of environmental benefits using the rural values for NOx from the Minnesota PUC's externality values. This calculation estimated benefits of reducing NOx from the Laskin plant at $186,960 per year. Taconite Harbor was estimated to deliver benefits worth $250,920 per year. These benefit estimates compare with Minnesota Power's estimate of annual capital and operating costs for the selected control technologies of $930,240 and $11,969,281, respectively.

The MPCA believes that Minnesota Power's estimate of benefits does not reflect all benefits that are associated with the project. There are a number of reasons for this:

1. The PUC's externality values were not designed or intended for this purpose. They are designed for use in resource planning and certificate of need determinations.

2. The externality values do not assign a value to all of the pollutants included in the AREA reductions, nor do their values reflect the current understanding of the impacts of air emissions from power plants.

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[19] MPCA, 2004. http://www.pca.state.mn.us/publications/wq-iw4-01a.pdf

For example, the PUC has no externality values for SO_2. (The SO_2 value expired in 2000 when EPA's cap and trade program for SO_2 emissions began its second phase.) The PUC also has no externality value for mercury. When it came to estimating the value of reducing mortality rates in affected communities, the foundation study for the PUC's externality values estimated a "value of a statistical life" (VSL) in the neighborhood of $3 million. EPA now uses a VSL estimate that is closer to $6 million.

Fine particles and their environmental costs were a significant, but unsettled, issue during the PUC's externality proceedings. EPA and others now find that fine particles derived from both SO_2, NOx and other emissions make a statistically significant contribution to mortality in affected communities. It is very likely that the relatively low NOx value and the exclusion of an SO_2 value significantly underestimate AREA's health benefits associated with fine particulate matter.

Regional haze/visibility impairment is not accounted for in the externality values. The use of rural values, while appropriate as to the physical location of the plants, does not adequately reflect the long-range transport of emissions from rural plants into urban areas or into nearby national parks and wilderness areas.

3. Benefits should be always estimated for the full term of the project and in this case, they were not. A discount rate for benefits of 3% is most appropriate for use in such a calculation as the benefits are public rather than private. EPA currently uses a 3% discount rate in its regulatory benefit analyses.[20]

Using the externality values as Minnesota Power did shows that the benefits associated with the AREA emission reductions are real. However, as discussed above, the MPCA staff believes that it does not appropriately reflect the full environmental and health benefits of the project because the externality values have too many missing elements. Evaluations of recent federal programs and CAIR have quantified benefit/cost ratios that range from nearly 20 to more than 50, indicating the environmental and health benefits far outweigh the control costs. EPA has recently made a detailed environmental benefit study for CAIR. The CAIR analysis method is believed to be the best method to more comprehensively estimate the full benefits associated with the AREA project. That's because this method takes into account:

- the reduction of SO_2 and NOx emissions from power plants,
- a range of environmental benefits that uses the latest available information,
- an up-to-date VSL estimate in the $6 million range,
- the latest findings on the health effects of fine particles, and
- environmental damages caused by SO_2 emissions.

EPA's analysis of the quantifiable benefits from reducing power plant emissions of SO_2 and NOx in the eastern 28 states and the District of Columbia shows that the average value of environmental and health benefits for a ton of emission reduced (estimated for 2010 and discounted at a 3% rate) is about $15,000. Extending the estimate beyond 2010 raises it. Applying this benefit estimate to the reductions expected from the AREA project would suggest a benefit in the range of $1 to 1.2 billion. It should be noted that benefits estimated from the use of CAIR data would occur both inside and outside Minnesota.

