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RS 70 – Mercury Deposition and Bioaccumulation
Cumulative Impact Report

Cumulative Impacts Analysis

Minnesota Iron Range Industrial Development Projects

Mercury Deposition and Evaluation of Bioaccumulation in Fish in Northeast Minnesota

Submitted in Support of the PolyMet Mining Company's NorthMet Mine and Ore Processing Facilities Project Environmental Impact Statement

Prepared by

Barr Engineering Company

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Overview

The Environmental Impact Statements for two currently proposed projects—PolyMet Mining Inc.'s NorthMet project in Hoyt Lakes, and Minnesota Steel Industries, LLC's mining to steel project near Nashwauk—require a series of "cumulative impact assessments" covering a range of environmental issues. These cumulative impact assessments are to address not only the impacts of these two projects but also those of other nearby "reasonably foreseeable" future projects.

The cumulative impact assessment for mercury deposition and bioaccumulation in fish is similar for both projects. Therefore, a combined report has evaluated whether the cumulative air emissions of mercury from the proposed projects could cause or significantly contribute to increased mercury deposition and bioaccumulation in fish in northeast Minnesota lakes.

The data contained in this cumulate impact assessment indicate that the cumulative potential mercury emissions from the proposed projects do not have the potential to cause or significantly contribute to mercury deposition and bioaccumulation in fish in northeast Minnesota lakes or streams.

Summary of the Potential for Cumulative Impacts

Background information regarding mercury deposition in Minnesota and bioaccumulation in fish includes:

- Minnesota point sources emit very little oxidized mercury, the form of mercury that tends to deposit locally near an emission source.
- The MPCA estimates that presently Minnesota point sources contribute only about 10% to mercury deposition in Minnesota.
- Total mercury deposition in northern Minnesota, and in the Great Lakes as a whole, has declined since the 1970's based on sediment core data and fish tissue concentration data.

This analysis includes nine new mining, processing, or energy projects proposed on or near Minnesota's Iron Range. If all proposed projects that are evaluated in this analysis are constructed and operated as planned, cumulative emissions on a potential to emit basis are estimated to be 212 pounds of mercury per year by 2015. Details on the potential individual project emissions are provided in Table 1 (Section 1.1). Based on available data these potential new emissions of mercury are expected to be 93-99% elemental mercury, with oxidized mercury (0.5-5%) and particle-bound mercury (0.2-2%) as minor species. This factor is significant in this assessment because elemental mercury is not expected to deposit locally.

The new projects are not expected to affect the amount of mercury deposited on Minnesota lakes—or the amount of mercury in locally caught fish—because the projects would potentially emit only a very small amount of oxidized and particle-bound mercury, the species that tend to deposit near an emission source. One conservative screening-level analysis that likely over-estimates potential contributions assumes the potential mercury emissions from the projects only affect northeast Minnesota. This analysis suggests that if oxidized and particle-bound mercury are emitted, the proposed projects may increase mercury deposition in the four-county project area by 0.16% to

1.6%. A second screening-level analysis that follows the MPCA's methodology for the statewide mercury Total Maximum Daily Load (TMDL) suggests that the proposed projects may increase mercury deposition in Minnesota by approximately 0.6% above existing background deposition. In both cases, the potential increase is so small that it is not likely to be measurable due to year to year background variability and the sensitivity of current mercury deposition monitoring methods. The small amount of mercury potentially contributed by the projects to Minnesota lakes is not expected to result in an increase in fish tissue concentrations.

As is discussed in more detail below and in subsequent sections of this report, statewide emissions of mercury have been decreasing. In addition, significant reductions of mercury will occur in the foreseeable future. The table below (Table OV-1) illustrates net statewide emissions of mercury compared to 2000.

Table OV-1. Mercury emissions summary related to proposed projects and expected future reductions due to Minnesota voluntary actions and the 2006 Mercury Reduction Act.

Description	Mercury Emissions (lbs/year)
Total Statewide Emissions in 2000 *	3,638
Emission Reductions from Point Sources 2000-2003**	(188)
Potential Emission Increases from Proposed Projects***	221
Reasonably Foreseeable Future Emission Reductions (2003-2015)****	(1,334)
Total	2,337
Net Change in Mercury Emissions Due to Reasonably Foreseeable Actions*****	(1,301)

* Statewide emissions of 3,638 pounds/year from the MPCA's "2005 Mercury Reduction Progress Report to the Legislature". (MPCA 2005a).

**Emission reductions include: 70 pounds/year due to Minnesota Power's switch to Western coal; 83 pounds/year due to LTV Steel Mining Company plant closure in 2001; 35 pounds/year Xcel Energy switch from coal to natural gas at the Black Dog facility.

***Proposed Projects: In addition to the Minnesota Steel project and PolyMet Mining's NorthMet project, seven other proposed projects are included in this analysis, including the Mesabi Nugget DRI project. Table 1 in Section 1.1 of this report lists the proposed projects included in this analysis and their estimated potential mercury emissions.

For Minnesota Steel which is reactivating the former Butler mine that closed in 1985, the estimated proposed project emissions include a high-end estimate of 81 pounds per year. The estimated emissions from Butler Taconite were approximately 55 pounds per year (Berndt 2003). Therefore the potential net site emission increase, based on these emission estimates for Minnesota Steel and Butler Taconite, is approximately 26 pounds per year. The actual emissions increase for the site may be approximately 6 pounds per year when the average Minnesota Steel mercury emissions of 61 pounds per year is taken into consideration.

****Future emission reductions include: 64 pounds/year, Minnesota Power AREA project; 170 pounds/year, Xcel Energy MERP; 1,100 pounds/year 2006 Mercury Reduction Act. The relationship between the emission reductions anticipated under the 2006 Mercury Reduction Act and the Clean Air Mercury Rule is uncertain at this time. To avoid double counting reductions, the estimated reductions due to the Clean Air Mercury Rule are not included in this table.

*****Additional reductions due to the implementation of the Statewide Mercury Total Maximum Daily Load (TMDL) are not included here. The TMDL goal is to reduce Minnesota mercury emissions to approximately 789 pounds per year. Based on the estimated "Total" emissions of 2,332 pounds per year, an additional reduction of 1,543 pounds per year (a 66% reduction) will be needed to meet the TMDL goal.

The MPCA currently estimates that total statewide mercury emissions are about 3,340 pounds per year. Therefore, on a statewide basis, the new projects represent a potential 6% emission increase. This potential increase in mercury emissions from the proposed projects does not account for planned or proposed emission reductions. The following information is provided to help put the potential mercury emissions from the proposed projects in perspective:

- Since 1985 mercury emissions in the four-county project area have decreased by about 138 pounds per year due to the shutdown of two taconite facilities (Butler Taconite, 55 pounds per year; and LTV Steel Mining Company, 83 pounds per year).

- Minnesota Power has proposed to initiate the Arrowhead Regional Emission Abatement (AREA) Project which will reduce mercury emissions in the four-county project area by an additional 64 pounds per year.

- Xcel Energy has initiated the Metropolitan Emission Reduction Project (MERP) which will reduce statewide mercury emissions by an additional 170 pounds per year

- The 2006 Mercury Reduction Act of 2006 requires a 90% reduction in mercury emission from the three largest power plants in Minnesota by 2012 to 2015 - Xcel Energy's Sherco Plant, Becker; Xcel Energy's Allen S. King plant, Oak Park Heights, and Minnesota Power's Clay Boswell plant, Cohasset. MPCA estimates an emission reduction of 1,100 lbs/year; a 33% reduction of state mercury emissions.

- Additional emissions reductions are expected as part of implementing the Statewide Total Maximum Daily Load (TMDL); the statewide emission goal in the mercury TMDL is 789 pounds per year. Table OV-1 indicates that after the reasonably foreseeable reductions are accounted for, statewide emissions could potentially be 2,332 pounds per year by 2015. Additional reductions of approximately 1,500 pounds per year could be required from existing sources in order to meet the emission goal of 789 pounds per year in the TMDL.

When potential mercury emissions from the proposed projects are compared to the emission reductions above, there is an overall net decrease in mercury emissions from Minnesota sources. Mercury emissions on a statewide and national basis are expected to continue to decline over the next decade due to proposed regulatory actions such as the EPA's Clean Air Mercury Rule. Additional future reductions in mercury emissions from the proposed projects and existing taconite facilities are also possible as new control technologies become available.

Based on the available information, the cumulative potential emissions from the proposed projects do not have the potential to cause or significantly contribute to mercury deposition and bioaccumulation in fish in northeast Minnesota lakes or streams.

Executive Summary

The Environmental Impact Statements for two currently proposed projects—PolyMet Mining Inc.'s NorthMet project in Hoyt Lakes, and Minnesota Steel Industries, LLC's mining to steel project near Nashwauk—require a series of cumulative impact assessments covering a range of environmental issues. These cumulative impact assessments are to address not only the impacts of these two projects but also those of other nearby "reasonably foreseeable" future projects (MDNR 2005a; 2005b).

The required cumulative impact assessment for mercury deposition and bioaccumulation in fish is similar for both projects. Therefore, one report evaluates whether the potential cumulative air emissions of mercury from the proposed projects could cause or significantly contribute to increased mercury deposition and bioaccumulation in fish in northeast Minnesota lakes.

Scope of Analysis

The Final EIS Scoping Decision Documents for both the NorthMet and Minnesota Steel projects requires a semi-quantitative approach to assess potential cumulative impacts of mercury deposition and bioaccumulation in fish (MDNR 2005a; MDNR 2005b,c). This semi-quantitative approach includes the following:

- A summary of mercury deposition in Minnesota, including:
    - The issue of long-range pollutant transport
    - Findings from studies that assessed mercury deposition and bioaccumulation in fish tissue in Minnesota's aquatic ecosystems
    - Emission source contributions based on national and state modeling efforts.
- Summary of state actions and the state's proposed statewide Total Maximum Daily Load (TMDL) for mercury which calls for a 93% reduction in Minnesota's mercury emissions.
- Assessment of potential emissions increases and decreases due to reasonably foreseeable actions, which include proposed projects and potential regulatory action through 2020.

The assessment of potential cumulative impacts includes evaluating trends in air emissions using existing statewide emission inventory data and annual wet mercury deposition data from three monitoring sites in northern Minnesota.

The relationship among mercury air emissions, deposition to aquatic systems and mercury accumulation in fish is complex. Nevertheless, the current scientific understanding is that in general, for any given water body the amount of mercury accumulating in fish is roughly proportional to the amount of mercury deposited on the watershed. Therefore, a semi-quantitative assessment of the potential impact of the proposed projects on mercury bioaccumulation in fish in northeastern Minnesota lakes can be made by assessing the extent to which the projects are likely to affect mercury deposition in that area.

First, current mercury deposition data in northern Minnesota and the likely sources of this mercury have been summarized. Next, the potential impact of the proposed projects on local mercury deposition in the context of mercury species reasonably expected to be emitted to air was assessed. Finally, the potential past and future local, state, and federal emission trends were assessed.

"Reasonably Foreseeable" Projects and Future Actions

In addition to the NorthMet and Minnesota Steel projects, the following projects and actions were identified in one or both of the EIS Final Decision Documents (MDNR 2005a; MDNR 2005b,c) to be included in this analysis:

- Projects:
  - Excelsior Energy, Mesaba Energy Coal Gasification Plant (Phase I and Phase II);
  - Laurentian Wood Fired Energy Project;
  - Mesabi Nugget Company's proposed Direct Reduced Iron (DRI) plant;
  - Minnesota Steel Industries Mining/Taconite/DRI/Steel plant;
  - Northshore Mining Company's Furnace 5 Reactivation Project;
  - PolyMet Mining Company, NorthMet Project;
  - United Taconite Emissions and Energy Reduction Project;
  - UPM/Blandin Paper Mill Thunderhawk Project, and
  - U.S. Steel – Keewatin Taconite fuel diversification and pollution control equipment upgrade.
- Actions (emission reductions):
  - Butler Taconite – shutdown of taconite furnaces in 1985*;
  - LTV Steel Mining Company (LTVSMC) – shutdown of taconite furnaces in 2001;
  - Minnesota Power's Arrowhead Regional Emission Abatement (AREA) Project**, and
  - Xcel Energy's Metropolitan Emission Reduction Project; (Existing Power Plants with Proposed Modifications).

* Butler Taconite is identified as a "private action" in the Scoping EAW, but is not identified as a specific action to be evaluated in the cumulative impact assessments. However, because Minnesota Steel proposes to operate in the same location as Butler Taconite, there is merit in providing a credit of sorts to Minnesota Steel similar to what was done for Mesabi Nugget regarding the LTVSMC mercury emissions at the Cliffs Erie site near Hoyt Lakes. Therefore, the shutdown of the Butler Taconite furnaces in 1985 is included as an "action" to be accounted for in some manner in this cumulative analysis.

** Minnesota Power's AREA Project, and subsequently announced emission reductions at its Clay Boswell Unit 3, was not identified in the list of foreseeable actions to be included in either EIS scope for the cumulative analysis. However, due to the significance of this voluntary action in reducing emissions in northeast Minnesota, it is included in this analysis to provide additional perspective on the potential emissions from the proposed projects.

Data for other sources, statewide and national emissions, and potential future trends are evaluated in the context of the following regulatory and voluntary emission reduction efforts:

- The Minnesota Mercury Reduction Act of 2006*
- Implementation of the Clean Air Mercury Rule (CAMR), and the related Clean Air Interstate Rule (CAIR)
- Implementation of the Electric Utility Maximum Achievable Control Technology (MACT) Standards
- Implementation of the Taconite MACT Standards
- Implementation of the Regional Haze Rule and Best Available Retrofit Technology (BART)**
- The MPCA Total Maximum Daily Load (TMDL) proposal
- The MPCA Voluntary Agreements and other ongoing state mercury reduction programs

* The Minnesota Mercury Reduction Act was signed into law May 11, 2006 and is expected to result in significant mercury reductions of more than 1,100 pounds per year. Therefore, this "action" is included in this analysis.

** Regional Haze Rule and BART were not originally identified for inclusion in this analysis. However, the control of SO_2, NOx, and/or fine particulate ($PM_{2.5}$) may result in mercury air emissions being reduced from those sources as well. Therefore, the Regional Haze Rule and BART are included in this analysis.

Current Mercury Deposition and Trends

Mercury is deposited in two basic forms: wet and dry. Mercury in rain and snowfall has been measured at sites throughout the U.S. since 1996 through a comprehensive monitoring system—the Mercury Deposition Network (MDN). Mercury deposited in dry particles is difficult to measure, and is therefore mostly assessed indirectly through historical sediment coring studies or other means.

Currently, total atmospheric mercury deposition, both wet and dry in northern Minnesota is estimated to be about 12.5 micrograms per square meter per year ($\mu g\ m^{-2}\ yr^{-1}$) (Swain et al. 1992). However, mercury deposition is not uniform throughout the state. The estimated mercury deposition in the Twin Cities metro area is approximately 35% higher than in northern Minnesota (Engstrom et al. 1999).

Information on atmospheric mercury deposition trends is not consistent. Based on sediment core data**,** total atmospheric mercury deposition has declined in the Great Lakes region and throughout North America over the past 25 years (EPA 2006). However, no decline is identified in Lake Superior sediments for the 1973 to 2000 time period (EPA 2006). Specific declines in mercury deposition have also been documented in parts of Minnesota: the Twin Cities metro area saw a 30% reduction, the Grand Rapids area had a 15-20% reduction, and Voyageurs National Park realized a 15-20% reduction (Engstrom et al. 1999). Again, however, mercury deposition has not declined in other lakes in northeast Minnesota, particularly within the Superior National Forest and within the Superior Highlands that parallel Lake Superior.

One explanation for the apparent inconsistency in the Minnesota data is that the lakes experiencing deposition declines since the 1970's were affected by local emissions that have subsequently been eliminated or controlled such as municipal waste incinerators or industrial sources. This also indicates that while other emission sources such as power plants and taconite facilities have been present on the Iron Range for sometime, these emission sources do not seem to affect mercury deposition to Lake Superior and other lakes in northeast Minnesota, east of Grand Rapids and Voyageurs, because these lakes show little change in mercury deposition over the applicable time period (Engstrom et al. 1999).

In comparison to the sediment core data, MDN data collected since 1996 in Minnesota indicates that the annual wet mercury deposition in northern Minnesota, at the midpoint of the precipitation, latitude and longitude for three recording stations, averages about 8.4 $\mu g\ m^{-2}$. The MDN data do not show a declining trend in deposition since 1996 despite continued state and national emission reductions. The data also indicate that wet mercury deposition across northern Minnesota increases in gradients from north to south and from west to east. Specifically, wet mercury deposition increases about 1.2 $\mu g\ m^{-2}\ yr^{-1}$ with each degree of longitude east and 2.0 $\mu g\ m^{-2}\ yr^{-1}$ with each degree of latitude south. This gradient in mercury deposition is reflected in the trend in mercury in organic litter and soil in forests that also increases from west to east across the north central United States (Nater and Grigal 1992). These gradients in Minnesota appear to be similar to those for both sulfate and nitrate deposition and are all likely related to the effect of distance to major sources of emissions to the east, such as the Ohio Valley, and the south, such as Missouri and Texas.

Emission Source Contributions to Mercury Deposition in Minnesota

Similar to acid deposition, about 90% of the mercury deposited in northern Minnesota comes from emission sources located outside the state. Only about 10% of deposition is attributable to sources within Minnesota (MPCA 2005b). However, unlike acid deposition, the amount of mercury falling in northern Minnesota is not only affected significantly by sources located throughout North America but also those throughout the world. Of the approximately 90% of mercury that comes from outside Minnesota, about one-third is from other North American sources, one-third from global sources, and one-third from natural background (MPCA 2005a; MPCA 2005b).

The importance of distant sources to mercury deposition at a receptor is not a constant. In general, modeling studies identify national and international emissions as the source of most mercury deposition in the Great Lakes region (EPA 2006). The decline in mercury deposition within the Great Lakes region is attributed to the known decrease in mercury emissions regionally and nationwide (EPA 2006). However, in Minnesota there are some examples where local source influences have been identified. Mercury deposition in the Twin Cities metro area is estimated to be approximately 35% higher than in other parts of Minnesota (Engstrom et al. 1999). No single dominant source of mercury in the Twin Cities has been identified, but the elevated loading is attributed to the aggregate of numerous sources that include coal combustion, sewage sludge incineration, solid waste incineration, and volatilization of mercury from other releases (Engstrom et al. 1999). Likewise, the decline in local mercury deposition in Itasca County and Voyageurs National Park, described above, implies a reduction in nearby mercury emissions as opposed to the regional/continental reductions (Engstrom et al. 1999). These localized reductions in mercury deposition have been attributed to improved waste incineration, phase-out of mercury fungicides in paint and paper-making, and phase-out of coal as a home-heating fuel (Engstrom et al. 1999; MPCA 2005b).

The localized deposition reductions seen in lakes in Itasca County and Voyageurs National Park appear to have no relationship to historic taconite emissions. In addition, the majority of lakes in St. Louis, Lake, and Cook Counties, within the Superior National Forest and the Superior Highlands, do not appear to be affected by local or regional sources (Engstrom et al. 1999; Berndt 2003). Berndt (2003) assessed the potential contribution of mercury emissions from taconite mining to mercury deposition in St. Louis County and determined that the annual atmospheric mercury emissions from taconite mining are approximately two to three times that deposited from precipitation in St. Louis County. Even if only a fraction of the mercury emitted from taconite processing were deposited locally it should be recorded in mercury in sediments from nearby lakes (Berndt 2003). Berndt (2003) reported that an assessment of Minnesota lake sediments by Engstrom et al. (1999) found that mercury accumulation rates for lakes closest to the Iron Range, near Silver Bay, did not obviously reflect mercury contributions associated with taconite processing mercury emissions. This finding is consistent with the available data that indicate that the primary form of mercury emitted from taconite processing is elemental mercury (Berndt 2003), and that form is not expected to be deposited locally (MPCA 2005b; EPA 2006).

Cumulative Potential Project Emissions and Statewide Trends

Based on available information as of February 1, 2006, it is estimated that the cumulative potential mercury emissions from the proposed projects are approximately 212 pounds per year. Similar to the existing taconite facilities and coal-fired power plants in the area, mercury emissions from the proposed projects are expected to be emitted almost entirely (93-99%) as elemental mercury—the form that does not tend to be washed out or otherwise deposited near the source. Emissions of oxidized mercury (0.5-5%) and particle-bound mercury (0.2-2%) are expected to be emitted in very small amounts.

Statewide, mercury air emissions were estimated to be about 3,341 pounds in 2005 (MPCA 2005a): about 1,923 pounds per year related to “Energy” (including ~ 1,650 pounds from coal-fired electric generation), about 679 pounds from “Other” (including ~ 665 pounds from existing taconite facilities), and the remainder (739 pounds per year) attributed to “Purposeful Use and Disposal.”

At the regional four-county level, mining-related mercury emissions have declined by approximately 138 pounds/year since the mid-1980s (55 pounds/year from Butler Taconite shutdown; 83 pounds per year from LTVSMC shutdown). The 1985 shutdown of Butler Taconite is not accounted for in the statewide estimates because it was not in operation when the mercury emission inventory began, but the shutdown of the LTVSMC taconite facility in 2001 is already accounted for in 2005 statewide estimates. In addition, Minnesota Power’s proposed AREA project is expected to lower emissions at its Taconite Harbor Plant by about 64 pounds per year by 2009 (MPCA 2006a). Therefore, compared to emissions in 2000, the potential “net” regional increase in potential mercury emissions from the proposed projects is approximately 74 pounds per year (221 pounds per year – 83 pounds per year – 64 pounds per year = 74 pounds per year).

Other emission reductions include voluntary actions to reduce statewide mercury air emissions in Minnesota from electric generating units have already occurred, and these include the following (MPCA 2005a):

- In 2000, Minnesota Power substituted lower-mercury coal to achieve a 70-pound annual reduction in mercury emissions from its operations. While not considered a permanent reduction in mercury emissions by the MPCA, Minnesota Power intends to continue to burn this lower-mercury coal to keep its mercury emissions at the current level (MPCA 2005a).

- In 2003, Xcel Energy completed the replacement of two coal-burning units at its Black Dog generating plant with a natural gas-fired turbine generator. This new unit reduces annual mercury emissions by up to 35 pounds compared to the old boilers and produces an additional 100 megawatts of electricity (MPCA 2005a).

Additional mercury reductions are anticipated due to the following actions:

- In December 2003, the Public Utilities Commission (PUC) approved Xcel Energy's Metropolitan Emissions Reduction Program (MERP), which will re-fire two coal plants with natural gas and upgrade the pollution-control equipment at a third Twin Cities-area plant. When fully implemented in 2009, the MERP will reduce annual mercury emissions by 170 pounds, assuming that electrical output at the two re-powered plants is similar to that from the existing units (MPCA 2005a).

- The Mercury Reduction Act of 2006, while allowing for flexibility and cost considerations in the final MPUC decisions, in effect requires 90% mercury emission reductions at Xcel Energy's King plant near Stillwater and its Sherco unit #3 in Becker by 2010, and at two other Sherco units by 2014. Minnesota Power would need to install mercury controls at its Clay Boswell unit #3 near Grand Rapids by 2010 and at Boswell unit #4 by 2014. Based on current mercury inventory data, if approved, these plans would translate into an approximately 480-pound per year reduction in mercury emissions by 2010, and an additional 630-pound per year reduction by 2014. Thus, once the required plans are proposed, approved, and implemented, the total mercury reduction would be about 1100 pounds per year by 2014.
- Shortly before the new state mercury reduction law passed, Minnesota Power separately announced plans to reduce mercury emissions at its Clay Boswell unit 3 by 90% by 2009 using activated carbon technology in combination with a new baghouse. This proposed reduction would, if implemented as planned, meet the new requirements of the Minnesota Mercury Reduction Act of 2006 for Boswell Unit #3 about one year ahead of schedule.

- Future implementation of the BART standards by Minnesota sources and the potential secondary control of mercury when additional controls for SO_2, NO_x, and/or fine particulate are implemented.

- Continuing research on many levels with respect to removing mercury from fuels and from post-combustion flue gas. This could lead to further reductions in mercury emissions from power plants and possibly from other industries, such as taconite and other iron production.
  - The MDNR continues to fund and participate in research regarding mercury transformations in the taconite indurating furnaces that may lead to an additional opportunity for mercury reductions from taconite processing (Berndt et al. 2005).
  - Minnesota Steel will be evaluating the potential for co-control of mercury emissions when assessing the feasibility and effectiveness of some technologies for removing NO_x. LoTox, thought to be a potential emerging technology for controlling NO_x emission from taconite plants, has also been shown to provide co-control of mercury emissions, when tested at power plants, ranging from 70% to 95%.
- The EPA Clean Air Mercury Rule (CAMR) is also likely to further reduce area power plant emissions over the next decade. Under the CAMR rule, utility emissions in Minnesota would have to be reduced to about 550 pounds per year by 2018 (EPA 2005c), a reduction of approximately 1150 – 1350 pounds per year from 2005 estimated emissions (MPCA 2005a). However, the CAMR caps and the MPCA inventory estimates are not directly comparable because they are based on different emission factor assumptions.

Taking into account the voluntary reductions that have already occurred and that are expected to occur and the recent Mercury Reduction Law of 2006, Minnesota electric generating units are expected to reduce their mercury emissions from approximately 1650 pounds per year in 2005 to as low as 300 pounds per year by 2014. In addition, Minnesota has proposed to EPA a draft TMDL with a fish tissue goal of 0.2 milligrams per kilogram (mg/kg or parts per million, ppm) as well as a long-term statewide emission target of 789 pounds per year (MPCA 2005b; MPCA 2006b). Although the exact timing and mechanisms to meet these proposed TMDL goals remain uncertain, the MPCA's draft implementation plan for the statewide TMDL indicates achieving the first emissions target through technology applications by 2015 (MPCA 2004), further indicating that statewide mercury emissions are likely to continue to decline over the next decade.

National and Global Emission Trends

Nationally, mercury emissions have decreased by more than 45% since 1990, to about 115 tons per year (EPA 2005a; EPA 2006). Of this, about 45 to 48 tons per year are estimated to be emitted by electric generation units (EPA 2005a). The first phase of the EPA CAMR rule would cap utility mercury emissions at 38 tons per year by 2010 and at 15 tons per year by 2018 (EPA 2005c). National mercury emissions therefore are expected to continue to decrease over the next 15 years, albeit at a slower rate than they have decreased since 1990 (EPA 2005c).

EPA's model runs indicate that the expected national decrease in mercury emissions due to the CAMR rule would result in about a 5% decrease in mercury deposition in Minnesota (EPA 2005c). The small modeled decrease in deposition in Minnesota and other parts of the Great

Lakes occurs for two primary reasons. First, EPA modeling assumed that most first-phase mercury reductions under CAMR would occur at eastern-coal fired electric generating plants that primarily emit ionized mercury—mercury that the model assumes currently deposits near the East Coast and does not reach Minnesota for the most part. Second, for the CAMR second phase, most reductions would be of elemental mercury, which the model assumes is mostly dispersed globally. Therefore, the EPA modeling shows little localized impact in Minnesota due to reduced electric utility emission reductions under CAMR (EPA 2005b).

Mercury air emissions from coal-fired electric generating facilities in the United States (45 - 48 tons per year) are approximately 2% of the total anthropogenic global emissions. Total global emissions are estimated at 2000 metric tons per year, approximately equivalent to 2205 tons. As discussed above, U.S. emissions are expected to decrease over the next several decades as a result of foreseeable regulatory actions. Global mercury emissions, however, are expected to increase, primarily because of increased coal combustion in China and India (EPA 2006). Because the global trend of mercury air emissions is expected to increase in future years, the potential decrease in mercury deposition related to compliance with the CAMR rule in some parts of the U.S., including Minnesota, is estimated to be small (EPA 2005c; EPA 2006).

Summary and Conclusions

- Proposed Cumulative Emissions:
    - Potential mercury air emissions from reasonably foreseeable projects are estimated to be approximately 221 pounds per year, primarily as elemental mercury (93-99% elemental). Statewide 2005 mercury emissions are estimated at 3,341 pounds, with emissions from taconite mining and coal-fired power plants estimated to be approximately 2,329 pounds (MPCA 2005a).
    - While the new projects may emit up to 221 pounds of mercury per year by 2015, emission reductions from Iron Range sources offset this potential increase:
        - Mining-related emissions have decreased by approximately 138 pounds per year since 1985 (shutdown of the Butler Taconite facility at 55 pounds per year and shutdown of the LTVSMC facility at 83 pounds per year).
        - When 2000 is used as a baseline, the following reductions have occurred: the shutdown of LTVSMC in 2001 reduced emissions by about 83 pounds per year; Minnesota Power's use of lower mercury coal reduced emissions by about 70 pounds per year (MPCA 2005a); the planned reductions at Minnesota Power's Taconite Harbor electric generating plant should further reduce nearby emissions by about 64 pounds per year (MPCA 2006a). When these reductions are taken into account, there is a net **decrease** of approximately 1 pound per year in mercury emissions in the four-county project area of Itasca, St. Louis, Lake, and Cook Counties by approximately 2015.

        - Implementation of the Minnesota Mercury Reduction Act of 2006 could reduce emissions from Minnesota Power's Clay Boswell Plant an additional 400 pounds per year by 2014.

    - The potential mercury emissions from the proposed projects are further offset by Xcel Energy's MERP which reduces emissions by 170 pounds per year.

- Potential Cumulative Deposition

    - The proposed projects are not expected to measurably increase mercury deposition to northern Minnesota; therefore, based on the current understanding that the amount of mercury accumulating in fish is roughly proportional to the amount of mercury deposited, the proposed new projects are not expected to cause an increase in bioaccumulation of mercury in fish in northeast Minnesota lakes or streams.

    - The proposed projects will primarily emit elemental mercury, which does not tend to be deposited locally near an emission source (MPCA 2005b; EPA 2006). As a result, the proposed projects are expected to have little effect on the current or future level of mercury deposited in northeast Minnesota.

    - Mercury deposition and fish bioaccumulation rates in northeastern Minnesota are primarily driven by national and global emission rates, not by in-state or local emissions. Approximately 10% of the mercury deposition to Minnesota is due to in-state sources; approximately 90% comes from outside the state (MPCA 2005b).

    - Sediment core data indicate that mercury deposition in the Great Lakes region (EPA 2006) and in parts of Minnesota has declined since the 1970s (Engstrom et al. 1999). However mercury deposition to northeast Minnesota lakes does not show a decline (Engstrom et al. 1999). Recent data indicate that mercury concentrations in fish in Minnesota and in the Great Lakes as a whole are declining in response to emission reductions (MPCA 2005b; EPA 2006).

    - Two scenarios of potential cumulative deposition from the proposed projects were calculated. Both scenarios likely over-estimate potential deposition from the proposed projects. Both scenarios were calculated assuming that all of the proposed projects move forward to full operation (~ 221 pounds/year) and there are no mercury reductions to offset the potential emissions from the proposed projects. (See Section 6.0 of this report for other calculation details.)

        - If oxidized and particle-bound mercury are emitted, the species that tend to deposit locally, the proposed projects may increase mercury deposition in the four-county project area by 0.16% to 1.6%; from 12.5 µg m^{-2} yr^{-1} to 12.52 to 12.7 µg m^{-2} yr^{-1}, respectively.

        - Using a conservative estimate, based on the proportionality concept used by MPCA in developing the statewide mercury TMDL (MPCA 2006b), the proposed projects could potentially increase mercury deposition by 0.6%, from 12.5 µg m^{-2} yr^{-1} to 12.58 µg m^{-2} yr^{-1}.

    - In both cases, this potential increase in mercury deposition is not expected to be measurable given the inherent variability in measuring and calculating mercury deposition.

- Future Actions to Reduce Emissions
    - Additional reductions in Minnesota's mercury air emissions are expected to occur due to foreseeable regulatory actions (Minnesota Mercury Reduction Act of 2006 and possibly from implementation of the Taconite MACT and BART/Regional Haze requirement, CAIR, CAMR, and the statewide mercury TMDL).
    - Because of the importance of out-of-state emissions to mercury deposition in Minnesota, the overall impact of the in-state emission increases or reductions on the deposition of mercury in northeast Minnesota and subsequent bioaccumulation in fish is likely to be small.
    - Implementation of the TMDL and the measured response, or lack of a response, in mercury deposition and fish concentrations will determine the extent of national and global emission reductions needed in order for Minnesota to comply with the mandates of the TMDL program.

Based on the findings presented above, the cumulative potential emissions from the proposed projects do not have the potential to cause or significantly contribute to mercury deposition and bioaccumulation in fish in northeast Minnesota lakes or streams.

1.0 Introduction

The joint Federal and State Environmental Impact Statement (EIS) for both the NorthMet and Minnesota Steel projects require an assessment of the potential "cumulative effects" of multiple proposed projects in northeast Minnesota on various aspects of the environment. These assessments are to evaluate not only the potential impacts of the two projects but also the additional potential impacts from other reasonably foreseeable projects in the area as well as from foreseeable regulatory actions (MDNR 2005a, 2005b,c). This report assesses whether mercury emissions from these projects have the potential to increase mercury deposition and mercury bioaccumulation in northeast Minnesota.

This section is divided into the following three subsections:

1.1 Potential Project Emissions

1.2 What Are Cumulative Effects?

1.3 Semi-Quantitative Approach

1.1 Potential Project Emissions

In addition to the Minnesota Steel and NorthMet projects, seven other proposed Iron Range projects are included in this analysis, including the Mesabi Nugget DRI Project. Table 1 shows the predicted maximum potential mercury emissions from each of the proposed projects included in this analysis. Cumulatively, the total potential mercury emissions for the projects listed in Table 1 are estimated to be approximately 221 pounds per year. Most of this mercury is expected to be emitted to air as elemental mercury.

This potential increase in mercury emissions is essentially offset by recent or proposed emission reductions in the four-county project area (Itasca, St. Louis, Lake, and Cook Counties): 1) actual emission reductions due to the 2001 closure of the LTV Steel Mining Company (LTVSMC) taconite plant in Hoyt Lakes and 2) potential reductions due to Minnesota Power's proposed AREA project (by 2009). These data are provided for comparison. The "net" increase in mercury emissions from the proposed projects is approximately 74 pounds per year when the LTVSMC and AREA project emission reductions are included.

Lakes in northeast Minnesota have been the focus of numerous mercury-related studies (Engstrom and Swain 1997; Engstrom et al. 1999), including selected lakes in and around Voyageurs National Park (VNP) and the Boundary Waters Canoe Area Wilderness (BWCAW). Figure 1 shows the general locations of the proposed projects in northeast Minnesota in relation to VNP and the BWCAW (defined as Federal Class I areas), other Federal Class I areas within 250 kilometers of Minnesota's Iron Range, tribal lands, and existing taconite production facilities.

Table 1. Maximum Potential Mercury Emissions from Proposed Projects and Comparison to Emission Reductions due to the 2001 LTVSMC Shutdown and Minnesota Power's Recently Proposed AREA Project.

Project	Location	Potential Emissions (pounds/year)	Mass Balance Completed/ Controls Evaluated?	Estimated Speciation Of Air Emissions [13]
Excelsior Energy [1]	Subject to State Site Process	42	Pending	Hg(0): 100%
Mesabi Nugget DRI Plant [2]	Hoyt Lakes	75	Yes	Hg(0): 99.3% Hg(II): 0.5% Hg(p): 0.2%
Minnesota Steel Industries[3]	Nashwauk	81	Yes	Hg(0): 99.8% Hg(II): 0% Hg(p): 0.2%
Northshore Mining Company: Furnace 5 Reactivation Project [4]	Silver Bay	1	Yes	Hg(0): 100%
PolyMet Mining, NorthMet Project [5]	Hoyt Lakes	8	Yes	Hg(0): 100%
United Taconite: Emissions and Energy Reduction Project [6]	Forbes	0	No	--
US-Steel Keewatin Taconite Fuel Diversification and Pollution Control Equipment Upgrade [7]	Keewatin	0	Yes	--
UPM/Blandin Paper Mill Expansion [8]	Grand Rapids	2	Yes	Hg(0): 100%
Laurentian Wood-Fired Energy Project [9]	Virginia/Hibbing	12	Yes	Hg(0): 100%
Total		221		
LTV Steel Mining Company (LTVSMC): Facility Closure (2001) [10]	Hoyt Lakes	-83		
Minnesota Power AREA proposal [11] (implemented by 2009)	Taconite Harbor	-64		
"Net" Emissions: Net Emissions = Proposed Projects – LTVSMC – AREA		74		
Other Emissions: Butler Taconite [12]	Nashwauk	-55		

Prepared April 2006 (updated July 2006):

[1] Preliminary emission estimates, total for Phase I and Phase II, based on emission factors and heat inputs provide on Excelsior Energy Web site, www.excelsiorenergy.com, accessed on October 28, 2005.

[2] Mesabi Nugget's Proposed Facility: Receive concentrate from off-site, Rotary Hearth Furnace: Air Permit Application, May 2005. Mercury mass balance completed; HG-2003 form completed.

[3] Minnesota Steel Industries, Draft Permit Application and HG-2003 Form submittal to the MPCA, September 2006. Based on data from Minnesota Steel's drill core analysis, the 95% confidence level high-end estimated emissions of mercury to air = 81 pounds. The "average" potential estimated emissions of mercury to air = 61 pounds. For this cumulative analysis, the high-end estimate of 81 pounds per year is used. If the average of 61 pounds per year is used in this analysis, the "net" increase in potential Hg emissions is 49 pounds/year, not taking into account the emissions reduction from Butler Taconite.

[4] Northshore Mining's Furnace 5 Project: reactivating 2 crushing lines, 9 concentrating lines, one pellet furnace (Furnace 5); new sources emissions only; EAW Table 6 (May 20, 2005). A "Total Facility Mercury Evaluation" was completed in 1999 for a direct reduced iron project. This total facility evaluation included an assessment of potential control technologies for reducing mercury releases to air, water, and land. The evaluation included Furnace 5. This 1999 evaluation was considered relevant and valid for the Furnace 5 Reactivation Project and was used as a reference in lieu of completing the HG-2003 form.

[5] PolyMet Mining's Proposed Facility: crushing/grinding of ore, reagent and materials handling, flotation, hydrometallurgical processing. Emission estimate is an update to EAW based on preliminary analysis of 2005 and 2006 pilot-plant stack test data using standard EPA Method 29; conservatively assumes non-detects are one-half the detection limit.

[6] United Taconite Emissions and Energy Reduction Project; this project did not involve a change in potential mercury emissions. MPCA, Permit Change/Modification Application Forms, Line 1 Emissions and Energy Reduction Project (EERP), September 2004.

[7] U.S. Steel Keewatin; Technical Support Document Permit Action #13700063-003, Dated 2/28/05. A total facility mercury mass balance was completed for the project. MPCA determined that there would be no change in the total facility mercury emissions.

Table 1 footnotes (continued)

[8} Draft EIS, UPM/Blandin Paper Mill Project Thunderhawk, January 2006, Table 6-29; (PTE Increase due to expansion).

[9] Laurentian Energy Project, Technical Support Documents for Virginia Public Utilities (MPCA Permit # 13700028-005) and Hibbing Public Utilities (MPCA Permit #13700027-003); Combined PTE for two new wood fired boilers (one at each site). The permit technical support documents estimate that actual Hg emissions are likely to be reduced by about one pound per year due to wood use in new boilers displacing coal in existing boilers.

[10] LTVSMC: Permitted emissions (potential to emit) information from Technical Support Document for Air Emissions Permit No. 13700009-001, Table 1. From http://www.pca.state.mn.us/data/edaAir/index.cfm; downloaded on December 14, 2005. Emission reductions due to the shutdown of Butler Taconite in 1985 were not included because statewide mercury inventory comparison data starts in 1990. Mercury emissions from Butler Taconite peaked at 59 pounds per year in 1971 (Berndt, 2003, Appendix 3).

[11] MPCA, January 17, 2006, Review of Minnesota Power's Arrowhead Regional Emission Abatement (AREA) Project. Table 12 (MPCA 2006a). Just prior to the MDNR's Final Decision Document being made available to the public on October 25, 2005, Minnesota Power announced a major initiative to reduce pollutant emissions, including mercury, at several of its power plants in northern Minnesota. Due to the significance of the AREA project, it was included in the analysis.

[12] Butler Taconite. Maximum estimated emissions of 55 pounds/year for Butler Taconite using an emission factor similar to National Steel Pellet Company (Berndt 2003, Appendix 3). (Note: National Steel Pellet Company is now known as US Steel - Keewatin Taconite).

[13] Speciated mercury air emissions for the proposed projects are from available information. As a point of comparison, speciation of taconite processing emissions has been characterized by the MPCA and MDNR for 2001 emissions (unpublished data):

Hibbing Taconite*:	93.3% elemental; 6.6% oxidized; 0.1% particle-bound
United Taconite*:	93.3% elemental; 6.6% oxidized; 0.1% particle-bound.
U.S. Steel Minnesota Ore Operations (MinnTac)*	93.3% elemental; 6.6% oxidized; 0.1% particle-bound
U.S. Steel - Keewatin Taconite	80% elemental; 10% oxidized; 10% particle-bound

*note: speciation for Hibbing Taconite, United Taconite, and MinnTac is based on Ontario Hydro test data from Hibbing Taconite (2000).

Recognizing uncertainty in the estimated speciation for the proposed projects, deposition calculations in Section 6.0 of this report are also conducted with the following mercury speciation for all of the proposed projects: 93% elemental, 5% oxidized, 2% particle-bound.

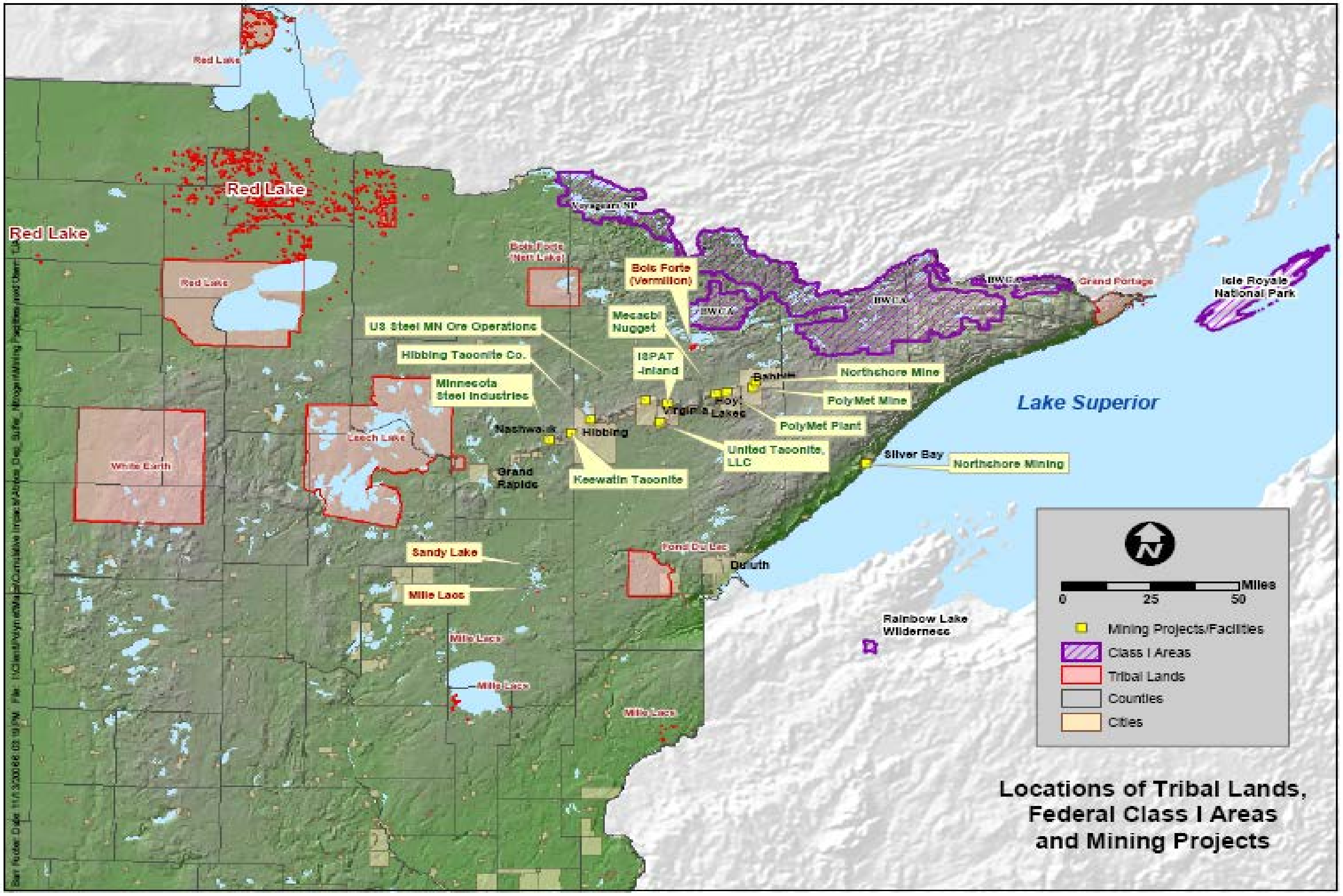


Figure 1. Locations of reasonably foreseeable proposed projects in relation to Federal Class I Areas within 250 kilometers, Tribal Lands, and existing taconite mining operations in Northeast Minnesota

1.2 What Are "Cumulative Effects"?

Federal and state environmental guidance provides a starting point for defining "cumulative effects." First, the Council on Environmental Quality's (CEQ) regulations, which implement the National Environmental Policy Act (NEPA), define cumulative effects as: "The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-federal) or person undertakes such other actions. …" (40 CFR 1508.7). The Minnesota Environmental Quality Board environmental review rules use a similar definition. (See Minnesota Rules, part 4410.0200, Subp. 11).

Some regulatory programs also in effect require a form of quantitative cumulative impact analyses as part of a permit review. For example, air quality modeling of all significant nearby emission sources is required for "New Source Review" air permits. Likewise, water discharge permits often require the applicant to account for the impact of other discharges that affect the same water body as the proposed project. But for most cumulative impact issues, such as those to be addressed for the NorthMet EIS and the Minnesota Steel EIS, there are no specific guidelines. Therefore, the approach used to assess cumulative impacts must be developed case by case (CEQ 1997).

1.3 Mercury "Cumulative Impact" Approach

The EIS scope requires a "semi-quantitative" approach for mercury based on an evaluation of likely local, state, and national emission trends (MDNR 2005a; MDNR 2005b,c). However, the relationship between mercury emissions and mercury accumulation in fish is complex. The amount of mercury accumulating in fish in a specific lake or stream is determined by a broad array of complex physical, chemical and biological processes. For example, some northeastern Minnesota lakes contain fish with the highest mercury concentrations in the state, but other nearby lakes show comparatively low fish mercury levels (MPCA 2005a). In addition, the relationships among mercury emissions, transport, and deposition are equally complex. Nevertheless, over the long-term, the MPCA estimates that for any given water body the amount of mercury accumulating in fish is roughly proportional to the amount of mercury deposited on the watershed (MPCA 2005b, 2006b).

This document adopts this same principle and assesses the combined projects' potential impact on mercury in fish in northeastern Minnesota lakes by evaluating the cumulative changes to mercury deposition rates in the four-county project area and the state as a whole. This approach assumes that local factors affecting mercury bioaccumulation rates remain unchanged.

The specifics of this cumulative impact analysis include the following: First, current mercury deposition data in northern Minnesota and the likely sources of this mercury is summarized. Then, the potential impact of the proposed projects on local mercury deposition in the context of the species of mercury that they are likely to emit is assessed. Finally, the potential impacts from the proposed projects based on past and expected future local, state, and federal emission trends, including a "net emissions" calculation that includes the project emissions, emission reductions from voluntary actions, and expected emission reductions from regulatory actions is assessed.

Additional details of the analysis are provided in the following sections of the report:

- Section 2. Analysis Boundaries
- Section 3. Proposed Projects and Air Emission Controls
- Section 4. Mercury Deposition in Minnesota
- Section 5. Local, State, and National Emissions and Trends
- Section 6. Potential Increase in Mercury Deposition from the Proposed Projects
- Section 7. Summary Findings and Conclusions

2.0 Analysis Boundaries

The CEQ (1997) Guidelines provide a minimum list of boundaries required to provide a coherent framework for a cumulative impact analysis. This analysis uses the following five boundaries:

1. The timeframe for the trends analysis, both past and future;
2. The list of specific past and future projects to be assessed in addition to the proposed project, including type, geographic limits, and project status;
3. The specific geographic area of concern ("zone of impact"), including resources, ecosystems, and populations of concern;
4. The extent and geographic limits of other sources that may affect resources in the zone of impact, for the specific issue under study;
5. Other direct and indirect factors that need to be evaluated, such as the relationship between sulfate reducing bacteria and mercury methylation, and any other potential additive, synergistic, and counterbalancing cumulative impacts.