However, EPA's findings on the benefits of CAIR are probably not directly applicable to AREA, because the reductions associated with AREA will occur in a more rural, less densely populated area than that of the eastern U.S. as a whole. Scaling the CAIR benefits in a manner similar to the way the PUC externality values are

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[20] These issues were also addressed by the MPCA in developing the benefits estimate for the Xcel MERP project. See MPCA, Metropolitan Emissions Reduction Project, Dec. 2002, pp. 43-44 http://www.pca.state.mn.us/publications/reports/xcelenergy-metroemissionproposal.pdf), and MPCA, MERP Final Reply Comments, May 28, 2003, pp14-15 (http://www.pca.state.mn.us/hot/pubs/xcel-merpcomments.pdf

scaled between urban and rural areas provides a more conservative way of looking at the potential benefits of this project. Application-scaled CAIR benefits, using the following "rural high" and "rural low values" are shown below:

	SO_2	NOx
Rural, high	$4,150	$1,573
Rural, low	$1,147	$726

Scaled benefits result in a "CAIR adjusted" benefit estimate for the AREA project of $63 million to $181 million. This estimate brings the benefits considerably closer to the $210 million present value cost estimate.

6.4 Unquantified Benefits from AREA

This approach still does not take all environmental and health benefits into account when lowering the ambient levels of $PM_{2.5}$ and mercury. Appendix A contains a description of the unquantified benefits EPA described in the development of CAIR. Most notable to Minnesota are the benefits associated with reduced mercury emissions and reduced visibility impairment:

- **Reduced emissions of mercury**
  The accumulation of mercury in fish tissue is a pervasive issue in Minnesota as well as many other states and countries. Power plants in Minnesota account for about half of the state's mercury emissions. An extensive discussion about the mercury problem in Minnesota and what is being done about it can be found in the MPCA's 2005 report to the legislature (MPCA, 2005).

  Evidence suggests that sulfates encourage bacteria to methylate mercury, that is, convert mercury present in the environment to the form that readily bio-accumulates in fish (methyl mercury). A decrease in SO_2 emissions, and the resulting decrease in atmospheric sulfate deposition, would likely reduce the amount of methyl mercury that accumulates in fish. The AREA project thus offers improvements to the environment by first reducing mercury emissions and also by reducing SO_2 emissions that may be contributing to fish contamination in lakes.

- **Reduced contribution to regional haze**
  Fine particles are the primary cause of regional haze, which impairs a person's ability to see for long distances as well as the brightness and clarity of vistas. While unquantified in MPCA's benefits analysis, regional haze benefits will also derive from reductions in power plant emissions. SO_2 and NOx emissions contribute to it. Recent federal rules require Minnesota to adopt regulations that meet federal visibility targets in wilderness areas and national parks. AREA's emission reductions will yield visibility improvements within its region. That region is particularly important because federal rules are tied to visibility in three nearby targets – the BWCA, Voyageur's National Park and Isle Royale National Park. In fact, given the close relationship between visibility and the location of emission sources, AREA's emission reductions are likely to have a more significant effect than would larger emission reductions from more distant sources.

All of these items listed are, or have a potential to, cause harm to human health and/or the environment. All of these impacts will be reduced as a result of implementing these projects. However, estimating a specific, or even a ballpark, associated dollar benefit is not possible.

6.5 Summary

In summary, using the best available quantifiable information, and considering the unquantifiable benefits, the MPCA believes that the environmental and health benefits associated with the AREA project approximate or likely exceed the costs of the project.

7.0 Appropriateness of the Proposed Projects

When the Clean Air Act was passed in 1970, existing power plants were grandfathered and thus exempt from having to upgrade pollution control equipment. Expectations were that as these grandfathered plants aged, they would be either replaced with a new plant, or refurbished in such a way that pollution control upgrades would be required.

Thirty-five years later, these expectations have not been met. In Minnesota and across the country, older plants have been nursed along, with regular repairs, and have lasted long beyond their original expected useful life. They continue to emit at much higher levels than would be allowed any newer power plant.

Through the years, environmental and health experts have identified a number of serious problems linked to power plant emissions that have required corrective actions. Two of the most significant are the acid rain limits required by the Clean Air Act Amendments of 1990, and the NO_x reductions needed to reduce regionally transported ozone pollution in the eastern U.S. More recently, EPA has promulgated additional rules to reduce visibility impairment in National Parks and Wilderness Areas, a rule to further reduce SO_2 and NO_x to address fine particulate matter, ozone and other problems, and a rule to reduce mercury emissions.