1. **Timeframe:** 1980 to 2020. This report summarizes historical emission rates and predicts expected future emission rates based on likely emission caps or other regulatory emission limits. In some cases, such as existing taconite facility emissions, consistent data are only available since about 1996. Future emission estimates out to the year 2020 are based on a comparison of existing emissions, and the likely impact of three categories of state and national regulations: (1) existing, (2) "on the way," or (3) under consideration.

2. **Proposed Projects and Reasonably Foreseeable Actions:** Figure 1 shows the general locations of the "reasonably foreseeable" projects to be assessed for cumulative impacts, as well as the locations of existing taconite facilities and Federally-protected Class I areas. The projects selected as "reasonably foreseeable" are defined as those that are already underway with regard to environmental review, or for which a completed data portion of an environmental assessment worksheet has been submitted to the MDNR or the MPCA. The following projects are considered to be underway, or "reasonably foreseeable:

   - Proposed Projects:
     - Excelsior Energy (Mesaba Energy Project, Phase I and Phase II);
     - Laurentian Wood-Fired Energy Project in Hibbing and Virginia;
     - Mesabi Nugget Company, DRI Plant;
     - Minnesota Steel Industries, Mining/Taconite/DRI/Steel Plant;
     - Northshore Mining Company, Furnace 5 Reactivation Project;
     - PolyMet Mining NorthMet Project;

    - United Taconite Emissions and Energy Reduction Project;
    - UPM/Blandin Paper Mill Expansion, Project Thunderhawk, and
    - U.S. Steel – Keewatin Taconite fuel diversification and pollution control equipment upgrade.

- Emission Reductions:
    - Butler Taconite, shutdown in 1985*;
    - LTVSMC, facility shutdown (taconite furnaces) in 2000;
    - Minnesota Power, Arrowhead Regional Emission Abatement (AREA) Project**;
    - Xcel Energy, Minnesota Emission Reduction Project (MERP), and
    - Minnesota Mercury Reduction Act of 2006.

* Butler Taconite is identified as a "private action" in the Scoping EAW, but is not identified as a specific action to be evaluated in the cumulative impact assessments. However, because Minnesota Steel proposes to operate in the same location as Butler Taconite, there is merit in providing a credit of sorts to Minnesota Steel similar to what was done for Mesabi Nugget regarding the LTVSMC mercury emissions at the Cliffs Erie site near Hoyt Lakes. Therefore, the shutdown of the Butler Taconite furnaces in 1985 is included as an "action" to be accounted for in some manner in this cumulative analysis.

** Minnesota Power's AREA Project, and subsequently announced emission reductions at its Clay Boswell Unit 3, was not identified in the list of foreseeable actions to be included in either EIS scope for the cumulative analysis (MDNR 2005a; MDNR 2005b,c). However, due to the significance of this voluntary action in reducing emissions in northeast Minnesota, it is included in this analysis to provide additional perspective on the potential emissions from the proposed projects.

3. **Zone of Impact:** The "zone of impact" is defined as the area of concern to be evaluated for potential impacts due to the multiple proposed projects. This area depends, of course, on what cumulative impact is being studied. For mercury deposition and bioaccumulation in fish the selected zone of impact is defined as northeast Minnesota, essentially the area consisting of the following four counties: Itasca, St. Louis, Lake, and Cook. This area of the state is highly prized for its many fishing lakes and streams and noted for its many wetlands. Mercury deposition and bioaccumulation in fish are statewide-regional-national issues and are not generally site-specific. It is not expected that ecosystems or lakes within a ten-kilometer (km) radius of the NorthMet or Minnesota Steel projects or within the Partridge River or Swan River watersheds would be at any greater risk for mercury contamination than other ecosystems in the four-county region. Therefore, the zone of impact for this analysis is considered to be the area encompassed by Itasca, St. Louis, Lake, and Cook counties.

4. **Geographic Extent of Analysis:** This boundary defines the area or sources that may affect resources in the zone of interest. In this case, the resources of concern—such as the lakes in the Boundary Waters Canoe Area Wilderness and Voyageurs National Park—are affected by air emissions not only from local and regional sources, but also by sources located throughout the Midwest, throughout the country, and in the case of mercury, throughout the world. The report summarizes mercury emission trends from

sources within the zone of interest, as well as from the state of Minnesota and the United States. Global emissions are also considered.

5. **Relationship of Mercury Deposition, Mercury Methylation, and Sulfate Deposition.** Mercury deposited in water bodies and wetlands can be transformed into methylmercury by sulfate-reducing bacteria. Methylmercury is the form of mercury that bioaccumulates in fish. Due to the importance of sulfate-reducing bacteria in mercury methylation, it may be possible to obtain additional reductions in methylmercury formation by decreases in sulfate deposition. Sulfate deposition trends in Minnesota and expected future emissions of sulfur dioxide (SO_2), on a local (four-county area), regional (Upper Midwest) and national basis are expected to decrease and discussed in a companion cumulative impact report entitled "Ecosystem Acidification". Additional discussion on sulfate deposition and its relationship is contained in Section 4.4.1 of this mercury cumulative impacts report.

3.0 Proposed Projects and Air Emissions Controls

The Scope of Work for this mercury cumulative impact report identified that a "…Description of air emission control technologies is expected to be a significant section of the report. …" (Minnesota Steel Scoping EAW, Question 29, Cumulative Impact Issue #3). As this report was being prepared it became clear that a description of emission control technologies that may be applicable to the proposed projects would be lengthy and may not be relevant for some of the projects with very small potential emissions. In addition, the MPCA requires that facilities having the potential to release mercury to the environment complete a HG-2003 form. A pollution control technology review is included as part of the HG-2003 form for the projects potentially releasing larger quantities of mercury and provides specific discussions on the relevancy of the technologies to that project. Therefore, this cumulative impact report relies on summary information from the project-specific HG-2003 forms as the description of mercury control technologies as originally identified in Question 29 of the Minnesota Steel Scoping EAW.

Each of the projects in this cumulative impact analysis is discussed below including potential air emissions and control technologies. The project descriptions were obtained from publicly available documents as cited. The projects are discussed in alphabetical order.

3.1 Excelsior Energy

Excelsior Energy has proposed the Mesaba Energy Project, which would be the first coal-fired Integrated Gasification Combined Cycle (IGCC) power plant in Minnesota. Two 606 MW (net) capacity units are currently planned. Phase I, which has an expected in-service date of 2011, will consist of three sets of gasification equipment termed "trains" that will send synthesis gas (referred to as "syngas") generated from coal to two combustion turbine sets to produce electricity. Phase II, roughly identical to Phase I, has a planned in service date of 2013. The waste heat from the combustion turbines will go to a heat recovery boiler in a combined cycle configuration to generate additional electricity. The IGCC process converts the fuel into more electricity than would a traditional coal-fired power plant.

Mercury emissions for Phase I and Phase II of the project are approximately 42 pounds per year (21 pounds per year for each Phase). Excelsior Energy proposes to control mercury by passing the syngas through fixed beds of activated carbon after removing sulfur as described above. The activated carbon would be specially impregnated to remove mercury. Multiple beds are used to obtain optimized adsorption. The lower temperature and lower moisture content of the syngas at this point in the process allows the carbon beds to operate at higher efficiencies. The activated carbon capacity for mercury ranges up to 20% by weight of the carbon (Parsons, 2002). Excelsior currently expects a mercury control efficiency of 90%.

Source: www.excelsiorenergy.com

3.2 Laurentian Wood-Fired Energy Project

Hibbing Public Utilities and Virginia Public Utilities have entered into a joint venture via formation of a third party, Laurentian Energy Authority (LEA), to generate electricity from biomass as required by an Xcel Energy purchase power agreement. LEA will lease the utilities' existing turbines to produce 15 MW at Virginia and 20 MW at Hibbing. The project requires, in addition to wood handling and storage facilities, the installation of a new wood-fired boiler at each of the two utilities.

The City of Virginia Department of Public Utilities is a citizen-owned utility providing cogeneration of steam and electricity to businesses and residents of the local Virginia area. The department currently operates any combination of three boilers using coal and/or natural gas as fuel. The three boilers are referred to as Boilers 7, 9, and10. Boiler No. 10 is a natural gas fired boiler. Boilers No. 7 can burn both coal, sub-bituminous or bituminous, and natural gas. Boiler No. 9 is a coal-only boiler.

The Hibbing Public Utilities Commission (HPUC) operates a co-generation facility for the City of Hibbing. The facility generates electrical power for the city and steam for space heating of businesses, schools, and residences. The HPUC power plant is located in downtown Hibbing and was originally constructed in 1919. The emission units at the source consist of three coal/natural gas-fired boilers, an ash-handling system, as well as the two natural gas-fired boilers located a few blocks away at Hibbing High School that are connected to the HPUC steam distribution system.

The MPCA recently reissued the total facility permits for both utilities. These permits allow the installation of a wood fired boiler to be used for district heating and electric generation. Also authorized with the permits are the installation of wood handling and storage equipment. These modifications at both plants were subject to federal new source review. The pollution control equipment required for the new wood-fired boilers at each location are identical: each includes a multiple cyclone w/o fly ash re-injection, a high-efficiency electrostatic precipitator for particulates, and selective noncatalytic reduction for NO_x.

Based on the Technical Support Documents in the MPCA air permits for Virginia Public Utilities and Hibbing Public Utilities, the new wood-fired boilers are subject to the industrial boiler MACT regulations for mercury. The existing coal-fired boilers are not subject to the MACT standards until September, 2007. (The potential emissions allowed for each of the new wood-fired boilers are the same at each facility for mercury as well as for SO_2, NO_x.) The mercury emissions from the new wood-fired boilers are assumed for the purposes of this report to be in addition to the mercury emissions from the existing coal boilers.

However, since the new wood-fired boilers are expected to emit less mercury per MMBtu than the existing coal boilers, as the wood-supply and wood-fired boilers displace the existing coal boilers, the total actual mercury emissions from the two utilities should decline.

Total Facility Potential to Emit Summary

	Virginia Public Utilities Mercury	Hibbing Public Utilities Mercury
New Wood Boiler	6 lbs	6 lbs
Total Facility Limited Potential Emissions	N/A	N/A
Total Facility Actual Emissions (2004)	7.3 lbs	5.7 lbs

Source: Laurentian Energy Project, Technical Support Documents for Virginia Public Utilities (MPCA Permit # 13700028-005) and Hibbing Public Utilities (MPCA Permit #13700027-003).

3.3 Mesabi Nugget Company Direct Reduced Iron Plant

The Mesabi Nugget facility is a large-scale demonstration plant. The facility will be constructed near Hoyt Lakes, Minnesota, on part of the site formerly occupied by the LTV Steel Mining Company taconite mining and processing facility.[1] The process utilizes coal, fluxes and binders to convert iron ore concentrates to metallic iron (nuggets) and slag in a rotary hearth furnace.[2] Iron nuggets produced by the facility will be approximately 96 to 98 percent iron suitable for feeding directly into electric arc furnaces (also known as mini-mills) and conventional iron and steel manufacturing facilities.[1]

The MPCA drafted water and air emissions permits for Mesabi Nugget LLC, to be located near Hoyt Lakes, Minnesota.[1] The permits were approved in July 2005. Sources of emissions include a rotary hearth furnace (RHF), green ball dryers, coal and flux pulverizer/dryers, material handling and storage, a backup generator, and cooling towers.[2] The permit places an overall limit on mercury emissions of 75 pounds per year based on an operating scenario of 24 hours per day, 365 days a year. It also requires the Mesabi Nugget facility to perform research and testing with a goal of reducing mercury emissions by fifty percent.[1]

The Air Emission Permit authorizes construction and operation of the Project. Pollution control equipment to be installed includes the following:

- A wet scrubber to control emissions of sulfur dioxide, particulate matter, particulate matter less than ten microns in diameter, lead, fluorides, sulfuric acid mist, metal HAPs, and inorganic salt HAPs from the RHF.[2]
- An air infiltration system to control combustion pollutants (carbon monoxide, volatile organic compounds, and volatile organic HAPs) from the RHF.[2]
- Fabric filters (baghouses) to control particulate emissions (PM_{10}) from the raw material pulverizers, dryers and material transfer operations.[2]
- A fugitive dust control plan to control particulate emissions from storage piles and roads.[2]

[1] http://www.pca.state.mn.us/hot/pubs/mesabinugget-factsheet.pdf

[2] http://www.pca.state.mn.us/about/board/mesabi-boarditem.pdf

3.4 Minnesota Steel Industries

Minnesota Steel Industries, LLC (Minnesota Steel) was created in February 2003 to construct an approximately $1.6 billion mine-mouth electric arc steel mill, capable of producing 2.5 million metric tons of steel per year. The Minnesota Steel project is to be located in northern Minnesota, on the western end of the Biwabik Iron Formation (the Mesabi Range) at the site of the former Butler Taconite Mining Company plant. Minnesota Steel is applying for a total facility permit, including the authorization for construction of a new facility for its proposed project on the Mesabi Iron Range in Nashwauk, Itasca County, Minnesota (the "Project").

The project has secured the 1.4 billion (long) ton mineral resources of the Butler properties and seeks to capitalize on the unique mineralogical characteristics of the iron ore body by vertically integrating all mining and manufacturing processes to produce a finished steel product on one site. The process will use commercially proven technology and will be the only fully integrated steelmaking facility in the United States. Minnesota Steel will reactivate the former (dismantled) Butler taconite mining and processing site to join six other taconite ore mining operations that have operated on the Range since the 1950's. Minnesota Steel will be distinguished from other Iron Range plants by further refining the taconite feed stock it produces to finished steel instead of shipping taconite to the Midwestern blast furnaces. Minnesota Steel will use its taconite to make direct reduced iron (DRI), a 94 percent iron interim product. DRI will be the primary feedstock for the electric arc furnaces in the steel mill that will ultimately produce steel slabs and rolled sheet steel coils for sale to steel product manufacturers.

Minnesota Steel has initiated the environmental review process, and has submitted a draft PSD air permit application (February 2006) to the MPCA. This application is currently being revised and is expected to be resubmitted to the MPCA in August 2006. The air quality impacts analysis and a human health and ecological risk assessment are based on a defined finished steel output that subsequently defines the capacity of the supporting elements of the project.

The primary raw material inputs to the Minnesota Steel project are iron ore, natural gas, electricity and water. The key processing steps with the potential for emissions to the environment consist of:

- Mining ore (shoveling, loading, haul road traffic, unloading),
- Concentrating iron mineral (two-stage crushing),
- Pelletizing (natural gas combustion, taconite pellet handling),
- Iron reduction (natural gas reforming, natural gas combustion, taconite and DRI pellet handling), and,
- Steel production (electric arc furnace melting and ladle furnace refining, casting, natural gas combustion and slag processing).

The Minnesota Steel project will be classified as a major stationary source of air emissions and will be permitted and regulated under the New Source Review provisions of the Clean Air Act. These estimates represent the potential to emit (PTE) in the September 2006 permit application. Revisions of mercury emission rates are possible for the final MPCA permit.

Potential to emit emissions (point sources + fugitive):

- natural gas based project: 81 pounds/year*
- coal based project: 111 pounds/year**

*Based on drill core analysis, the 95% confidence level high-end estimate of mercury emissions are approximately 81 pounds per year (0.039 tons). When available data are averaged, the resulting estimate of potential mercury air emissions is approximately 61 pounds per year. For this cumulative impact analysis, the high-end emission estimate of 81 pounds per year was used.

**Using natural gas as the primary fuel for the project decreases potential mercury emissions by approximately 30% from a coal-based project when using the high-end estimate of potential mercury emissions.

The Minnesota Steel project has primary air emission points at the mine, taconite indurating furnace, at the DRI reformers and at the steel mill EAFs. Smaller emission points include numerous individual materials handling operations, smaller combustion sources and cooling towers. All emission points have been included in the evaluation of best available control technology (BACT) required under the PSD provisions and some emission points are subject to the maximum achievable control technology (MACT) standards set by the national emission standards for hazardous air pollutants (NESHAPs).

The primary routes of mercury to the environment will be via tailings separated during the concentrating process and to the air from the taconite indurating furnace stack, which is associated with the first high-heat treatment of the ore. Mercury associated with tailings is sequestered in the tailings basin due to adsorption of the mercury onto the tailing material. This mechanism provides for approximately 99% control in the tailings basin.

Mercury emissions to the air from the indurating furnace are estimated to account for 85% of the air releases. The second largest source of mercury air emissions is natural gas combustion at the DRI Plant, which accounts for 13% of the estimated air releases. Unlike most other EAF-based steelmaking operations, Minnesota Steel will use 100% DRI to charge its furnaces. Except during initial or post-maintenance startups, there will be no outside scrap charge to the EAFs at Minnesota Steel other than internally-produced, virgin iron, "home scrap". The amount of clean outside scrap to be used for startups is estimated to be 1% of the annual steel production.

The BACT determination for the indurating furnace hood exhaust is a wet scrubber for control of particulate. BACT for the indurator waste gas stream is wet scrubbing with lime for control of particulate and SO_2 and LoTox for control of NO_x. The LoTox technology requires integration with a wet scrubber. These technologies have the added benefit of providing potential co-beneficial control of mercury emissions. Minnesota Steel will be evaluating the potential for co-control of mercury emissions when assessing the feasibility and effectiveness of some technologies for removing NO_x. LoTox, thought to be a potential emerging technology for controlling NO_x emission from taconite plants, has also been shown to provide co-control of mercury emissions, when tested at power plants, ranging from 70 to 95%.

Similar to other taconite processing facilities, there is expected to some variability in mercury emissions from Minnesota Steel's taconite processing. Based on the analysis of 12 samples from one ore drill core (Air Permit Application, Appendix N data), the concentration of mercury in the ore to be used by Minnesota Steel ranges from 4.5 to 22.0 ng Hg/g. The proportioning of mercury between the hood exhaust and the waste gas stack are just beginning to be studied and additional research is needed. No mercury control technologies have been tested, let alone installed, on a currently operating indurating furnace. Of the mercury control technologies considered to be potentially feasible, most are emerging technologies at best. Minnesota Steel already proposes to use one of the best measures to reduce mercury emission by committing to the use of natural gas rather than coal. As shown above, the use of a natural gas based project results in a 30% reduction in potential mercury emissions from a coal based project.

Although no additional mercury controls are proposed at this time, Minnesota Steel remains committed to further reducing mercury emissions as more knowledge is gained about the generation and control of mercury emissions from taconite processing and as technologies are proven to be technically and economically feasible for taconite processing. Minnesota Steel will comply with any new regulations related to control of mercury from taconite production when they are promulgated along with the rest of the taconite industry.

Source: Application for a Permit to Construct and Operate an Integrated Steel Plant. Minnesota Steel Industries, LLC Nashwauk, Itasca County, Minnesota (February 2006) (Revised Application September 2006.)

3.5 Northshore Mining Company Furnace 5 Reactivation Project

Northshore Mining (NSM) currently mines taconite near Babbitt, Minnesota and transports the ore to its processing facility at Silver Bay. The taconite ore is concentrated and converted to pellets that are sold as raw material for steel production. NSM is proposing to reactivate equipment that is permitted but has been idle for more than twenty years. Specific changes associated with the project include the following:

- Reactivating two fine crushing lines along with their corresponding existing fabric filters.
- Reactivating nine concentrator sections and upgrading multiclones on all nine with fabric filters as the sections are reactivated.
- Replacing multiclones on all currently operating concentrator sections with new fabric filters.
- Constructing a concentrate handling system consisting of three conveyor belts and two storage silos for concentrate.
- Reactivating a pelletizing furnace along with three wet-wall electrostatic precipitators (WWESPs) for emission control.

- Rendering the Iron Nugget Pilot Demonstration Research and Development Plant inoperable.
- Expanding Milepost 7 WWTP and its associated discharge to the Beaver River.
- Revising the effluent amphibole fiber limit.

Total project mercury emissions, on a potential to emit basis based on the currently operating Furnace 6, are approximately 1 pound/year.

As a result of the proposed project, several changes will be made to existing sources of air emissions and the corresponding pollution control equipment. The specific changes that have the potential to affect mercury emissions are as follows:

- The reactivated fine ore crushing lines will produce PM_{10} and will be controlled by fabric filters, which meet Best Available Control Technology (BACT) requirements.
- The reactivated concentrators will be a new source of PM_{10} as well. All concentrators will be upgraded to control PM_{10} with fabric filters to meet BACT requirements and modeling-based emission rates prior to start-up.
- The concentrate handling system is not expected to generate PM_{10} emissions due to the concentrate having 9 – 10% moisture, but the project proposal specifies equipping the new storage silos with fabric filter bin vents to control air flows within the silos.
- The reactivated pelletizing furnace will emit NO_x, PM_{10}, SO_2, and Hg and will be equipped with three WWESPs to control PM_{10}, SO_2, and acid gas emissions. Mercury is also captured by the WWESPs.
- The project proposal will also replace an existing rotoclone with a wet scrubber for PM_{10} control at the furnace discharge transfer point.
- PM_{10} emissions from material handling processes downstream of the furnaces are controlled by wet control devices, by screening fines from the product and by wetting the product with water.

Source: Environmental Assessment Worksheet, Northshore Mining Company Furnace 5 Reactivation Project, May 2005. Northshore Mining Company – Furnace 5 Reactivation Project, MPCA Board Item, November 2005.

3.6 PolyMet Mining, NorthMet Project

The following information is taken from the NorthMet Project Description (April 26, 2006).

Overview

PolyMet plans to excavate and process a low-grade disseminated sulfide mineral deposit (NorthMet deposit) in northeastern Minnesota. The NorthMet deposit is approximately 6 miles south of the town of Babbitt and about 2 miles south of the operating Northshore Mining Company (NMC) taconite open pit. Ore processing and tailings disposal will occur at the currently inactive Cliffs Erie taconite processing facility (formerly operated by LTV Steel Mining Company [LTVSMC]) and the adjoining tailings basin, which are situated about 8 miles west of the NorthMet deposit and about 5 miles north of the town of Hoyt Lakes. PolyMet has acquired these facilities. This mining and processing effort, designated the NorthMet Project, will utilize a hydrometallurgical process for extracting copper, nickel, palladium, platinum, cobalt and gold from the ore.

Project plans call for the excavation of an average of 32,000 short tons of ore per day, using open-pit mining methods. After overburden and waste rock striping and stockpiling, ore will be hauled in conventional diesel haul trucks from the open pit to a rail loading pocket located near the pit rim where it will be transferred to rail cars and transported from the mine site to the processing plant on a largely existing railroad.

The former LTVSMC taconite crushing plant and concentrator will be refurbished and modified to process the NorthMet ore to produce a bulk sulfide flotation concentrate. This concentrate will then be further processed in a hydrometallurgical extraction facility that will be constructed adjacent to the concentrator within the former LTVSMC industrial site. The hydrometallurgical plant will be a state-of-the-art facility that will produce high purity copper metal in the form of electro-won cathodes and separate precipitates of nickel/cobalt and platinum/palladium/gold, which will be shipped off-site for further refining. Processing will also result in carbon dioxide and gypsum byproducts. Markets may be found for both of these. Flotation tailings from the concentration process and reactive residue from the hydrometallurgical process will be disposed of on top of the former LTVSMC taconite tailings basin.

Mining operations comprising overburden stripping, drilling, blasting, loading, and hauling of waste rock and ore and stockpiling of overburden and waste rock will be conducted 24 hours per day, 365 days per year over the 20-year life of the project.

Processing Plant

The process for recovering the base metals and PGM's from the NorthMet deposit will be a concentration step to recover all of the sulfide minerals by flotation followed by a hydrometallurgical step that includes an autoclave leaching process. After the autoclave process, copper will be recovered by solvent extraction/electrowinning and the remaining base metals and PGM's will be separated and recovered by precipitation and filtering.

The processing plant design will be based on the following key parameters:

- An average annual mining rate of 32,000 short tons/day or 11.7 million short tons/year.
- Acquiring the nearby Cliffs Erie mothballed crusher/concentrator and all land needed for tailings disposal, water supply and water storage. This facility also includes a fully established infrastructure of roads, rail, warehouses, offices and workshops.
- Simplification of the process circuits by producing only copper metal on site and separate PGM sulfide and nickel/cobalt hydroxide or carbonate concentrates for off-site shipment and refinement.

The processing plant design features the following unit operations:

Unit Process	General Description
Crushing	The ore is crushed in stages to the size of about 0.4 inches or finer.
Grinding	The crushed ore particles are further reduced to fine sand (0.008 inch particles).
Flotation and Concentrate Regrinding	The metal sulfide-bearing particles are separated for further processing.
Autoclave Leach	The metal sulfides in the flotation concentrate are oxidized under high pressure and temperature to allow recovery of the metals from solutions.
PGM Precipitation	The Platinum Group Metals (Palladium, Platinum and Rhodium) and gold are recovered from the leach Solution
Solution Neutralization	The acidic leach solution is neutralized using Limestone
Copper Solvent Extraction (SX)	The neutralized leach solution is mixed with an organic solvent to selectively remove the copper. The copper is then stripped from the solvent using an acidic aqueous solution.
Copper Electrowinning (EW)	The copper is removed from solution by electrochemical means.
Raffinate Neutralization	The raffinate solution is neutralized with limestone.
Iron and Aluminum Removal	Iron and aluminum are selectively removed from the leach solution after the Copper SX process to allow recovery of higher-value nickel and cobalt.
Residual Copper Recovery	Residual soluble copper is also removed by precipitation.
Mixed Hydroxide Precipitation	Nickel, cobalt and some zinc are precipitated together to be sold for further refining.
Magnesium Removal	Small amounts of magnesium and other undesired metals are removed from the process stream before it is recycled.

Mercury Emission Estimate

The current estimate of annual mercury emissions is 8.34 lbs/yr based on controlled potential emissions and 7.30 lbs/yr based on estimated actual emissions. This is an increase compared to the estimate in the NorthMet Project Scoping EAW. When the EAW was prepared, the only data available to determine mercury emissions were based on a material balance using analyses conducted on the ore, concentrate, and tailings as part of the 2000 pilot study. During the 2005 and 2006 pilot studies, substantial additional data was collected including EPA Method 29 stack testing conducted on the autoclave vent and autoclave flash vent. Multiple sample fractions were collected from the standard EPA Method 29 stack sampling train. Each of these fractions was analyzed separately, with the results for each fraction summed to produce the total mercury result. Some of the EPA Method 29 train fractions have relatively high detection limits, and the treatment of non-detect values can have a significant impact on the reported results. Current emission estimates assume a result of 1/2 the detection limit for the fractions for which the laboratory reported results as "non-detect." As a result, approximately half (4lbs/year) of the total 8.34lbs/year estimated emissions is due to the uncertainty created by results below the detection limit in the back half (after the filter) of the sampling train. More detail on the mercury emission calculation procedures will be included as part of the air emissions permit and other documents.

Emission Controls

Emission controls are subject to change based on the results of ongoing air quality modeling studies and final determinations of applicable regulatory requirements such as Best Available Control Technology for existing emission units or the applicability of Maximum Available Control Technology requirements. Itemized below are the potential emission control options being discussed with regulatory agencies for selected emission units.

- Crushing/grinding operations emit PM_{10} and existing control equipment (rotoclones, baghouses on specific units) will continue to operate.

- Milling and flotation are wet processes and PM_{10} emissions are minimal. No additional controls have been proposed for this part of the process.

- Hydrometallurgical Plant emissions of PM_{10}, SO_2 and acid gases are proposed to be controlled with venturi-type scrubbers. The autoclaves and the associated flash vessels would each have their own scrubber, with these scrubbers then feeding into a main scrubber for the Hydromet plant.

    - Off-gases from other components of the Hydromet process, such as emissions from iron and aluminum removal, would be routed to the main scrubber.

    - Emissions from the copper removal tanks would also be sent to the main scrubber.

    - Emissions of acid gases and particulate from copper electrowinning will likely be sent to one of 4 wet scrubbers.

    - Particulate emissions from the handling and bagging of products (i.e., hydroxide product) would likely be controlled with fabric filters or equivalent controls.

    - Particulate emissions from the flocculent storage silo would likely be controlled with a fabric filter.

Source: http://files.dnr.state.mn.us/input/environmentalreview/polymet/scoping_eaw.pdf

http://files.dnr.state.mn.us/input/environmentalreview/polymet/table_23_2.pdf

http://files.dnr.state.mn.us/input/environmentalreview/polymet/table_23_3.pdf

NorthMet Project Description, April 26, 2006. EIS Report RS56.

3.7 United Taconite Emissions and Energy Reduction Project

This equipment upgrade, known as the Emissions and Energy Reduction Project ("EERP") includes installation of new control equipment, installation of energy recovery equipment, and replacement and renovation of existing plant equipment that will result in lower energy use, improved product quality, and lower emissions per ton of taconite produced at the facility.

Specifically, the EERP includes the following components:

- Install heat recoup and rebalance air flows to reduce Line 1 fuel usage (and combustion-related emissions). Based on computer modeling simulations, the heat recoup system is expected to:
    - Return approximately 67,000 scfm of hot gases (1,275 F) from the secondary cooling zone of the cooler to the "Downdraft Drying II" zone of the grate.
    - Reduce the fuel requirements of the kiln by approximately 250,000 Btu/dry long tons pellets.
    - Reduce the flow of the gases venting via the cooler exhaust from approximately 70,000 to 20,000 scfm.
    - Reduce the flow exiting the waste gas stack (SV 046) from approximately 300,000 to 270,000 scfm.
- Replace the two vibrating feeders at the cooler discharge to reduce Line 1 upsets (and associated emissions) and to reduce the amount of pellet spillage that occurs at the cooler discharge, thereby improving indoor air quality in this area of the plant;
- Replace the pan conveyor that transfers oversize material from the Line 1 vibrating feeders to the outdoors pellet reclaim pocket to reduce the amount of pellet spillage that occurs at the cooler discharge, thereby improving indoor air quality in this area of the plant;
- Install gooney removal systems to improve product quality and to reduce dust loading to the waste gas stack and downstream operations;
- Install better slats in the waste gas scrubber to increase particulate removal;
- Improve energy utilization of regrind mills in the concentrator;
- Replace vacuum pumps and possibly concentrate filters to improve energy efficiency of these units.

Based on calculations in the permit modification forms submitted to the MPCA in September, 2004 the project will result in a reduction of NO_x emissions of 2060 tons per year because of decreased fuel use, and an increase in emissions of PM_{10} of 14 tons per year (Permit Change Form CH-10). United Taconite did not request a change in the permit limit for NO_x, however, so the permitted emission rate will not change. Since permitted potential to emit NO_x limits will not change, no NO_x reduction was assumed for this report. PM_{10} emissions, however, will increase and a permit limit increase has been requested. However, since the MPCA has not yet determined final PM_{10} permit limits, the applicant's calculated net increase of 14 tons per year of PM_{10} (or 3.27 lbs/hr) was used to assess the project's potential contribution to cumulative impacts in the area.

The project is expected to reduce fuel use, which should result in some reduction in mercury emissions. However, the fuel used on Line 1 is natural gas, which has a small amount of mercury associated with its combustion. No specific estimates are available for the project. The report uses an estimate of zero for potential project emissions of mercury.

Source: United Taconite LLC - Fairlane Plant, Forbes, Minnesota, MPCA, Permit Change/Modification Application Forms, Line 1 Emissions and Energy Reduction Project (EERP), September 2004.

3.8 UPM/Blandin Paper Mill Expansion, Project Thunderhawk

The UPM-Kymmene/Blandin Paper Company (UPM/Blandin Paper) is proposing a major expansion and modification of its paper mill located in Grand Rapids, Minnesota. The mill currently produces lightweight coated publication-grade paper through two paper machines at an annual output of approximately 380,000 short tons. Project Thunderhawk's main feature is the addition of a complete paper manufacturing line, including increasing pulp producing capacity, optimizing existing paper lines, and adding warehouse facilities.

The Facility is located in an area designated as attainment with respect to all National and Minnesota Ambient Air Quality Standards (NAAQS and MAAQS, respectively). The main contributing air emission sources at the existing plant consist of four boilers (two natural gas-fired units and two wood/coal-fired units), a PGW mill, PM5, PM6, two coater/dryers, miscellaneous material handling, and truck traffic. The current facility has a PTE of greater than 250 tons per year for all criteria pollutants except lead and thus is an existing major source under the Prevention of Significant Deterioration (PSD) program. In addition, the Facility is a major source of hazardous air pollutants (HAPs).

The paper mill's production will increase by an additional 314,000 short tons per year of lightweight publication-grade paper. Allete/Minnesota Power operates the Rapids Energy Center (REC) at the UPM/Blandin Paper Mill site. Energy-related infrastructure improvements at the REC include installation of a new steam accumulator, improvements to the water demineralization plant, installation of a new gas-fired back-up boiler, and installation of a new power feed line. A new heat-recovery system would also be installed. This modification is considered a connected action in the EIS for the project.

The UPM/Blandin Paper Mill currently operates under Air Emission Permit No. 06100001-006, issued February 7, 2005 by the MPCA. Included in the operating permit is both the paper mill and the Allete/Minnesota Power owned and operated REC located at the mill (collectively, Facility). Because the REC provides steam and electricity only for the paper mill, UPM/Blandin Paper Mill and the REC are co-permittees. The electricity produced by REC is used to offset power that would otherwise be brought in by the electric power grid servicing the paper mill.

Schedule

Once all approvals have been secured, UPM/Blandin Paper Mill indicates that construction could commence in late 2006 to early 2007, with new paper machine line start-up possible in late 2008-2009.

Mercury Emissions

According to company estimates that have been reviewed by MPCA staff, mercury emissions could increase by approximately 1.5 lbs per year because of the increased solid fuel use in the existing boilers. Total annual emissions from the entire facility after this expansion are estimated to be about 4.3 lb per year, compared to 2.8 lb currently. The boilers at this facility will be subject to a federal emissions limit (40 CFR Part 63, Subpart DDDDD) for mercury with a compliance deadline of September 13, 2007. The facility's current mercury emissions are less than the federal emissions limit and will remain below the standard after the expansion is completed. Based on the small amount of mercury from this expansion and from the facility as a whole, and the fact that this facility will be subject to a federal emission limit for mercury, MPCA staff recommended during the EIS process that the Project proceed without further mercury analysis.

Source: Table 6-29 of the UPM/Blandin Project Thunderhawk Draft EIS, January, 2006.

3.9 US Steel Keewatin Taconite, Fuel Diversification and Pollution Control Upgrade

U.S Steel operates a taconite (iron ore) mine and processing plant in Keewatin, Minnesota. The facility produces taconite pellets for use as a primary raw ingredient at iron and steel mills. Major activity areas at the facility include: mines and crushers, concentrating, pelletizing, pellet storage and loadout, additive receiving and handling, concentrate storage, loadout and receiving, and support activities.

The facility recently received an air permit amendment that, among other things, allows the Phase II furnace to fire coal and petroleum coke as well as the installation of a new wet scrubber system. In the permit amendment, the MPCA estimates that the mercury removed by the wet scrubber would offset any increased mercury emissions due to the use of coal or petroleum coke—so mercury emissions are expected to remain unchanged. No mercury limits were imposed; however, the EPA has reopened the taconite MACT standard to evaluate mercury control feasibility.

The net change in mercury emissions is zero for the projects (from Table 1 of the Technical Support Document for Air Emission Permit No. 13700063-003):

In addition to new monitoring requirements, this permitted project includes the following components:

a. Pollution control equipment upgrade, which in itself does not require a major permit amendment, as per Minn. R. 7007.1150, Item C(1). Phase II induration waste gas stream at the outlets of the two existing multiclones (CE 030 and CE 031) will be connected to two new wet scrubbers (CE 110 and CE 111, respectively) for venting through one new, combined waste gas stack (SV 051). U.S. Steel broke ground to begin construction of this project, on September 27, 2004.

b. Fuel diversification, the second project, will enable the Phase II indurating kiln to burn coal and petroleum coke in addition to natural gas and distillate fuel oil. Coal handling equipment (GP 003), which is subject to Subpart Y of New Source Performance Standards (NSPS; 40 CFR § 60.250 to 60.254).

c. Adding a scrubber-equipped secondary annular cooler to the Phase II grate-kiln-cooler system (commonly referred to as grate-kiln system), the third project, will enable U.S. Steel to make approximately 6.0 million long tons of taconite concentrate pellets per year, a 10 percent increase from the current level. The new, secondary cooler is expected to start up initial operation on May 31, 2007, after the actual startup of the first project and the compliance date of NESHAP, subp. RRRRR, October 30, 2006. It is subject to both NESHAP, subp. RRRRR, and NSPS, subp. LL.

U.S. Steel was able to show that through netting, the proposed annual emission limits for Phase II waste gas stack on PM, PM_{10}, NO_x, SO_2, CO, and VOC, calculated as their respective 12-month rolling sums, the three projects combined were a minor modification under Prevention of Significant Deterioration (PSD; 40 CFR § 52.21) regulations.

Source: AIR EMISSION PERMIT NO. 13700063- 003 (Issued March 2005)

3.10 Potential Emissions from Power Generated for the Proposed Projects

A total of 10 proposed Iron Range projects have been identified to be included in the air quality related cumulative impact assessments to be completed in support of the respective EIS for Minnesota Steel or PolyMet. (Note: nine of the 10 projects are listed in Table 1 for inclusion in this analysis.) Table 2 below lists all ten projects. Seven of the 10 proposed projects are considered energy consuming projects and power will need to be generated for them. The discussion below provides a qualitative assessment as to 1) whether the emissions related to power generated for the proposed projects are already included in some manner in this cumulative impact analysis, and 2) the potential for the emissions related to power generated for the proposed projects to have cumulative impacts with the proposed Iron Range projects.

Seven of the proposed Iron Range projects evaluated for cumulative air quality impacts will require electric power for their operations (Table 2). The power requirements of the proposed Iron Range projects are not expected to result in the need to build new power generation facilities specifically for the proposed projects. The Mid-Continent Area Power Pool (MAPP) will supply power for the potential projects that become operational. The MAPP includes electric generating facilities in Minnesota, North Dakota, South Dakota, Iowa, and Wisconsin). Total generation capacity of the MAPP, as of 2004, is 41,956 megawatts (MWs) (www.mapp.org/content/fast_fact.html), with approximately 21.1% of the power generated from hydroelectric, 8% from nuclear, 46.9% from coal, 22.5% from gas, and 1.6% from "other". The available data indicates the MAPP has the capacity to absorb some level of future power requirements because the maximum summer peak is approximately 33,187 MWs, while the winter peak usage is approximately 30,660 MWs (based on 2004 data; www.mapp.org/content/fast_facts.html).

The electric power potentially required by the proposed Iron Range projects is approximately 672 MWs (Table 2); the potential 672 MWs is about 1.6% of the existing MAPP power generation capacity in 2004. The potential power requirements of the respective projects is expected to be supplied by either 1) existing power generation facilities in the MAPP grid (coal-fired, natural gas, nuclear, hydroelectric, wind, biomass, geothermal, etc.) or 2) "new" power from independently planned future facilities that are already under construction, have already been proposed, and/or are in some form of environmental or permitting review that would then become part of the MAPP in the future. The independence of "new" power generation from the proposed projects that will consume energy is emphasized in Minnesota Steel's Scoping EAW (EAW Question 28, Public Review Scoping EAW, July 2005):

> *"… The power required for the project can be provided from existing sources, from market purchases of power and from power production facilities currently planned or proposed. Any new power production facilities would not be a direct result of the Minnesota Steel project and might be built (or not built) independent of the decision on the feasibility of the Minnesota Steel project. …."*

Table 2. Power related information for the proposed projects

Proposed Projects	Estimated Megawatts (MW)	Notes
Megawatts Potentially Needed		
Cliffs Erie Railroad Pellet Transfer Facility	2	Estimate includes railroad, car dumping, the reactivation of the stacker and the pumps for pellet spray water. [Source: Mr. Jim Jagunich, Barr Engineering].
Mesabi Nugget DRI Plant	10	A range of 3-10 MW is estimated by Mesabi Nugget. The upper estimate of 10 MW is used in this table.
Minnesota Steel Industries	450	Estimated power requirements [Source: Scoping Environmental Assessment Worksheet, Minnesota Steel Industries, LLS.]
Northshore Mining Company: Furnace 5 Reactivation	0	Reactivation of Furnace 5 and the crushing and concentrating equipment is expected to increase facility electricity needs by 5-10 MW. The onsite power plant has historically operated at full capacity to meet process electricity needs, while selling excess power to the grid. This excess power that has previously been sold on the grid will now be used for the project. Therefore, the Furnace 5 Reactivation Project will not create new or increased emissions from the onsite power plant.
PolyMet Mining, NorthMet Project	100	The demand load was initially estimated at about 100 MW; refinements and adjustments to the process are expected to reduce the power required for the project. The revised estimate of project power needs is not yet available. [Source: personal communication with Mr. Jim Scott, PolyMet Assistant Project Manager, June 2006.]. This table uses the initial estimate of 100 MW for potential project power needs.
UPM/Blandin Paper Mill Expansion: project Thunderhawk	100	From Allete Annual Report 2004 at http://www.allete.com/invest/ annual_rpt2004/ energy.html.
US-Steel Keewatin Taconite Permit Modification	10	A placeholder estimate of 10 MW is used in this table. Estimated power requirements for the project = ~ 4 - 5 MW, but this does not include the potential power requirements for the big fan motors associated with the new scrubber installation.
SUM	672	

Proposed Projects	Estimated Megawatts (MW)	Notes
Energy Reduction Projects United Taconite: heat recoup project	0	Specific information on potential project power requirements is not available. A best estimate is that the project will result in reduced power requirements but as of July 2006 there is no official documentation available from public agencies as to the project's reductions in energy consumption at the facility. Therefore, for this analysis it is assumed that there is neither a net increase or decrease in energy consumption.
Megawatts Potentially Produced		
Excelsior Energy, Mesaba Energy Project	1,212	The estimate of 1,212 MW is for net production capacity. [Source: Excelsior Energy website; www.excelsiorenergy.com]
Laurentian Wood Fired Energy Project	0	The Laurentian Energy Authority, LLC, will lease existing turbines at the Hibbing Public Utilities and Virginia Public Utilities, respectively, to produce energy from biomass. Total MW to be produced from biomass = 35; 15 MW at the Virginia Public Utilities; 20 MW to be produced at the Hibbing Public Utilities. The installation of a new wood-fired boiler at the Virginia Public Utilities and at the Hibbing Public Utilities, respectively, does not create new capacity.
SUM	1,212	

If existing facilities provide power for the proposed projects, this power could be provided from existing permitted capacity as well as from energy reductions elsewhere on the MAPP grid. Energy reductions can occur in several forms such as facility closures or the implementation of specific energy reduction projects. In both cases, power becomes available to be used for new proposed projects in the MAPP region. One example of energy reductions that free up power for use elsewhere on the MAPP grid is the closure of the LTVSMC facility in 2001. Prior to closure, the LTVSMC facility consumed well over 100 MWs of power. Upon closure, this 100+ MWs of power previously consumed by LTVSMC became available for use elsewhere on the power grid. A second example of reducing power consumption at one facility that becomes available for use elsewhere on the power grid is United Taconite's energy reduction project. Specific information on the amount of the energy reduction associated with the United Taconite project is not publicly available at this time. However, it is likely that some MWs that previously had been used at United Taconite would now be available to other facilities on the MAPP grid. These two types of energy reductions are likely occurring in the MAPP region and will likely continue to occur into the future. Therefore, some portion of the power required by the proposed projects is likely to become available from energy reduction projects similar to those discussed in this paragraph.

"New" power generation may also be used to supply power to the proposed projects. In this context, the power could be generated from increased utilization of existing power generation facilities or from newly constructed facilities. Two of the proposed Iron Range projects are power generation projects; Excelsior Energy's Mesaba Energy Project ("new" power; 1,212 MW), Laurentian Wood-Fired Energy Project (potentially increased utilization of existing boilers; the project does not increase generating capacity) (Table 2). These two proposed projects may provide power to the other proposed Iron Range projects at some time in the future. However, the Mesaba Energy Project and the Laurentian Wood-Fired Energy Project are independent of each other and they are independent of the other proposed projects as well. Emissions from both of these projects are included in this analysis.

The critical question for this analysis is whether potential emissions from power generated for the proposed projects have been accounted for in this analysis. It is believed that the emissions related to power production for the projects are included in this analysis based on the following:

- If the power provided to the proposed projects is from nuclear, hydroelectric or wind sources, then the potential air emissions related to power production are zero and there is no potential for power-related emissions to contribute to potential cumulative impacts.

- If existing power plants in the MAPP grid, which includes Minnesota power plants, provide the power to the proposed projects, these power plants are permitted and subject to a number of current and foreseeable regulatory actions, including the Clean Air Interstate Rule. In this regard, the emissions from these existing facilities have been accounted for in this cumulative impact analysis and these foreseeable actions indicate that power-related emissions will be decreased significantly in the next decade (see Section 5.0).

  - In addition, two electric utilities in Minnesota (Minnesota Power and Xcel Energy) have volunteered to significantly reduce their emissions of SO_2 and NO_x in the very near future, more than off-setting any potential emissions related to power production for the proposed projects (see Section 5.0 for additional discussions).

- If "new" power is provided for the proposed projects, possibly from the Mesaba Energy Project or the Laurentian Energy Project, then these emissions have been accounted for because these two projects are specifically included in this analysis.

- If "new" power is provided for the proposed projects from a power plant located outside of the Iron Range, or possibly from outside of Minnesota, the potential emissions from this power production are likely also included in this analysis by virtue of the fact that a new power plant (i.e., the Mesaba Energy Project) has already been included in the analysis. The estimated emissions from the Mesaba Energy Project provide a ballpark estimate of potential emissions associated with new power production to meet the potential energy demands for the proposed energy consuming projects.

In summary, the emissions from existing or new power plants in Minnesota or from outside of Minnesota related to the production of power for the proposed projects are included in this assessment. As discussed in Section 5, the foreseeable voluntary reductions and regulatory actions are expected to reduce power plant emissions significantly in the upcoming years and therefore, the potential emissions associated with power generation for the proposed projects do not represent additional emissions that need to be considered for the proposed projects.

4.0 Mercury Deposition in Minnesota

The Minnesota Pollution Control Agency recently published a comprehensive review of the mercury contamination problem, mercury emissions, and strategies to solve the problem in a draft mercury Total Maximum Daily Load proposal to EPA (MPCA 2005b, 2006b). This report will incorporate that information as appropriate in discussing the following issues.

Section 4.1 Forms of Mercury and Relevance to Deposition

Section 4.2 Sources Contributing to Mercury Deposition in Minnesota

Section 4.3 Deposition and Trends

Section 4.4 Relationship between Mercury Deposition and Bioaccumulation

4.1 Forms of Mercury and Relevance to Deposition

The rate at which mercury is deposited depends greatly on the speciation of the emitted mercury. The common forms of mercury emissions are elemental (Hg(0)), ionic (Hg(II)) (referred to as oxidized mercury), and particle bound (Hg(p)). For the proposed projects, more than 90% of the potential emissions are in the elemental form. Based on available data, mercury emissions from the proposed projects have the following speciation: elemental, 93-99%; oxidized, 0.5-5%; particle bound, 0.2-2%. For Minnesota Steel, the majority of the mercury emissions are associated with the taconite indurating furnace stacks and are speciated as 93% elemental, 5% oxidized, and 2% as particle bound, based on available stack testing data from similar facilities.

Most of the mercury in the atmosphere is elemental mercury, and being insoluble, does not readily deposit after being emitted (EPA 2006). Ionic mercury, on the other hand, is soluble and can deposit readily at the local and regional level (EPA 2006). Some particle-bound mercury may be deposited locally near an emission source as well. Oxidized mercury and particle-bound mercury are the main focus of concerns related to local deposition of mercury.

Estimates of worldwide emissions of the three major inorganic mercury species remain highly uncertain. Recent estimates for each of the three major species are shown in Table 3, below, for the year 1995 (Pacyna and Pacyna, 2002). According to these estimates, anthropogenic mercury emissions are about 2427 metric tons per year (or approximately 2675 tons per year).