7.1 Costs and Benefits

The MPCA has carefully evaluated the estimated cost of the project, which can be reasonably quantified, and the benefits of the project, which, as described above, are difficult if not impossible to quantify fully.

It is unfortunate that current science and economics makes it impossible to fully and quantitatively assess all the benefits associated with a project like this. Keep in mind what this benefit estimate *does not* quantitatively measure or consider:

- It does not quantify all health information associated with fine particulates. Recent damage estimates link virtually all of the potential costs of power plant emissions to fine particulate. This assessment does not include effects of long-term exposure to fine particulate matter.
- It does not account for the fact that SO_2 emissions play an important role in fine particulate formation and account for perhaps 20 percent or more of the mass of fine particulates in Minnesota's atmosphere and one-third nationally.
- It does not account for benefits that occur more than 200 miles away. Recent benefit assessment estimate indicate that the majority of benefits will occur at significant distances from where the emissions occur.
- It does not account for mercury reductions. The reductions proposed in AREA are significant, reducing mercury emissions from the Taconite Harbor plant by about 90%. Mercury remains one of the most important environmental problems for Minnesota lakes and streams.
- It does not account for the reduction in visibility impairment in the Boundary Waters Canoe Area Wilderness, Isle Royale National Park and Voyageurs National Park.

In weighing the projected costs for this two-plant proposal against the estimated benefits as well as the benefits that cannot be quantitatively estimated, the MPCA believes that the benefits approximate and most likely exceed the projected costs.

Both the Syl Laskin and Taconite Harbor plants are older coal-fired generating stations located in northeastern Minnesota, near important natural resources. The AREA project will result in significant emissions reduction

for both of these plants, including mercury and the precursors to fine particulate matter and regional haze.

The Mobotec technology proposed for Taconite Harbor is not a familiar one to many nor in as wide-spread a use in the U.S as other possible choices. The control technology is rooted in fundamental combustion and air pollution control, and has been proven to work well to control NOx and SO_2[21]. The MPCA has reviewed the literature provided by Mobotec where the company describes how its process works to control mercury emissions. Mobotec system performance testing indicates success in achieving mercury reductions, and the MPCA expects the technology to work at Taconite Harbor to remove mercury. However, it is possible that the overall removal of mercury may not be as great as hoped in the proposal. Given that Taconite Harbor has little or no current or expected mercury controls, even a slight improvement in mercury emission reduction is a positive development. The technology has potential for application at a number of other smaller plants in Minnesota as well as throughout the rest of the country.

Finally, Minnesota Power has proposed a project schedule that would have reductions in place by the end of 2008. Recall that federal cap and trade programs forcing NOx and SO_2 reductions from the utility sector have effective dates some 10 years later than that (final CAIR NOx and SO_2 cap of 2015, final Clean Air Mercury Rule deadline of 2018, a regional haze intermediate goal deadline of 2018). Under this proposal, reductions are known to occur in Minnesota rather than elsewhere and the early reductions mean environmental benefits begin accruing sooner, rather than later.

7.2 Summary

Given the emission reductions that would be achieved and the low costs of the proposal, the MPCA believes it is appropriate to allow cost recovery for this project as specified by the statute.

[21]EPA reviewed NOx reduction strategies in its final rule establishing regional haze regulations and guidelines for BART determinations, and describes Mobotec's ROFA process as an advanced combustion control technology that is available and demonstrated on a variety of types of utility boilers, achieving "significantly lower NOx emission rates than convention over-fire air…." 70 FR 39135.