Although emissions contain a relatively large proportion of Hg(II) and Hg(p) (Table 3), nearly all the Hg in the atmosphere occurs as Hg(0) (> 95%) (Iverfeldt and Lindqvist 1986, Munthe 1992, Munthe et al. 1991). Elemental mercury dominates because it is relatively unreactive. In contrast, Hg(II) is very soluble and is the dominant form in precipitation (Fitzgerald and Mason 1996, Porcella 1994), and Hg(p) is subject to both washout by precipitation and dry deposition. Atmospheric concentrations of Hg(p) are about two orders of magnitude lower than those of Hg(II) (so much less than 1%) (Guentzel et al. 1995, Keeler et al. 1994, Keeler et al. 1995, Lamborg et al. 1994, Lamborg et al. 1995).

Table 3. Estimated annual worldwide anthropogenic emissions of mercury species – 1995.

(From Pacyna and Pacyna, 2002)[1]

Mercury Species	Estimated 1995 Annual Emissions (metric tons/yr)	Percent Of Total
Elemental Hg(0)	1447	60%
Oxidized Hg(II)	775	32%
Particle-bound Hg(p)	205	8%
TOTAL	2427	100%

[1] The underlying mercury emission data used for this estimate is available from the United Nations Global Emissions Inventory Activity (GEIA) at www.geiacenter.org. The GEIA is a program of the International Global Atmospheric Chemistry (IGAC) Project of the International Geosphere-Biosphere Program

4.2 Sources Contributing to Mercury Deposition in Minnesota

The generally accepted best source of the information on the historical and current rates of mercury deposition in Minnesota is based on a comparative analysis of lake sediment data (Swain *et al*, 1992). There is also a long-term effort to accurately attribute the sources of mercury deposition in the United States using a variety of air dispersion and deposition models. A brief overview of these modeling efforts and their results is provided below.

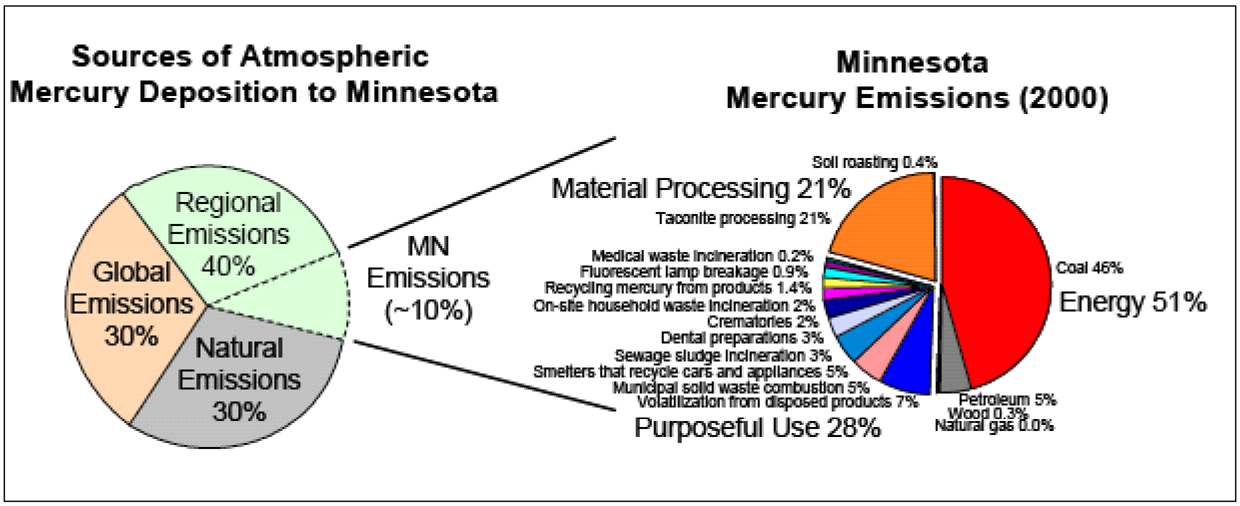
4.2.1 Estimated In-State Source Contributions

An estimate of in-state emission source contributions to mercury deposition was derived using several pieces of information. The MPCA's methodology to derive an estimate of in-state source contribution is summarized below (as described by the MPCA (2005b)):

> *By the early 1990s it was clear that the atmosphere is the main source of mercury to most surface waters. By 1994, an expert panel (Expert Panel 1994) was able to conclude that anthropogenic activities accounted for 50 to 75% of mercury emissions to the atmosphere, and hence 50 to 75% of mercury deposition to aquatic systems.*
>
> *A more recent study in Minnesota (Engstrom and Swain 1997) indicated anthropogenic sources contribute 70% of the mercury deposition to the state. The 70% proportion was calculated by the relative change in mercury accumulation in seven rural lakes, as presented in Swain et al. (1992). According to those calculations, atmospheric mercury deposition in the rural upper Midwest increased from 3.7 g km^{-2} yr^{-1}) in 1850 to 12.5 g km^{-2} yr^{-1} in 1990. If 3.7 was the natural deposition rate, then natural sources contributed 30% of total deposition in 1990, leaving 70% as anthropogenic. By comparing to sediment cores from coastal Alaska, we can attribute recent (1990s) atmospheric sources to Minnesota as follows: 30% natural from outside the state (e.g., volcanoes), 30% global pollution, and 40% regional pollution (Engstrom and Swain 1997). Jackson et al. (2000) estimated that one quarter of the 40% regional pollution, or 10% of total deposition within Minnesota, is because of emissions within the state. The balance of the regional sources was attributed to the rest of the United States. Jackson et al. (2000) apportioned the source region as follows, using qualitative knowledge of source strengths and likely transport distances: "…the United States is assumed to be the regional area that Engstrom and Swain determined contributes 40% of the deposition in Minnesota.*

> *The 40% is then subdivided: 10% being local deposition from Minnesota emissions; 15% from the rest of the Midwest and the remaining 15% from U.S. sources outside of the Midwest."*

As shown in Figure 2 below, based on the calculations from Jackson et al. (2000), only about 10% of the mercury deposited on lakes in northeastern Minnesota is attributable to sources within Minnesota (MPCA 2005a). The majority of mercury deposited in Minnesota (~ 90%) originates outside of the state. In this respect, mercury deposition is similar to acid deposition. But unlike acid deposition, the amount of mercury falling in northern Minnesota is also significantly affected by sources located not only throughout North America but also throughout the world. Of the approximately 90% of mercury deposition that comes from outside Minnesota, about one-third is from other North American sources, one-third from global sources, and one-third from natural background (MPCA 2005a). Based on coring data, the current best estimate of total mercury deposition to northeast Minnesota is 12.5 micrograms per square meter per year ($\mu g/m^2$-year) (MPCA 2005a).



(From MPCA 2005b)

Figure 2. Sources of atmospheric mercury deposition to Minnesota.

4.2.2 Indications of Iron Range Emission Source Contributions

The MPCA has estimated that 90% of mercury deposition in northeast Minnesota originates from out-of-state sources; however, the MPCA has also found that local sources have a measurable effect on mercury deposition in some areas of the state. For example, mercury deposition in the Twin Cities metro area is estimated to be approximately 35% higher than in other parts of Minnesota (Engstrom et al. 1999). No single dominant source of mercury has been identified, but the elevated loading is attributed to the aggregate of numerous sources that include coal combustion, sewage sludge incineration, solid waste incineration, and volatilization of mercury from other releases (Engstrom et al. 1999). Also, the localized decline in mercury deposition in the Twin Cities metro area (by 30%), in the Grand Rapids area (Itasca County) (by 15-20%), and in Voyageurs National Park (by 15-20%) implies a reduction in nearby mercury emissions as opposed to the regional/continental reductions (Engstrom et al. 1999). Engstrom et al. speculated that these localized reductions were due to improved waste incineration, phase-out of mercury fungicides in nearby paper plants, and phase out of coal as home-heating fuel (Engstrom et al. 1999; MPCA 2005b).

The localized deposition reductions seen in lakes in Itasca County and Voyageurs National Park appear to have no relationship to historic taconite emissions. In addition, the majority of lakes in St. Louis, Lake, and Cook Counties (i.e., in the Superior National Forest, in the Superior Highlands) do not appear to be affected by local or regional sources (Engstrom et al. 1999; Berndt 2003). Berndt (2003) assessed the potential contribution of mercury emissions from taconite mining to mercury deposition in St. Louis County, Minnesota, and determined that the annual atmospheric mercury release is approximately two to three times that deposited from precipitation in St. Louis County. Even if only a fraction of the mercury released by taconite processing were deposited locally, it should be recorded by mercury distributions in sediments from nearby lakes. Berndt (2003) reported that an assessment of Minnesota lake sediments by Engstrom et al. (1999), where clusters of lakes in various parts of the state were sampled, found that mercury accumulation rates for lakes closest to the Iron Range (e.g., near Silver Bay) did not obviously reflect mercury contributions associated with taconite processing mercury emissions.

It is noted that Northshore Mining has the lowest mercury emissions of the Minnesota taconite operations and that conclusions drawn from available data in the Silver Bay area may not be representative of other parts of the Iron Range where taconite plants emit more mercury than does Northshore Mining. However, Northshore Mining’s Silver Bay facility has been in operation since the 1950s and even with relatively low emissions of mercury, the approximately 50 years of operation would seem to be sufficiently long to allow for a measurable increase in mercury to occur in lake sediments or fish if mercury were depositing locally, within 10 to 50 kilometers of the source. In addition, the prevalence of primarily elemental mercury emissions from the taconite plants, similar to Northshore Mining, would seem to allow for an extrapolation of the findings from the Silver Bay area to other parts of the Iron Range.

The findings from the Silver Bay area lakes are consistent with the available data that indicates that taconite processing primarily emits elemental mercury. That form of mercury remains in the atmosphere for a longer period of time than does oxidized mercury (Hg(II)), ranging from weeks (Signeour et al. 2004) to a year or more (MPCA 2005b), and is not deposited locally (Berndt 2003). Available information on the proposed projects (referenced in Table 1) indicates that the primary form of emissions will be elemental mercury. Therefore, most of the estimated emissions are not expected to deposit near the respective emission sources and therefore are not expected to measurably increase mercury deposition in the four-county project area (Itasca, St. Louis, Lake, and Cook Counties).

4.2.3 Air Dispersion and Deposition Modeling

There is considerable uncertainty in modeling mercury transport and deposition (MPCA 2005b). In addition, the modeling results provide conflicting results with regard to local, regional, national, and global source contributions to a specific receptor.

Efforts to use computer models to estimate the amount of mercury deposition in the Midwest attributable to specific mercury emission sources are ongoing. No generally accepted modeling technique has emerged, although EPA considers the Community Multiscale Air Quality

(CMAQ) model the best available for evaluating mercury deposition (EPA 2006). Sophisticated multi-scale modeling systems that simulate emissions, transport, chemistry and deposition show significant discrepancies between modeled and monitored deposition rates in the Great Lakes area (Tesche et al. 2004).

Deposition modeling efforts for the Great Lakes region were evaluated and summarized as follows by EPA (2006):

- The flux of mercury from the atmosphere to land or water at any one location is comprised of contributions from natural sources, human-caused activities, regional sources, and local sources (EPA 1997).

- EPA estimates that out of 144 tons of mercury deposited in the U.S., 23 tons or 16 percent resulted from U.S. and Canadian anthropogenic mercury emissions. The remaining 84 percent, according to the model, comes from the global anthropogenic sources, natural sources, and re-emission of previously deposited mercury (U.S. EPA, 2005f).

- U.S. EPA modeling using the CMAQ modeling system shows that the share of mercury deposition to the Great Lakes region resulting from sources outside the U.S. and Canada varies greatly, and is higher in the upper lakes than in the lower lakes (EPA 2006). Modeling results indicate that the non-U.S./Canada share for deposition to most of Lake Superior is estimated to be more than 87.5 percent (EPA 2006).

- Seigneur et al. (2004) estimated that North American anthropogenic sources contributed 30 percent to the total mercury deposition over the continental U.S; other anthropogenic emission sources contribute 37 percent (with Asia contributing the most at 21 percent), while natural emissions account for the remaining 33 percent.

- EPA and Environment Canada collaborated on a global scale modeling effort to determine regional contributions to surface concentrations of elemental mercury. As presented by EPA (2006), results from this modeling effort indicate that for Great Lakes receptors, the largest contributor in all seasons is Asia. Additional modeling results indicates that while Asia is the largest contributor to surface air concentrations of elemental mercury in the Great Lakes, U.S. sources were the largest contributor to deposition in 1995 (EPA 2006). However, EPA (2006) identifies that experiments recently performed using year 2000 inventory data have determined that the contribution of mercury deposition from North American sources has decreased, while the contributions from Asia and other regions (excluding Europe) have increased.

- Seigneur et al. (2003) suggest that current models of the atmospheric fate and transport of mercury may overestimate the local and regional impacts of some anthropogenic emission sources. Therefore, according to Seigneur et al. (2003), the calculated contributions of anthropogenic North American emissions are likely to represent upper bounds of actual contributions.

A number of modeling efforts remain underway to determine the relative importance of different sources of mercury deposition in the Great Lakes Basin. For example, Dr. Mark Cohen of the National Oceanic and Atmospheric Administration (NOAA) Air Resources Laboratory has been attempting to determine the relative contributions of different sources and source regions to the overall atmospheric deposition to any given receptor (e.g., the Great Lakes). Cohen et al. (2004) reported that sources up to 2,000 kilometers (km) from the Great Lakes contributed significant amounts of mercury through atmospheric transport and deposition. Cohen et al. (2004) also reported that while there were significant contributions from incineration and metallurgical sources, coal combustion was generally the largest contributor to atmospheric mercury deposition to the Great Lakes.

It is important to recognize that the reported average deposition values conceal a tremendous variation in deposition from place to place (EPA 2006). For instance, modeling results indicate that the places with the lowest global source contribution (eastern Ohio/western Pennsylvania), and therefore the highest U.S./Canadian source contribution, are also the places with the highest total deposition (EPA 2006). In some places, U.S. and Canadian sources account for most of the mercury deposition (e.g., eastern Ohio/western Pennsylvania) (EPA 2006). Compliance with recently promulgated mercury rules is expected to reduce future U.S. deposition caused by U.S. sources, particularly in areas of highest deposition.

There are also many uncertainties in both model inputs and in the models themselves. Moreover, the model results may understate variation from place to place in local source contribution. For example, the CMAQ modeling produces results averaged across 36 kilometer square grid cells, but there may be a large variation in actual deposition within a grid cell (EPA 2006).

In spite of the discrepancies between modeled deposition and monitored deposition at specific receptors, there is general agreement between modeled global and national mercury contributions and estimates based on lake sediment cores (MPCA 2005b). For example, mercury cycling monitoring in the Devil's Lake, Wisconsin Total Maximum Daily Load (TMDL) pilot project has been conducted to provide verification of an EPA model. Based on this study, Seigneur et al. (2004) estimated that at the site (MDN WI31), North American anthropogenic emissions contribute 34 percent of mercury deposition, other global anthropogenic emissions contribute 40 percent, and natural emissions contribute 26 percent.

Overall, while these models are helpful in linking deposition in an area to emissions from large regions or groups of sources, they are not yet accurate enough to predict the amount of mercury deposition to a site attributable to a specific remote source or group of emission sources. This limitation in models and the uncertainty in estimating source contributions in general have led the EPA (2006) to conclude that sources close to the Great Lakes likely have a bigger impact on mercury deposition to receptors in the Great Lakes than more distant sources that emit equivalent amounts of mercury. In particular, sources that emit ionic mercury (i.e., oxidized mercury; Hg(II)) close to the Great Lakes are likely to have the greatest impact (EPA 2006). It is noted here that the proposed projects have a low potential to emit ionic mercury and therefore are not expected to have an effect on mercury deposition to Lake Superior. Based on available data, potential mercury emissions from the proposed projects is estimated to be primarily elemental mercury (93-99%), while emissions of ionic mercury are estimated to be very small (0.5-5% of potential emissions).

4.3 Deposition and Trends

Mercury is deposited in two basic forms: wet and dry.

- Wet deposition occurs when ionic mercury directly combines with droplets of water as they condense during formation of precipitation, and the aerosols can then be "washed out" of the atmosphere during a rain or snow event.
- Some mercury does not fall with precipitation, but instead comes directly into contact with and remains on surfaces such as tree leaves. Dry deposition is continuous and is not dependent on a precipitation event.
- "Total" mercury deposition is the sum of "wet + dry" deposition.

Further, estimates of mercury deposition and trends can be derived from two different data sources:

- Collection of sediment cores from selected lakes, partitioning the cores into various ages of sediment, determining the mercury concentration in each strata, and then deriving estimates of mercury deposition (wet + dry) for each strata (i.e., current and historical estimates of mercury deposition); and
- Deposition monitoring sites where precipitation samples are collected, the mercury concentration in the sample is determined, and the individual sample data for a calendar year are used to derive an estimate of annual wet mercury deposition. The annual wet deposition estimates for a number of years are then used in assessing trends in wet deposition.

Information from both types of data sources is presented below.

4.3.1 Current Estimates of Total, Wet, and Dry Mercury Deposition

Total Deposition

Based on sediment coring data, the best estimate of total (wet + dry) mercury deposition to northern Minnesota is 12.5 µg/m^2-year (MPCA 2005b, 2006b).

Wet Deposition

Mercury in precipitation (rain and snowfall) has been measured by the Mercury Deposition Network (MDN) at a number of sites throughout the U.S. since 1996. The MDN is part of the National Atmospheric Deposition Program/National Trends Network (NADP/NTN) which is operated in cooperation with many different groups, including the State Agricultural Experiment Stations, U.S. Geological Survey, U.S. Department of Agriculture, and numerous other governmental and private entities.

The MDN began a pilot network of 13 sites in 1995. Beginning in 1996, MDN became an official network in NADP with 26 sites in operation. Currently, over 85 sites are included in the network. The MDN uses standardized methods for collection and analyses. Weekly precipitation samples are collected in a modified Aerochem Metrics model 301 collector. The "wet-side" sampling glassware is removed from the collector every Tuesday and mailed to Frontier Geosciences in Seattle, WA for analysis of mercury by cold vapor atomic fluorescence. The MDN provides data for total mercury, but also includes methylmercury if desired by a site sponsor (NADP, http://nadp.sws.uiuc.edu/mdn).

Four MDN sites in Minnesota have been in existence since the network began in 1996: one is located in the agricultural area of southern Minnesota (Lamberton) and three are located in northern Minnesota (Camp Ripley, Morrison County, near Little Falls; Ely – Fernberg Road, Lake County; and Marcell Experimental Forest, Itasca County – slightly north and east of Grand Rapids).

Since 1996, MDN monitored wet mercury deposition in the northern Minnesota sites has ranged from approximately 6 to 12 µg/m^2-year at Camp Ripley, 7 to 11 µg/m^2-year at Marcell, and from 4 to 10 µg/m^2-year at Ely. For all sites, the average wet deposition of mercury in northern Minnesota is approximately 8.4 µg/m^2-year for the 1996-2004 time period.

Dry Deposition

Mercury deposited in dry particles is difficult to measure, and is therefore mostly assessed indirectly through historical sediment core studies or other means. Depending on the nature of the atmosphere, the collecting surface, and climatic conditions, dryfall can account for as much or more of the mercury delivered to an ecosystem as wet deposition.

As previously reported, sediment core studies indicate that total mercury deposition to northeast Minnesota is about 12.5 µg/m^2-year (MPCA 2005b). MDN monitored wet mercury deposition in northeast Minnesota has averaged approximately 8.4 µg/m^2-year since 1996. Subtracting the wet deposition from total deposition provides an estimate of dry deposition. For northern Minnesota, this means that approximately 4.1 µg/m^2-year – or one third of the mercury deposition – is due to dry deposition.

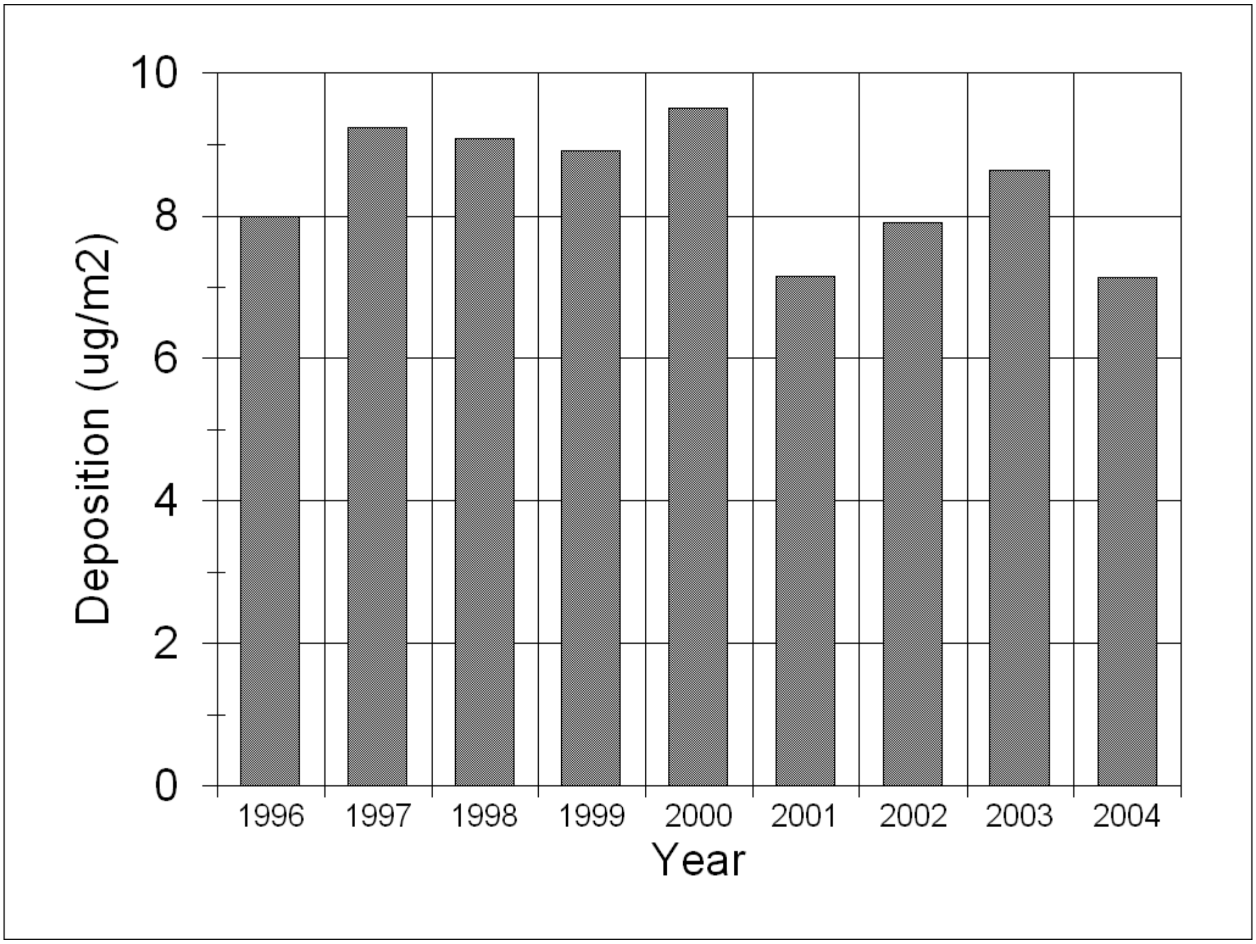
4.3.2 State Deposition Trends

Mercury deposition data for Minnesota sites is presented in Figure 3. A statistical analysis (multiple regressions) of the MDN data (i.e., wet deposition data) for the years 1996 through 2004 for the three northern Minnesota monitoring sites (Camp Ripley, Fernberg Road, and Marcell –from http://nadp.sws.uiuc.edu/, accessed 1 November 2005) showed that mercury deposition significantly differed with precipitation, latitude, and longitude as continuous variables, but did not differ with "year" as a categorical variable (Table 4). In other words, deposition to northern Minnesota was independent of year over this period. Similarly, when the influences of precipitation, latitude and longitude were statistically isolated, the time-trend of the annual rates of deposition was not statistically significant (Figure 3). However, if the data are arbitrarily divided into two periods, 1996 to 2000 and 2001 to 2004, deposition during the latter period is lower than that during the earlier period (Figure 3), but the basis for such a division is questionable at this time without further information on local/regional changes in emissions for the two time periods. Data for the individual monitoring sites are provided in Appendix A.

The statistical analysis does show that a geographic deposition gradient exists across Minnesota. As stated earlier, mercury wet deposition is significantly related to precipitation, latitude and longitude (Table 4). Mercury deposition increases from west to east and from north to south across northern Minnesota. These findings are similar to the trend analysis results for sulfate and nitrate deposition (see EIS Cumulative Impacts Analysis Report: Ecosystem Acidification). The following results are highlighted from this statistical analysis:

- Annual mercury wet deposition increases about 0.2 :g m^{-2} with each centimeter (cm) increase in precipitation.
- More importantly, annual deposition also increases about 1.2 :g m^{-2} with each degree of longitude east and 2.0 :g m^{-2} with each degree of latitude south.

These gradients in mercury deposition, similar to those for both sulfate and nitrate deposition (see EIS Cumulative Impacts Analysis Report: Ecosystem Acidification), are very likely the effect of distance to major sources of mercury emissions to the east, such as the Ohio Valley, and the south, such as Missouri and Texas.



Data from the following MDN Stations are included in this analysis: Marcell Experimental Forest, Itasca County; Fernberg, Lake County; and Camp Ripley, Morrison County.

Figure 3. Annual average mercury deposition to northern Minnesota over the period 1996 to 2004, statistically isolating the influence of precipitation, latitude and longitude (the estimate is at the midpoint of those variables for the recording stations).

Table 4. Summary statistics showing the change in mercury wet deposition to northern Minnesota with longitude, latitude, and precipitation (1996 – 2004 time period).

Area	Variable	# of Data Points (n)	Period (years)	Longitude: To east	Prob.	Latitude: To south	Prob.	Precipitation	Prob.
Northern MN	mercury	27	1996 - 2004	1.20	0.061	1.96	0.048	0.18	0.002

Units: Change in units of µg m^{-2} $degree^{-1}$ yr^{-1} for longitude and latitude; µg m^{-2} cm^{-1} yr^{-1} for precipitation.

- Area
    - Northern Minnesota includes the following monitoring sites: Marcell Experimental Forest, Itasca County; Fernberg Road (Ely), St. Louis County; Camp Ripley, Morrison County.
- Data accessed from http://nadp.sws.uiuc.edu/ on 11 November 2005.

Abbreviations:

cm = centimeter m = meter µg = microgram yr = year

n = number of data points prob. = probability

The finding that mercury wet deposition, based on MDN data from Minnesota monitoring sites, has not significantly decreased in the period from 1996 to 2004 is in contrast to the deposition trends identified in sediment core studies. Much of the mercury delivered to a lake in the form of precipitation or runoff is deposited and stored permanently in sediments. Thus, coring and age-dating the sediments from a lake make it possible to evaluate historical changes in mercury deposition. Findings from sediment core studies include:

- Mercury deposition in the Great Lakes Region has declined since peaking in the 1960's and 1970's (Marvin et al 2004; EPA 2006).
- As reported by Berndt (2003), other coring studies indicate that mercury deposition in some areas of Minnesota peaked in the 1960s and 1970's and has declined since (Swain et al. 1992; Engstrom and Swain 1997; Engstrom et al. 1999).
    - The greatest change in mercury fluxes to lakes in Minnesota occurs in the east central part of the state, near Minneapolis and St. Paul (~ 30% reduction).
    - A group of lakes near Grand Rapids and another group of lakes in Voyageurs National Park show declines in mercury deposition since the mid-1970s (15–20%), leading the authors to conclude that the localized decline in deposition is probably due to local source emission reductions (Engstrom et al. 1999).
    - Another group of lakes near Silver Bay, relatively close to Northshore Mining's taconite processing plant, show sediment mercury concentrations similar to concentrations found in remote lakes in the Superior National Forest (west and north of Silver Bay) that are more distant from emission sources. The lakes in the Superior National Forest and in the Silver Bay

area have not shown a decline in mercury deposition (Engstrom et al. 1999).

- The Wisconsin Department of Natural Resources and the Electric Power Research Institute funded an effort to assess temporal trends in mercury deposition at a precipitation-dominated lake in northern Wisconsin. Little Rock Lake is a seepage lake situated in a sparsely-populated area far removed from industrial activities. Data from this study indicated that between 1988 and 1999, concentrations of aqueous mercury and aqueous methylmercury in wet deposition declined by approximately 40 percent and 50 percent, respectively, in the surface waters of Little Rock Lake (Watras et al. 2000).

- Mercury concentrations in surface waters in Little Rock Lake also appear to be on a decreasing trend (Watras et al., 2000), although other lakes in Wisconsin are not showing the same trend (EPA 2006).

Due to the nature of sediment core studies, whereby the cores are sectioned into unique time periods (i.e., decades) for analysis, a longer period of deposition can be assessed. As with most trend analyses, identification of trends is clearer over longer versus shorter time periods. The wet deposition data from 1996–2004 may not represent a sufficiently long time period to statistically identify a trend in mercury deposition (Berndt 2003; MPCA 2005b).

4.3.3 National Deposition Trends

EPA currently estimates that about 144 tons of mercury is deposited on the United States every year (EPA 2005f). Approximately 16% of this deposition is from U.S. and Canadian anthropogenic emission sources (EPA 2005f). Average mercury wet deposition in the U.S. from MDN sites is shown below in Figure 4 for 2003. Isopleth maps such as Figure 4 indicate a general declining gradient in deposition from south to north and east to west, ranging from over 20 $\mu g/m^2$-year in Florida to under 5 $\mu g/m^2$-year in the western United States.

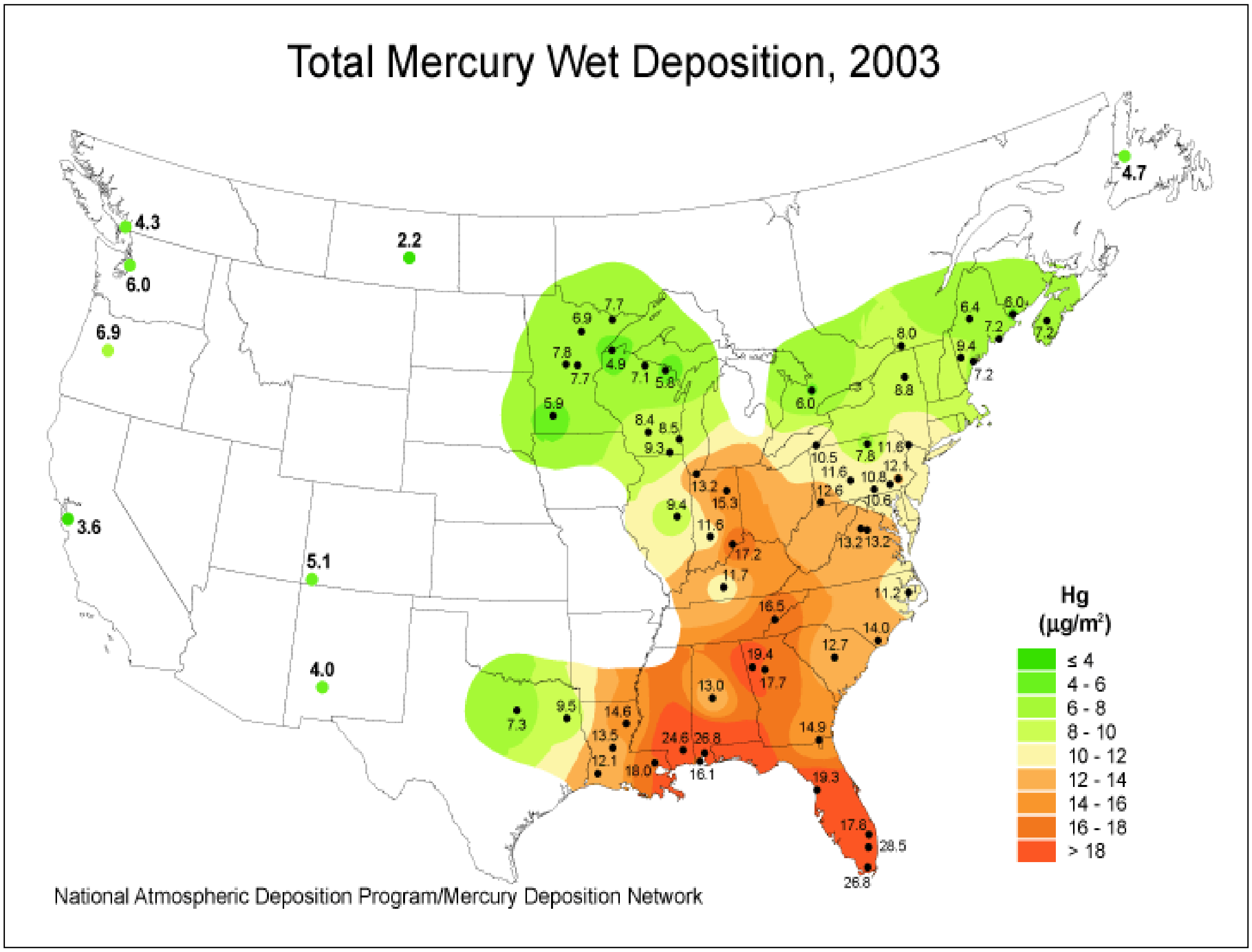


Figure 4. Wet mercury deposition as reported by the NADP Mercury Deposition Network in 2003.

Other than some specific sites where emissions from nearby waste incinerators were controlled, deposition rates at most sites across the U.S. show no discernable decrease nationally between 1995 and 2003 even though U.S. emissions decreased more than 40 percent between 1990 and 2000 (EPA 2006). One possible explanation for the lack of correspondence between the emission and deposition trends is that reductions in deposition caused by U.S. emissions have been offset by increases in deposition caused by global emissions (EPA 2006). Other explanations for the lack of measurable declines in wet deposition, despite apparent reductions in emissions, include a measurement timeframe that is too short to establish trends or the possibility that emission reductions have primarily affected unmeasured dry deposition, not wet deposition (EPA 2006).

4.4 Relationship between Mercury Deposition and Bioaccumulation

The amount of mercury that bioaccumulates in fish in a specific lake or stream is determined by a broad array of complex physical, chemical and biological processes. The following discussion highlights some important points that will be used in deriving conclusions about the potential cumulative impacts from the proposed projects on mercury deposition and bioaccumulation in fish in northeast Minnesota lakes.

4.4.1 Deposition and the Relationship to Methylmercury Formation

Mercury can be deposited on the terrestrial watershed and to the water body itself, typically as Hg(II) complexed with other compounds to form non-volatile species that are water soluble and adsorb readily to particles. Grigal (2002) reported that in forested watersheds vegetative matter is an important trap and transport mechanism for mercury in the form of litterfall (mercury captured by and transported with falling vegetation) and throughfall (precipitation moving downward through the forest canopy and scavenging mercury). However, Grigal (2002) also reported that only about 5% - 25% of the mercury deposited on forested lands typically reaches lakes and streams. The majority of mercury falling on a watershed is either volatilized back into the atmosphere or sequestered in soils. Depending upon the relative surface area of the lakes compared to that of the surrounding watersheds, this watershed-derived mercury can account for 5% - 85% of the mercury delivered to a lake (Berndt 2003).

Mercury typically forms complexes with organic molecules such as fulvic and humic acids, and there is a strong correlation between mercury concentration and dissolved and/or total organic carbon (DOC; TOC, respectively – Sorensen et al. 1990). Mercury also has a strong affinity for reduced-sulfur functional groups such as thiol (Skyllberg et al. 2000, Xia et al. 1999). Transport rates of mercury deposited on a lake surface downward to the lake sediments can range from relatively quickly to well over several months (Krabbenhoft and Goodrich-Mahoney 2003). Once deposited in the sediment, the mercury, as Hg(II), can be transformed into methylmercury by sulfate-reducing bacteria (SRB) (Gilmour et al. 1992; Benoit et al. 1999). The methylmercury generated in the sediments can then diffuse upward into the water column. Methylmercury represents only a small fraction of the dissolved mercury in lakes but due to its high affinity for living tissue it readily bioaccumulates in the food chain and accounts for nearly all of the mercury present in fish tissue.

The rate of sulfate deposition is considered a potentially important factor in the rate of methylmercury formation in lakes, which in turn drives the rate of mercury bioaccumulation in fish (Gilmour et al. 1991; Gilmour et al. 1992; MPCA 2005b). As discussed in the MPCA's draft Mercury TMDL, wetlands are an important land cover in Minnesota and they are also important sites of mercury methylation (MPCA 2005b). Sulfate-reducing bacteria thrive in wetlands. As discussed by the MPCA (2005b), methylmercury associated with dissolved organic carbon released from wetlands is conveyed to surface waters (Driscoll et al. 1995). Consequently, wetland density is correlated with mercury concentrations in water and fish (e.g. Greenfield et al. 2001, Grigal 2002). Studies have also found that addition of sulfate to a wetland can stimulate SRB activity, leading to increased mercury methylation (MPCA 2005b).

Research conducted by the Mercury Experiment To Assess Atmospheric Loading in Canada and the United States (METAALICUS) has identified several important pathways that link mercury deposition and fish uptake. "New mercury" was applied directly to the surface of the study lake and its surrounding forested watershed. Less than 1% of the "new mercury" was transported from the watershed to the lake, with approximately 90% of the mercury in the application area remaining bound to vegetation and soils (Hintelman et al. 2002). Follow-up dosing of isotopic mercury confirmed that mercury deposited on the forested watershed did not contribute significantly to the lake-mercury reservoirs (water column, sediments, or methylmercury), at least on a short-term basis (Krabbenhoft and Goodrich-Mahoney 2003). However, the "new" mercury deposited on the lake surface appeared in the sediments within 6 days of the dosing, and deposition to the sediments continued over the course of several months, demonstrating a relatively rapid transport of mercury. While additional work continues on the project, these data indicate that "new" mercury may be the dominant source of mercury for the formation of methylmercury in an aquatic system. (See http://www.umanitoba.ca/institutes/fisheries/METAALICUS1.html for additional information on the METAALICUS project).

In addition to the above discussions, other conclusions from the literature indicate the following:

- Only a very small amount of mercury deposited in a region is incorporated in the tissues of fish.

- Wetlands are an important sink (i.e., storage) for mercury, but they can also be an important source of methylmercury production and input to a lake or stream.

- "New" mercury deposited directly on the surface of a lake appears to have a significant link to the methylmercury produced during the summer months when sulfate-reducing bacteria are most active.

- It seems reasonable to conclude that a reduction in mercury deposited on the lake surface should result in a reduction in the production of methylmercury in that same year.

- The potential future trend of sulfate deposition in Minnesota has been assessed in a companion cumulative impact report on the proposed Iron Range projects entitled "Ecosystem Acidification." The "Ecosystem Acidification" cumulative impact report has also been submitted to state agencies in support of the Minnesota Steel EIS. The findings from the Ecosystem Acidification report indicate that up to 90% of the sulfate deposition in Minnesota is due to out-of-state emissions of SO_2 and that sulfate deposition has been on a downward trend since the mid-1980s. The proposed projects are estimated to have potential SO_2 emissions of approximately 2,340 tons per year, representing a potential increase in statewide emissions of 1.5% before emission reductions are taken into account. Estimated statewide SO_2 emissions of 134,642 tons per year in 2000 are projected to decrease to 98,497 tons per year by 2015; a reduction of 36,145 tons per year. Given the current downward trend of sulfate deposition in Minnesota and the relatively small contribution from Minnesota sources to sulfate deposition in Minnesota, the proposed projects are not expected to have a measurable effect on sulfate deposition in the state. The trend of decreasing sulfate deposition in Minnesota is expected to continue into the future due to foreseeable regulatory actions that are expected to further reduce SO_2 emissions on a national basis as well as from specific Minnesota sources. Additional details and discussion on SO2 emissions and sulfate deposition in Minnesota can be found in the "Ecosystem Acidification" cumulative impact report.

- Due to the importance of sulfate-reducing bacteria in mercury methylation, it may be possible to obtain additional reductions in methylmercury formation by continued decreases in sulfate deposition. However, mercury methylation depends on the presence of multiple interacting reactants, including mercury, sulfate, and reduced carbon (organic matter), and a suitable environment, including anoxic conditions and a suitable temperature. Each of those variables can limit methylation, and probably do in specific instances. Additional research is needed in order to derive a quantitative estimate of potential reductions in methylmercury formation through decreases in sulfate deposition.

4.4.2 Deposition and Relationship to Concentrations of Mercury in Fish

Berndt (2003) provides a summary discussion of fish tissue concentrations for northeast Minnesota based on findings from Jeremiason (2002), with an emphasis on lakes located in the immediate area of the Mesabi Iron Range. Major items summarized by Berndt (2003) include the following:

- For an organism such as a fish, mercury may accumulate through its lifetime and mercury concentration reflects a time-integrated snapshot of mercury uptake processes.
- The concentration of mercury in fish varies among lakes and species, but within a single lake, mercury in fish tends to increase with the size and age of the fish.
- To compare mercury concentrations in fish from different lakes it is important to compare similar-sized fish of the same species.
- Empirical relationships have been developed to estimate mercury concentrations for a 55 centimeter (cm) northern pike (NP55) using mercury concentrations measured in northern pike of other sizes or fish of other species.
- Fish consumption advisories take effect at a level of 0.038 micrograms per gram (µg/g; same as parts per million, ppm; which is the same as mg/kg).
- NP55 fish mercury concentrations in northern Minnesota range up to 2 µg/g. Some of the highest mercury fish concentrations in Minnesota have been found in small lakes within Voyageurs National Park, but the highest concentrations of mercury in fish have not been observed in lakes near the Iron Range.
- The highest NP55 concentrations near the Iron Range are in Wynne (0.60, 1.11 µg/g in 1996), Esquagama (0.64 and 0.66 µg/g in 1999), Colby (0.82 µg/g in 2000), and Embarrass lakes (0.64 and 0.94 µg/g in 1999) located on or just south of the eastern side of the Mesabi Iron Range (as reported by Jeremiason via personal communication to Berndt, 2003). These concentrations are within the range of fish mercury concentrations found in other northeast Minnesota lakes more distant from the Iron Range.

Berndt (2003) also provides a summary regarding trends in fish tissue concentrations, based on the data from Jeremiason (2002):

- 114 lakes had fish mercury data available for 1995 and later and had also been sampled at least 5 years previously.
- Fish-mercury concentrations declined in 63 of the 114 lakes.

- Fish-mercury increased in 22 of the 114 lakes.
- Fish-mercury stayed approximately the same in 29 of the 114 lakes.

As discussed by Berndt (2003), these data suggest that fish mercury levels may be declining. The MPCA's evaluation of mercury fish concentrations identified a decline of approximately 1% per year over the last 15 years ((MPCA 2005b). MPCA's assessment of the mercury concentrations in fish has led them to conclude that mercury in fish from Minnesota lakes decreased 10 percent between 1990 and 2000 and appears to be continuing to decline (MPCA 2005a). However, Berndt (2003) further reports that when the data for the 114 lakes sampled by Jeremiason were grouped by year, regardless of which lakes were sampled, a regression of fish mercury levels versus time showed no significant change. These conflicting data indicate that additional studies are needed in order to assess whether state, regional, national, and international efforts to reduce mercury emissions have a direct impact on mercury concentrations in Minnesota fish.

In light of the uncertainty in the relationship between mercury deposition and fish mercury concentrations, the MPCA currently relies on empirical data that indicates over the long term, the rate of accumulation of mercury in the fish in a given water body is roughly proportional to the rate of mercury deposition to the watershed (MPCA 2005b). For the purposes of this report, it is assumed that the rate of bioaccumulation of mercury in fish in northeastern Minnesota is roughly proportional to the rate of annual mercury deposition in the area.

5.0 Local, State, and National Emissions and Trends

This section is divided into the following four subsections:

Section 5.1 National and State Emission Sources

Section 5.2 Four-County Arrowhead Area Emission Trends

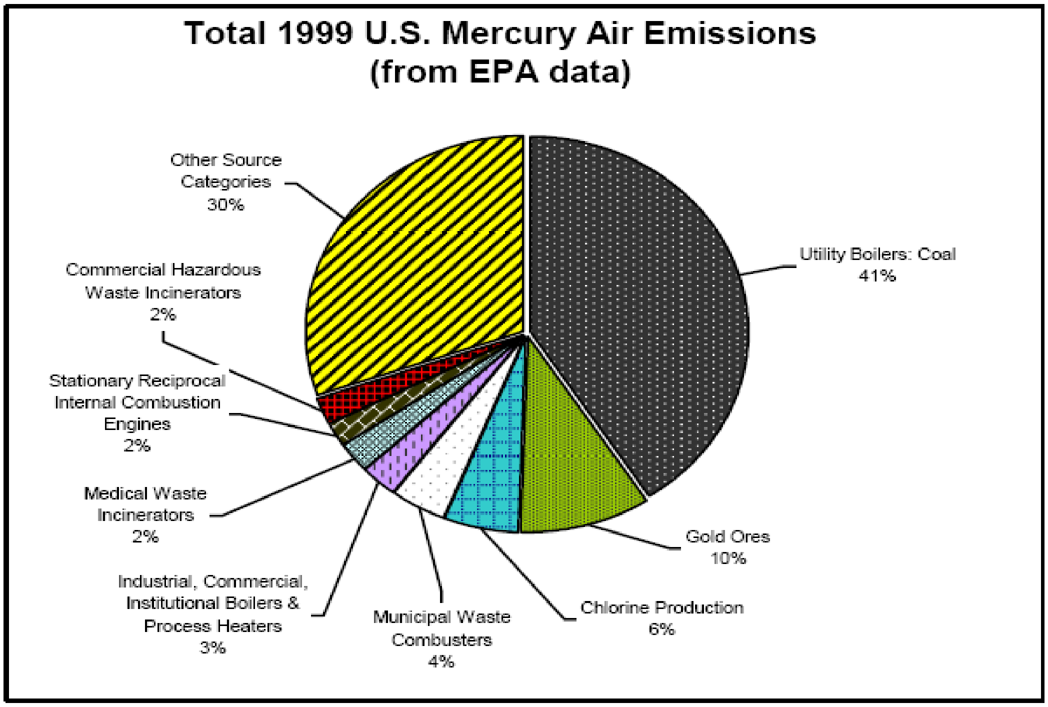
Section 5.3 Statewide Emission Trends

Section 5.4 National Emission Trends

Section 5.5 Regulatory Program Projections

5.1 National and State Emission Sources

Current estimated percentages of mercury emissions by source category are shown for the United States (Figure 5) and for the state of Minnesota (Figure 6). In these figures, the category "Other Source Categories" for national emissions and "Purposeful Use" in the state emissions is somewhat similar; both refer largely to emissions incidental to use of mercury in products such as electronics. The major difference between the two classifications is that EPA excludes various kinds of incinerators from the "Other Source Categories", while Minnesota includes them in "Purposeful Use". Without the incinerator emissions, "Purposeful Use" in Minnesota is only about 12% of total emissions compared to the national estimate of 30%. There are other differences between national and state emissions: Coal-fired power plants contribute a substantially higher proportion of emissions in Minnesota (53%) than nationally (40%). Emissions from taconite facilities (which comprise most of the "Materials Processing" category) account for 25% of total emissions in Minnesota, but are not a significant source of mercury emissions on a national level. Conversely, emissions from gold mining are important on a national basis (10%) but not in Minnesota**.**



(From: EPA 1999 National Emission Inventory data)

Figure 5. Average relative contribution of major sources to national emissions of mercury in 1999.

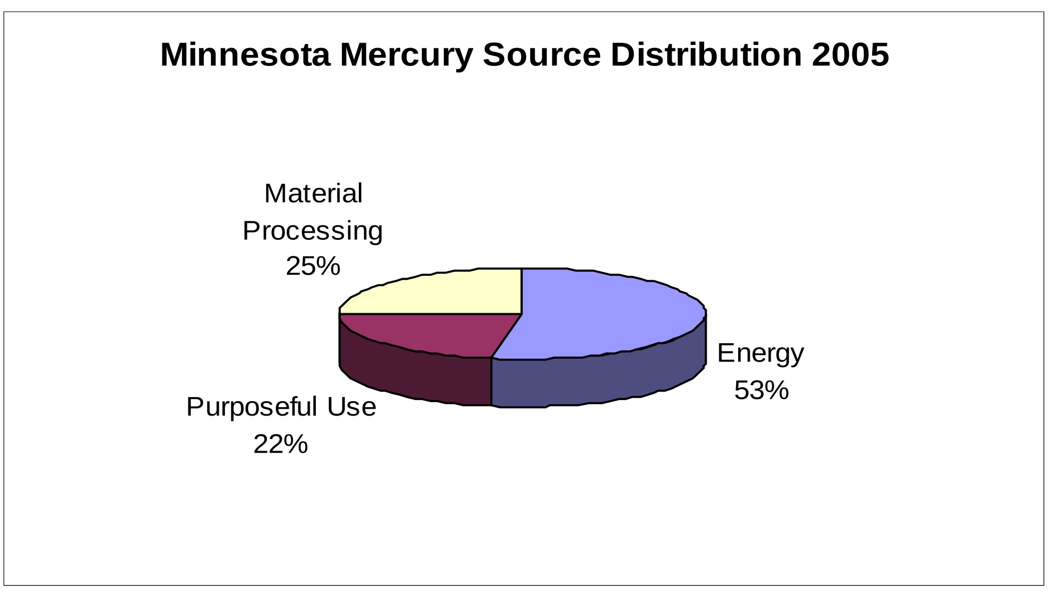


Figure 6. Average relative contribution of major sources to Minnesota mercury emissions.