8.0 References

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Appendix A: Health and Welfare Benefits

In it's CAIR rulemaking, EPA assessed the benefits of lowering NOx and SO_2 emission from electric generating units. EPA quantified health and environmental improvements where it was able to do so, but was unable to quantify or monetize all of the health and environmental benefits associated with lowering the ambient air levels of $PM_{2.5}$ and ozone. As stated in its regulatory impact analysis, "EPA believes these unquantified benefits are substantial, including the value of increased agricultural crop and commercial forest yields, visibility improvements, reductions in nitrogen and acid deposition and the resulting changes in ecosystem functions, and the health and welfare benefits associate with reduced mercury emissions." (U.S. EPA, 2005, p. 1-10)

The health and welfare improvements are real and will be experienced over the long term as electric generating units work to come into compliance with the NOx and SO_2 caps established in CAIR.

Table 10, on the next page, identifies the health and environmental impacts that EPA was unable to quantify or monetize. Like EPA, Minnesota's externality values do not account for these benefits.

Appendix A,Table 10. Unquantified or non-monetized effects from regulating fine particle precursors as identified by EPA in CAIR rulemaking (*see footnotes, page 31*)

Pollutant/Effect	Effects Not Included in Primary Externality Estimate—Changes in:
Ozone—Health[a]	• Premature mortality[b] • Chronic respiratory damage • Premature aging of the lungs • Non-asthma respiratory emergency room visits • Increased exposure to ultraviolet light
Ozone—Welfare	• Yields for: – commercial forests, – fruits and vegetables, and – commercial and noncommercial crops • Damage to urban ornamental plants • Recreational demand from damaged forest aesthetics • Ecosystem functions • Increased exposure to ultraviolet light
PM—Health[c]	• Premature mortality from short-term exposures[d] • Low birth weight • Pulmonary function • Chronic respiratory diseases other than chronic bronchitis • Non-asthma respiratory emergency room visits • Exposure to UVb (+/-)[e]
PM—Welfare	• Visibility in many Class I areas • Residential and recreational visibility in non-Class I areas • Soiling and materials damage • Ecosystem functions • Exposure to UVb (+/-)[e]
Nitrogen and Sulfate Deposition—Welfare	• Commercial forest due to acidic sulfate and nitrate deposition • Commercial freshwater fishing due to acidic deposition • Recreation in terrestrial ecosystems due to acidic deposition • Existence values for currently healthy ecosystems • Commercial fishing, agriculture, and forests due to nitrogen deposition • Recreation in estuarine ecosystems due to nitrogen deposition • Ecosystem functions • Passive fertilization due to nitrogen deposition
Mercury Health	• Incidence of neurological disorders • Incidence of learning disabilities • Incidence of developmental delays • Potential reproductive effects[f] • Potential cardiovascular effects[f], including: – Altered blood pressure regulation[f] – Increased heart rate variability[f] – Incidence of myocardial infarction[f]
Mercury Deposition Welfare	• Impacts on birds and mammals (e.g., reproductive effects) • Impacts to commercial, subsistence, and recreational fishing

[a] In addition to primary economic endpoints, there are a number of biological responses that have been associated with ozone health effects including increased airway responsiveness to stimuli, inflammation in the lung, acute inflammation and respiratory cell damage, and increased susceptibility to respiratory infection. The public health impact of these biological responses may be partly represented by our quantified endpoints.

[b] Premature mortality associated with ozone is not currently included in the primary analysis. Recent evidence suggests that short-term exposures to ozone may have a significant effect on daily mortality rates, independent of exposure to PM. EPA is currently conducting a series of meta-analyses of the ozone mortality epidemiology literature. EPA will consider including ozone mortality in primary benefits analyses once a peer-reviewed methodology is available.

[c] In addition to primary economic endpoints, there are a number of biological responses that have been associated with PM health effects including morphological changes and altered host defense mechanisms. The public health impact of these biological responses may be partly represented by our quantified endpoints.

[d] While some of the effects of short-term exposures are likely to be captured in the estimate, there may be premature mortality due to short-term exposure to PM not captured in the cohort study upon which the primary analysis is based.

[e] May result in benefits or disbenefits.

[f] These are potential effects as the literature is insufficient.