5.2 Local (Four County Area of Interest) Emissions and Trends

Table 5 below compares the cumulative potential mercury emissions from the proposed projects to the existing facility emissions in the four-county area of interest (Itasca, St. Louis, Lake, and Cook Counties). Proposed project emissions are added to estimated existing facility emissions in year 2015 based on the assumption that the proposed projects are likely to be in full operation by that time (Figure 7).

These data show that mercury emissions in the four-county Arrowhead region are currently about 1000 pounds per year (MPCA 2005a, Appendix A). Based on available data, it is estimated that at their maximum the proposed projects would emit about 221 pounds of primarily elemental mercury per year (93-99% elemental; 0.5-5% oxidized; 0.2-2% particle bound; speciation presented in Table 1 and accompanying footnotes).

Table 5. Estimated maximum mercury emissions for the proposed projects and annual mercury emissions for existing major emission sources in the four county "project area" in northeast Minnesota

(Local zone of impact; four counties of interest: Itasca, St. Louis, Lake, and Cook).

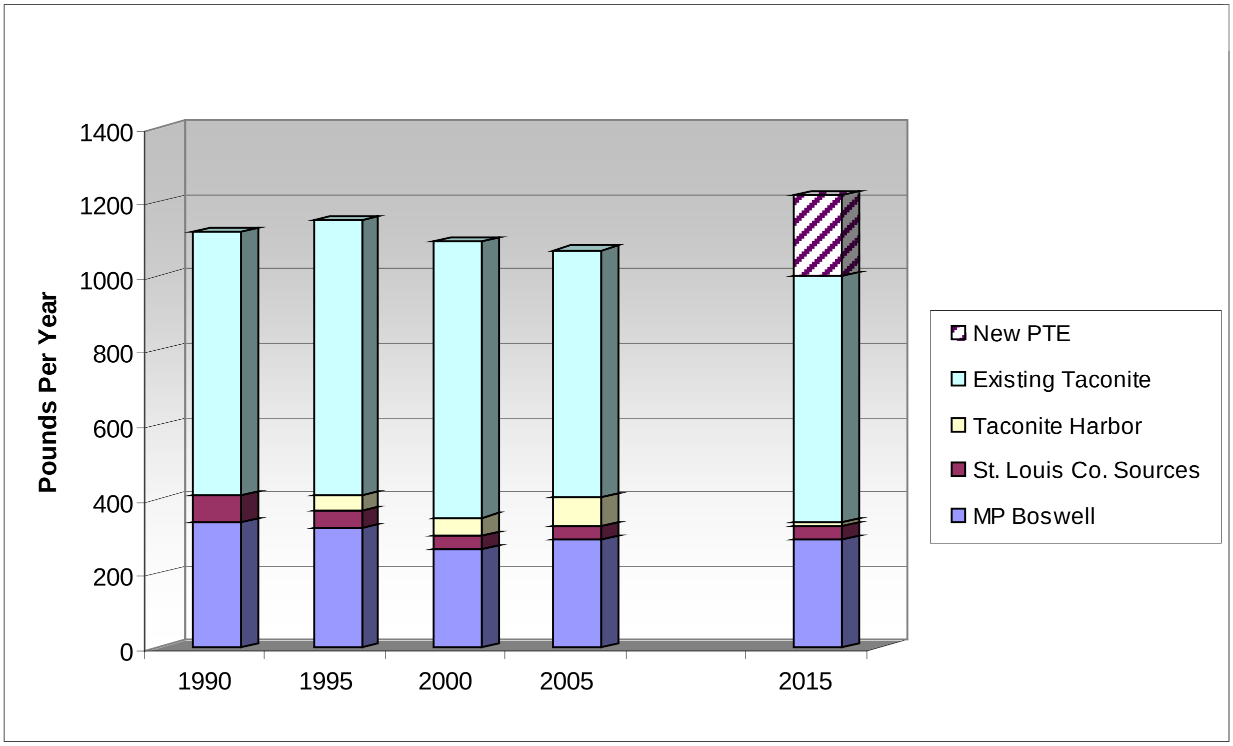
	Annual Mercury Emissions (pounds per year)				
Year	**MN Power (Boswell)**	**Utilities in St. Louis County [3]**	**Taconite Harbor [4]**	**Existing Taconite Facilities**	**Proposed Projects Summed Emissions (potential to emit) (from Table 1)**
1990 [1]	337	74		711	
1995[1]	323	46	40	742	
2000[1]	263	38	49	745	
2005[1]	288	40	76	666	
2015[2]	288	38.3	8	666	221

[1] Historical electric generation emission data based on most recent (20030 utility data reported in Appendix A, MPCA Air Quality Legislative Report, February, 2005, data available at http://www.pca.state.mn.us/publications/reports/lraq-1sy05-appa.pdf. Emissions from existing taconite facilities are from MPCA Mercury Reduction Progress Report to the Legislature, Appendix A.

[2] 2015 emission estimates for existing electric generation facilities assumes 2005 emission rate unless otherwise noted. Actual emissions from power plants likely to be lower by 2010-2015 due to 2006 Minnesota Mercury Reduction Act and recent proposed voluntary emission reductions by Minnesota Power for Boswell Unit 3. These reductions were not included since details not yet available.

[3] "St. Louis County Utilities" includes Minnesota Power's Hibbard and Laskin coal-fired power plants, Hibbing and Virginia Public Utilities, and Western Lake Superior Sanitary District; reduction between 1990 and 1995 due to WLSSD mercury minimization efforts and eventual shut down of sludge incinerator in 2001.

[4] No data for LTV-owned Taconite Harbor plant reported for 1990. 2015 emission estimate assumes AREA mercury control at Taconite Harbor is implemented.



Notes:

MP: Minnesota Power, Boswell Plant (Itasca County), No future emission reductions assumed for voluntary or Minnesota Mercury Reduction Act of 2006 requirements.

St. Louis: St. Louis County; includes Hibbing Public Utilities, Virginia Public Utilities,

MP Syl Laskin Plant (near Hoyt Lakes), and MP Hibbard Plant (Duluth); Western Lake Superior Sanitary District (Duluth)

Taconite Harbor: owned by MP, is in Cook County; 2015 emission reduction to 8 lbs/yr due to proposed AREA Project; Otherwise, this analysis excludes known or reasonably foreseeable emission reductions due to voluntary or expected regulatory actions.

Figure 7. Potential cumulative mercury emissions from the proposed projects of 221 pounds per year compared to historical emissions (1996 – 2003) and projected future emissions (2015) for existing taconite plants and power plants in the four county area (assuming AREA reductions at Taconite Harbor, but none at Clay Boswell).

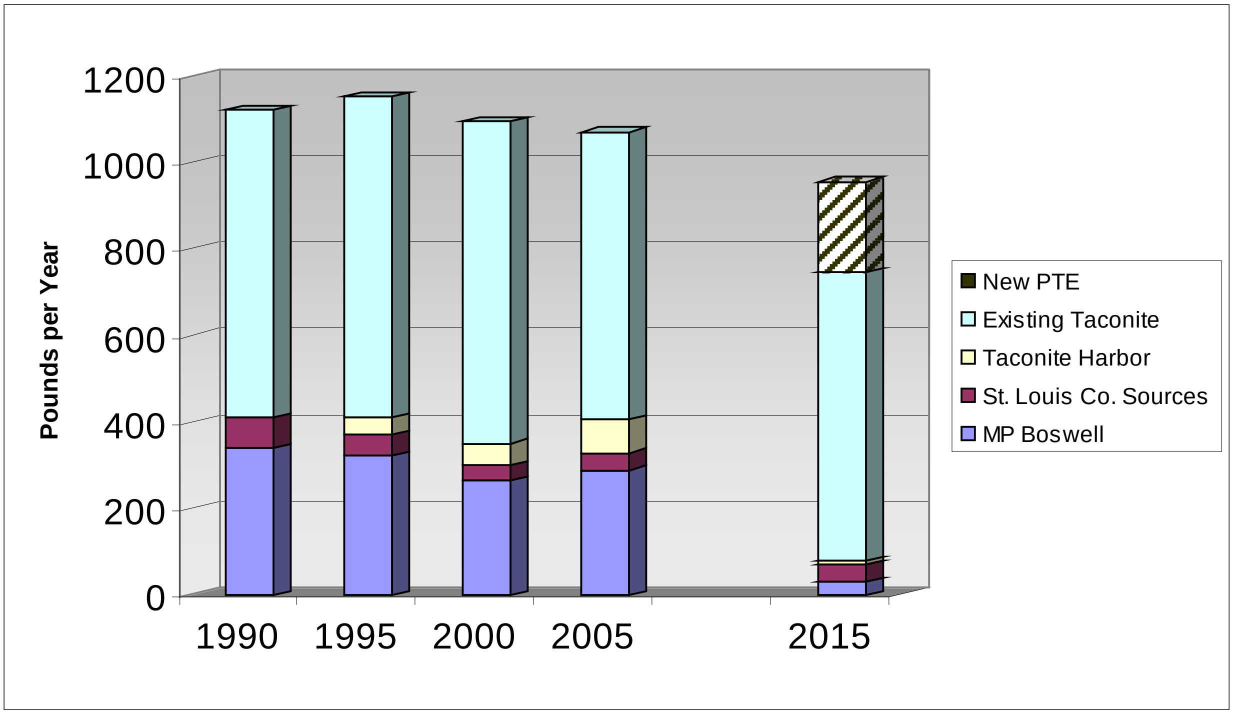
To help provide a historical perspective, the emissions from the proposed projects were compared to recent and expected emission reductions at nearby facilities. First, the shutdown of the LTVSMC taconite facility in 2001 reduced mercury emissions by about 83 pounds per year. Second, Minnesota Power has applied to the Minnesota PUC for formal approval of its Arrowhead Regional Emission Abatement Project (AREA), which is expected to reduce mercury emissions by about 64 pounds per year (MPCA 2006a). Third, the Butler Taconite shutdown in 1985 reduced mercury emissions by approximately 55 pounds per year (average from 1968-1984; Butler Taconite emissions are estimated to have peaked at 59 pounds per year in 1971) (Berndt, 2003, Appendix 3). The Butler Taconite reduction, however, is not included in this specific analysis because MPCA emission inventories for other sources are only available starting in 1990. Total reductions due to the 2001 LTVSMC shut down and the future AREA Project total 147 pounds per year. The majority of this potential emission increases (221 pounds per year) will be offset by this 147 pound per year reduction. Total mercury emissions in the four-county area in 2015 are projected to be at most about 74 pounds per year (i.e., a net increase) more than in the year 2000.

Perhaps more importantly, additional mercury reductions can be expected due to the Minnesota Mercury Reduction Act of 2006. Predicted four county area mercury emissions are again shown below in Figure 8, but the emissions in Figure 8 are assuming a 90% reduction (about 250 pound reduction) in emissions from Minnesota Power's Clay Boswell Plant by 2015 as planned under the Mercury Reduction Act of 2006. When comparing Figure 8 to Figure 7 for estimated emissions in 2015 that includes the proposed projects, Figure 8 shows a marked decline in future mercury emissions.

5.3 Statewide Emissions and Trends

Historical Emissions

The most recent mercury emission inventory update for Minnesota is contained in the 2005 Mercury Reduction Progress Report to the Minnesota Legislature (Appendix A) (MPCA 2005a) and presented in Figure 9 below. These data show a large decline in emissions between 1990 and 1995 due to the national phase-out of mercury in fungicides and paint, as well as reductions due to emission controls on waste combustors and incinerators (all in the "Product Use and Disposal" category). Between 1995 and 2005, there was a much smaller decline in emissions, again primarily related to reductions in the same category. The 2005 Mercury Reduction Progress Report to the Legislature contains details on progress and emission reduction efforts to date (MPCA 2005a).



Notes:

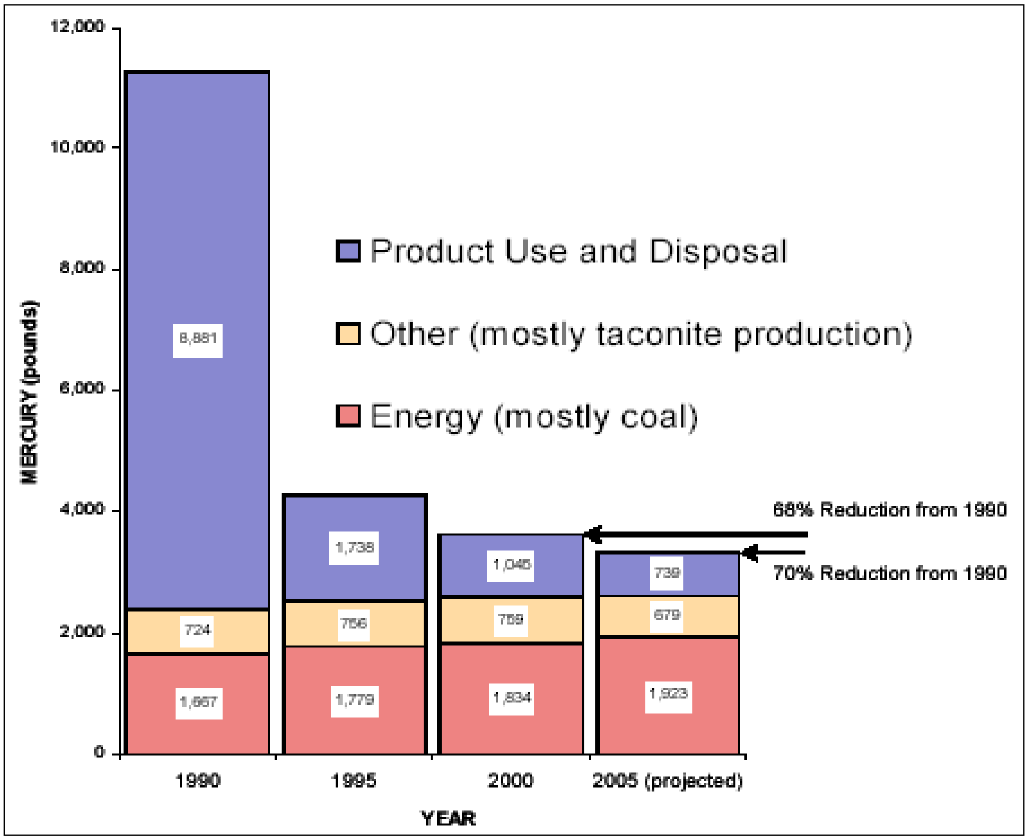
MP: Minnesota Power, Boswell Plant (Itasca County), 90% mercury emission reduction assumed for Minnesota Power's Clay Boswell Plant by 2015.

St. Louis: St. Louis County; includes Hibbing Public Utilities, Virginia Public Utilities,

MP Syl Laskin Plant (near Hoyt Lakes), and MP Hibbard Plant (Duluth); Western Lake Superior Sanitary District (Duluth)

Taconite Harbor: owned by MP, is in Cook County; emissions at 8 lbs/yr due to proposed AREA Project.

Figure 8. Potential cumulative mercury emissions from the proposed projects of 221 pounds per year compared to historical emissions (1996 – 2003) and projected future emissions (2015) for existing taconite plants and power plants in the four county area (assuming AREA reductions at Taconite Harbor and 90% reduction at Clay Boswell .



(From: MPCA 2005a)

Note: The statewide mercury emission target in the MPCA draft TMDL proposal is 789 lbs/yr.

Figure 9. Mercury emission trends in Minnesota: 1990-2005.

Projected Future Emissions

Projected state mercury emissions for 2009 and 2015 are shown below in Figure 10. The emissions data presented in Figure 10 are based on the following four major assumptions:

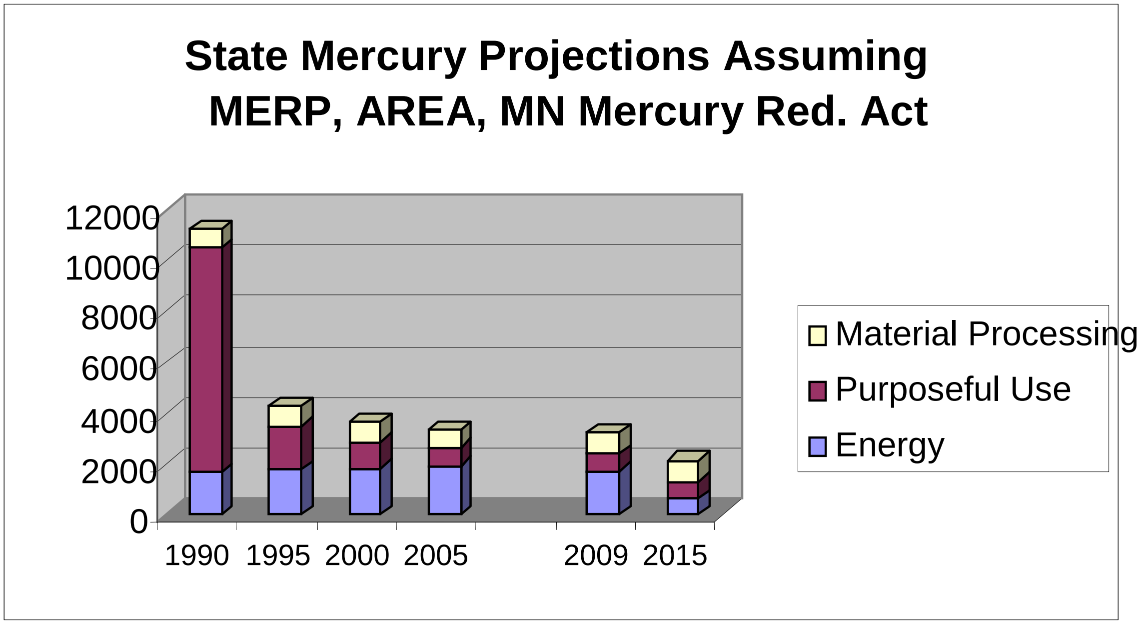
1. That all proposed projects evaluated in this analysis are constructed and operational in 2015.
2. That by 2009 reductions due to MERP and AREA go forward as planned;
3. That by 2015 the Minnesota Mercury Reduction Act of 2006 is implemented as planned (1100 lb/yr reduction expected by 2015);
4. All other emissions from Minnesota sources remain unchanged from 2000.

As illustrated in Figure 10, statewide mercury emissions were about 3,341 pounds in 2005 (MPCA 2005a). Included in this total are about 1,650 pounds from electric generating units (out of 1,923 pounds estimated for the Energy Sector) and 665 pounds from existing taconite facilities (out of 679 pounds estimated for the "Other" category) (MPCA 2005a).

Mercury emissions from Minnesota's electric utilities are expected to decline further due to voluntary reductions (primarily MERP and AREA) as well the recently passed Minnesota Mercury Reduction Act of 2006. The Mercury Reduction Act does not technically mandate 90% reductions at the affected electric generation units, but allows flexibility in final controls based in final review by the Minnesota PUC. However, if implemented and approved as planned, mercury emissions from Xcel Energy's Sherco Unit III and Allen S. King plants, and Minnesota Power's Clay Boswell Unit 3 could first be reduced by as much as 90% by 2010. This would reduce emissions by about 480 lbs/yr. Then, the Act envisions that Xcel Energy and Minnesota Power would reduce mercury emissions by 90% at Sherco Units I and II, and Clay Boswell Unit 4, respectively, by 2014. This could reduce emissions by about another 630 lbs/yr. Thus, the total expected emission reductions due to the Act could be about 1110 lbs/yr.

In addition, as described below, the EPA CAMR rule requires state electric generation units to make somewhat less ambitious reductions than required by the Minnesota Act by 2018. However, comparisons between CAMR emission caps and the Minnesota mercury inventory data cannot be made because of different reporting assumptions used for the two programs. In any case, under these foreseeable actions, Minnesota electric generating units are expected to reduce their mercury emissions from 1,650 pounds per year to about 300 to 500 pounds per year by about 2015 or shortly after; a reduction of 1150 – 1350 pounds per year. These reductions are reflected in the statewide emission estimates presented in Figure 10.

By 2015, additional reductions from other sources such as existing taconite and new iron and steel production facilities are also likely. In addition, Minnesota has proposed to EPA a draft TMDL to the EPA that includes a long-term statewide emission target of 789 pounds per year. The timing and mechanisms to meet the emission target in the proposed TMDL remain uncertain. However, these foreseeable actions indicate that statewide mercury emissions are likely to continue to decline over the next decade.



Note: This Figure 10 is based on the information from Figure 9, with projected emissions for 2011 and 2015 based on assumptions 1 through 4 listed in the text previous to this figure.

Definitions: MERP = Metropolitan Emission Reduction Project; Xcel Energy

AREA = Arrowhead Regional Emission Abatement Project; Minnesota Power

CAMR = Clean Air Mercury Rule; EPA proposed emissions cap for Minnesota electric utilities

Figure 10. Estimated mercury emissions for Minnesota in 2011 and 2015 based on voluntary emission reduction projects by Xcel Energy and Minnesota Power, and compliance with Minnesota Mercury Reduction Act of 2006 (Minnesota Law anticipates slightly greater reductions by 2015 than are required by EPA's Clean Air Mercury Rule by 2018).

5.4 National Emissions and Trends

As illustrated in Figure 11 below, national mercury emissions have also declined dramatically since 1990, primarily due to declines in emissions from medical waste incinerators, waste combustors, and incidental emissions from using mercury in products. Total estimated emissions decreased 45% between 1990 and 1999 (MPCA 2005b). Table 6 provides a more detailed breakdown of these national data.

In some cases, the emissions data presented in Figure 11 and in Table 6 for 1990 and 1999 may show a somewhat misleading estimate of a decreasing trend in mercury emissions. For example, for some source categories the change in estimated emissions may reflect changes in estimating techniques or improved knowledge about a source category, rather than actual changes in emissions (EPA 2006). Revised emission estimates for the U.S. are provided in Table 7 (EPA 2006). These emissions, adjusted to reflect likely changes in the mercury content of scrap between 1990 and 1999, indicate an approximate 44% reduction in total mercury emissions between 1990 and 1999. The two estimates of reductions in total emissions, those from Table 6 (45%) and those from Table 7 (44%), are not significantly different although they vary in some of the subcategories (EPA 2006).

Finally, Figure 12 below shows that national consumption and mercury emissions peaked in the 1970s and declined rapidly thereafter until the mid-1990's. Reductions in mercury emissions since 1999, however, have been less dramatic. The peaking of mercury emissions in the 1960s and then declining rapidly matches well with the findings from sediment core studies that show a corresponding peak in deposition in the 1960 and 1970s, followed by a decline in deposition through the early 1990s.

With respect to potential regulatory actions that will affect national emissions of mercury, reasonably foreseeable actions include the Clean Air Mercury Rule (CAMR) that creates a market-based cap-and-trade program that would permanently cap utility mercury emissions in two phases:

- The first phase of the rule sets a cap of 38 tons and is projected to reduce emissions from 48 tons to 31 tons beginning in 2010;

- Emissions will continue to decline thereafter until they are reduced to the second phase cap of 15 tons when the program is fully implemented.

In part due to the CAMR or equivalent regulation or legislation, and in part due to the additional controls described below, national emissions of mercury are expected to continue to decline over the next decade.

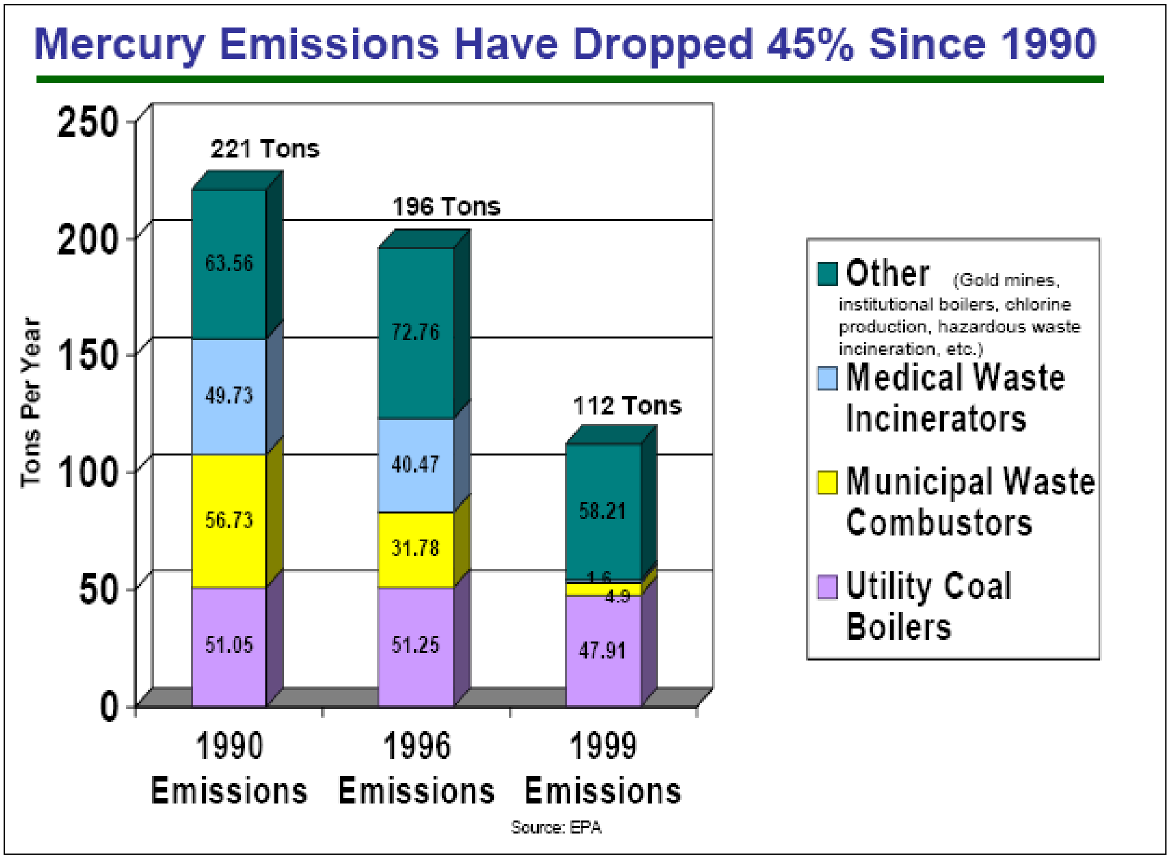


Figure 11. National mercury emission trends since 1990.

Table 6. Estimates of mercury air emissions for the United States in 1990 and 1999 by source category. (From: EPA 2006)

Source Category	Emissions (tons)	
	1990	**1999**
Utility Boilers	52.09	48.41
Coal-fired boilers	(51.05)	(47.91)
Oil-fired boilers	(1.04)	(0.5)
Industrial Boilers	11.83	11.91
Gold Mining	0.16	11.52
Hazardous Waste Incineration	6.57	6.58
Mercury Cell Chlor-alkali Plants	9.96	6.53
Municipal Waste Combustion	56.73	5.10
Medical Waste Incineration	49.73	2.84
Portland Cement Manufacturing	2.35	2.35
Refuse Systems	0.08	2.11
Pulp and Paper Production	1.9	1.62
Stationary Reciprocating Internal Combustion Engines	0.15	1.33
Industrial Inorganic Chemicals, NEC	0.25	1.2
Residential Heating: Distillate Oil	1.27	1.15
Petroleum Refineries, Catalytic Cracking and Reforming and Sulfur Plant Units	1.41	1.17
Lamp Breakage	1.5	1.01
Lime Manufacturing	0.1	1
Sewerage Systems	1.8	0.9
Primary Lead Smelting	1.3	0.0001
Hydrochloric Acid Production	2.98	0.0005
Other	7.38	8.84
Total	209.57	115.59

NEC – Not elsewhere Classified

Source: U.S. EPA National Emissions Inventory 1990 and 1999

Table 7. Revised estimates of mercury air emissions in the United States based on incorporating estimates for gold mining in 1990 and estimates for electric arc furnaces and iron and steel foundries.

(Table and accompanying footnotes are from EPA 2006)

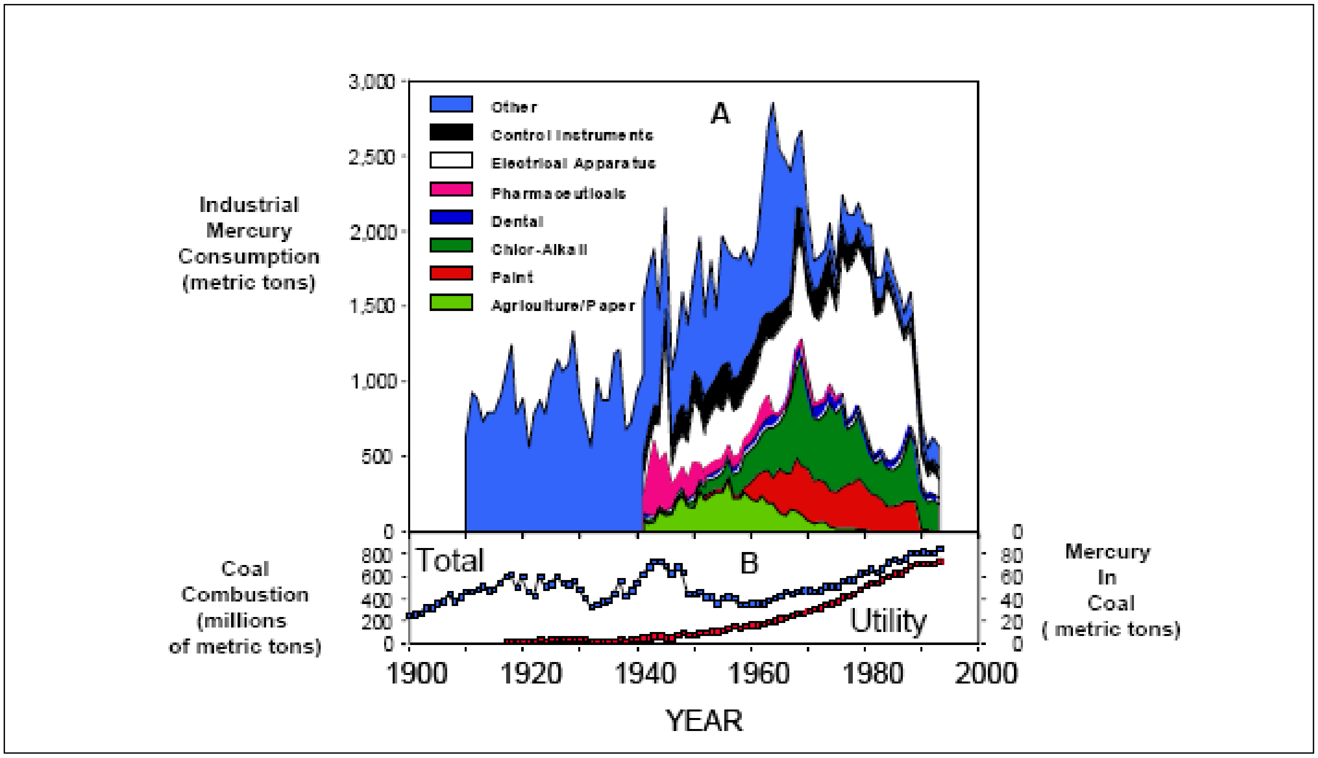
Source Category	Emissions (tons)	
	1990	1999
All Sources other than Gold Mines and Steel Production	209.41	104.07
Gold Mining	9.90	11.52
Electric Arc Furnaces[1]	8.56	10.70
Iron and Steel Foundries[2]	1.40	1.75
Total	229.27	128.04

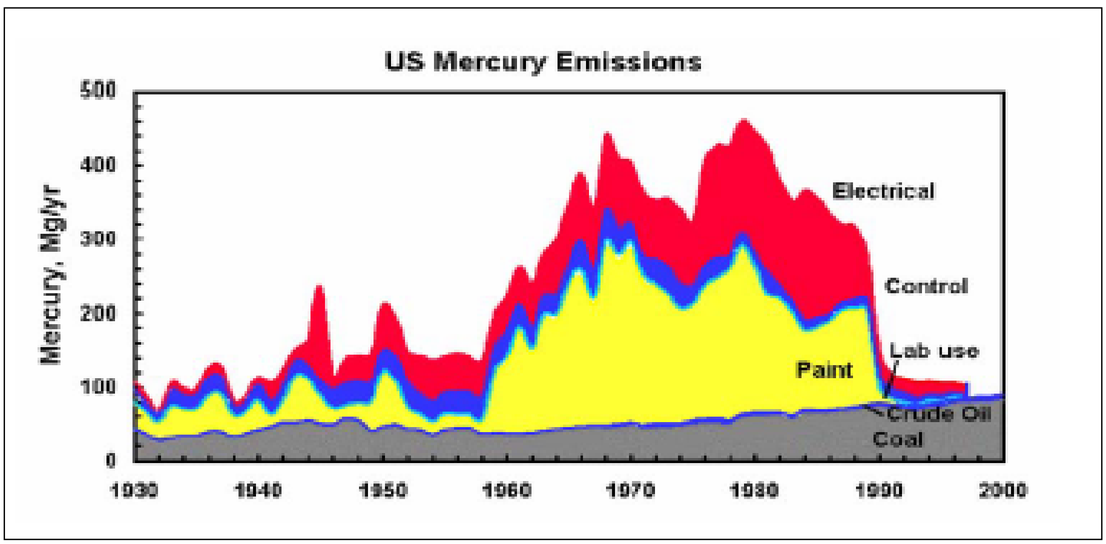
Footnotes:

[1] Data from 1999 is based on preliminary estimate of current emissions by OAQPS. 1990 data is based on assumption that 50 percent of emissions from these facilities are caused by mercury in vehicles, and that mercury content of end-of-life vehicles has approximately doubled between 1990 and 1999, and that 50 percent of emissions are from appliances and industrial equipment, and that the amount of mercury in such equipment that gets disposed of improperly, ending up in these facilities, has declined roughly 50 percent since 1990.

[2] The1999 estimate is based on data collected during development of the final air emissions standard for iron and steel foundries (implied by estimate that rulemaking will achieve 80 percent reduction from current emissions or 1.4 tons of reduction). See 69 FR 21910. 1990 data is based on assumption that 50 percent of emissions from these facilities are caused by mercury in vehicles, and that 50 percent of emissions are from appliances and industrial equipment, and that the amount of mercury in such equipment that gets disposed of improperly, ending up in these facilities, has declined roughly 50 percent since 1990.

Source: U.S. EPA National Emissions Inventory 1990 and 1999





(Adopted from MPCA 2005b)

Figure 12. National mercury consumption trends since 1900 (upper) and emission trends since the 1930s (lower).

5.5 Future Foreseeable Regulatory Impact on Minnesota Emissions

It is outside the scope of this study to attempt to predict the exact schedule or scale that existing sources in Minnesota will reduce mercury emissions over the next ten to fifteen years. However, in addition to the MERP and AREA reductions described previously in this report, there are several regulatory programs that are considered to be "on the books" or "on the way" that are likely to result in mercury emission reductions from both existing taconite facilities and existing coal-fired power plants in Minnesota.

These regulatory programs include at least the following federal and state initiatives:

- The Minnesota Mercury Reduction Law of 2006, H.F. 3712, 84th Session ("On the Books").
- The taconite Maximum Achievable Control Technology (MACT), 40 CFR Part 63, (FR Vol. 68, No. 210, October 30, 2003; ("On the Books"), and voluntary remand of Taconite MACT standards for mercury.
- The Clean Air Interstate Rule (CAIR), modifying 40 CFR Parts 51, 72, 73, 74, 77, 78, 96; ("On the Way").
- Regional Haze Rule, including Best Available Retrofit Technologies (BART) requirements for certain sources. On July 6, 2005, the U.S. Environmental Protection Agency (EPA) published final amendments to its 1999 regional haze rule in the Federal Register, including Appendix Y, the final guidance for Best Available Retrofit Technology (BART) determinations (70 FR39104-39172) ("On the Way").
- The Clean Air Mercury Rule, modifying 40 CFR Parts 60, 61, 63, 72, and 75 ("On the Way").
- Minnesota's proposed mercury Total Maximum Daily Load (TMDL), initial draft dated May, 2005 (MPCA 2005b); updated draft dated June 2006 (MPCA 2006b) ("On the Way").
- Minnesota's voluntary reduction agreements and other mercury reduction efforts; described in detail in the MPCA's recent 2005 Mercury Reduction Progress Report to the Minnesota Legislature (MPCA 2005a).

A detailed assessment of the purpose, scope, and potential reductions in mercury emissions from specific sources due to these regulations is outside the purview of this report. Further, some of these regulations, or some section(s) within a regulation, are under review by EPA or under judicial review. Nevertheless, while the timing of each of these regulatory initiatives is different, each may lead to reductions in mercury emissions from existing sources in Minnesota. How these programs will work together, which units will be affected, and on what schedule are yet to be determined. However, some general predictions can be made.

5.5.1. The Minnesota Mercury Reduction Act of 2006

This recently passed Minnesota Mercury Reduction Act of 2006 (H.F. 3712), which amends Minnesota Statutes 216B.682, requires Xcel Energy and Minnesota Power to submit plans to the MPCA and the MPUC by the end of 2007 that demonstrate how each utility would reduce mercury emissions by 90% at its largest coal-fired power plants. These plans—which must be approved by the MPUC before they are implemented—must propose mercury control technology that is likely to reduce emissions by 90% by 2010 for dry-scrubbed units, and 90% reductions by 2014 for wet-scrubbed units. While these reductions are not mandated (the Act allows for flexibility and cost considerations in the final MPUC decision), the law in effect requires 90% mercury reductions at Xcel Energy's King plant near Stillwater and its Sherco unit #3 in Becker by 2010, and at two other Sherco units by 2014. Minnesota Power would need to install mercury controls at its Clay Boswell unit #3 near Grand Rapids by 2010 and at Boswell unit #4 by 2014. Based on current mercury inventory data, if approved, these required plans translate into an approximately 480 pound per year reduction in mercury emissions by 2010, with an additional 630 pound per year reduction by 2014. Thus, the total mercury reduction would be about 1100 pounds per year by 2014.

5.5.2 Maximum Achievable Control Technology (MACT) for Taconite Facilities

The deadline for meeting taconite MACT requirements was October 30, 2006, the earliest of the three applicable regulatory programs. The requirements of this technology-based regulation are already established for taconite facilities (although the mercury portion of the rule is again under review and revisement). The MACT requirements are primarily focused on reducing particulate metal emissions from the taconite facilities, with particulate matter and control serving as a surrogate for the individual metals. Several taconite facility pellet lines are planning to install new wet scrubbers to reduce particulate emissions. For facilities installing a new wet scrubber to meet MACT, these new particulate controls may incidentally reduce actual mercury emissions from the affected pellet lines. In addition, the EPA is currently preparing new provisions of the rule that may require specific control of mercury from taconite facilities.

5.5.3 Clean Air Interstate Rule (CAIR)

The CAIR rule is focused on reducing emissions that cause or contribute to ozone and $PM_{2.5}$ non-attainment areas in the country. The details of this rule depend on how it is implemented by the MPCA. Although this rule is not focused on mercury reductions, it is being implemented by EPA as a companion rule to the Clean Air Mercury Rule (CAMR) because the EPA expects and assumes that the emission reductions required in the first phase of the CAMR rule (2010) will almost entirely be met by new emission controls installed on coal-fired power plants in the CAIR states—emission controls that will be designed to simultaneously control NO_x, SO_2, and mercury (EPA 2005a; EPA 2005b). As described below, the mercury emission reductions due to the first phase of the CAIR/CAMR rules are not expected to be significant in Minnesota.

EPA's (2005b) estimate of reductions from electric generating units due to emission controls required for CAIR (not including CAMR phase II) are shown below in Table 8.

Table 8. Summary of National Mercury Emissions by Species: 2001 and 2020 (with CAIR) Baselines (adopted from EPA 2005b).

Emissions Source	Mercury Emissions Species (tons)			Total Mercury Emissions (tons)
	Elemental	Reactive Gaseous	Particulate	
2001 Base Year				
EGUs	26.26	20.58	1.73	48.57
Non-EGU Point	37.85	13.33	7.60	58.78
Non-point	5.05	1.53	0.96	7.54
Total, All Sources	69.16	35.44	10.29	114.89
2020 (with CAIR) Baseline				
EGUs	25.72	7.87	0.83	34.42
Non-EGU Point	28.03	10.37	6.61	45.01
Non-point	5.69	1.30	0.77	7.76
Total, All Sources	59.44	19.54	8.21	87.19

5.5.4 Best Available Retrofit Technology (BART) and Regional Haze Rule

BART requirements are part of the EPA effort to improve visibility in Federal “Class 1” protected areas, such as Voyageur’s National Park and the Boundary Waters Canoe Area. Pollutants of interest with regard to visibility impairment are SO_2, NO_x and fine particulate ($PM_{2.5}$). Mercury is not a pollutant of interest with regard to visibility. However, potential additional controls installed to reduce SO_2, NO_x, or fine particulate emissions may also remove additional mercury from combustion flue gases (e.g., LoTox technology to reduce NO_x emissions that may also co-control mercury; new or additional wet scrubbing that may enhance the capture of oxidized mercury or particle-bound mercury).

The MPCA recently released a summary of BART-eligible units in Minnesota, which includes four existing taconite facilities and Minnesota Power’s two largest coal-fired power plants. The current BART implementation schedule would require BART compliance by about the year 2013. Although it is difficult to predict how BART will affect emissions from northeastern Minnesota sources, it seems likely that it will require some NO_x reductions from existing taconite facilities. See http://www.pca.state.mn.us//publications/reports/aq1-27.pdf . In addition, BART may require SO_2 and NO_x reductions from Minnesota Power’s two generating plants in the area: the Boswell Energy Center and possibly Taconite Harbor. See http://www.pca.state.mn.us/publications/aq-sip2-02.pdf.

Additional SO_2 and NO_x reductions are possible in Minnesota as part of the anticipated visibility-related SIP requirements that may be needed to meet national visibility goals. The potential decrease in mercury emissions that may be related to implementation of BART emission controls is not yet known and likely cannot be predicted until BART implementation is in its final stages.

5.5.5 Clean Air Mercury Rule (CAMR)

EPA’s March 2005 Clean Air Mercury Rule sets out new source performance standards for new coal-fired power plants, and creates a market-based cap-and-trade program that will permanently cap utility nationwide mercury emissions in two phases: the first phase of the rule sets a cap of 38 tons and is projected to reduce emissions from 48 tons to 31 tons beginning in 2010. Nationwide mercury emissions from coal-fired power plants are then required to continue to decline thereafter until they are reduced to the second phase cap of 15 tons when the program is fully implemented by 2020. The mandatory declining caps, coupled with significant penalties for noncompliance, will ensure that mercury reduction requirements are achieved and sustained.

The emission allocations for Minnesota's electric generation units under CAMR are 1,390 pounds per year in 2010, and 548 pounds per year in 2018 (EPA 2005a). These caps, however, cannot currently be directly compared with MPCA inventory data because of different utility emission assumptions. Generally though, in Minnesota, the 2010 mercury cap under CAMR could partly be met through the MERP (170 pound reduction) and AREA (64 pound reduction) voluntary actions that are already planned (summed reduction = 234 pounds). In addition, the newly passed Minnesota Mercury Reduction Act of 2006 is expected to further reduce statewide mercury emissions by approximately 480 lbs/yr by 2010.

- Under this scenario, the MERP and AREA reductions would reduce the power sector emissions to approximately 1416 pounds per year (1650 – 234 = 1416);

- Reductions due to the Minnesota Mercury Reduction Act would be about 480 lbs/yr by 2010; (90% reductions at Minnesota Power's Boswell #3; Xcel Energy's Sherco #3 and King);

- 2010 electric generation emissions would be reduced to about 935 lbs/yr (1416 – 480 = 935);

- Assuming the EPA and MPCA emission estimates are reasonably close, the expected state emissions of 935 lbs/yr are already below the 2010 CAMR cap of 1,390 lbs/yr.

In addition, the approximately 630 lb/yr reduction planned by 2015 under the recently signed 2006 Minnesota Mercury Reduction Act would bring total electric generation emissions down to about 300 lbs/yr (935-630). Although the 300 lb/yr projection for 2015 appears to be well below the 548 lb/yr CAMR Phase II cap, EPA and MPCA will need to reach agreement on the assumptions to be used in determining compliance with the CAMR caps should the rule move forward as currently proposed.

Most coal-fired power plants in Minnesota use subbituminous coal from Wyoming's Powder River Basin. The mercury in this coal is largely emitted as elemental mercury, which typically has been projected to be both more costly and more difficult to control than mercury associated with bituminous coals. Therefore, any mercury emission reductions required in Minnesota by the first phase of CAMR are likely to be met by obtaining mercury credits from eastern state coal-fired plants because emissions from those plants are likely to be less costly to control than emissions from Minnesota's coal-fired plants. To the extent that additional reductions are needed to meet the CAMR Phase II caps in Minnesota, actual emission reductions rather than credit trading may be required.

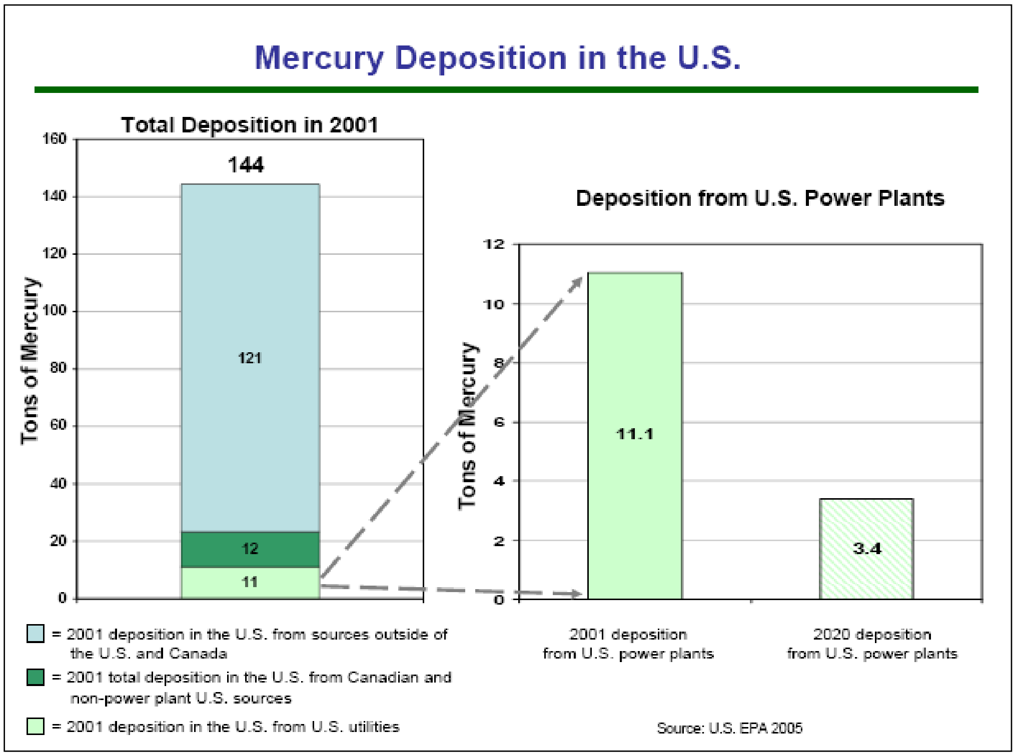
he United States that is due to mercury emissions from coal-fired power plants located in the

United States—both for current conditions and after full implementation of CAMR in 2020 (EPA 2005b). These EPA estimates are summarized in Figure 13 below. Out of an estimated 144 tons of mercury deposited on the U.S every year, EPA estimates about 11 tons are due to U.S. coal-fired power plants (~ 7.6% of deposition is from coal-fired power plants). As shown in Figure 12, EPA expects the amount of mercury deposition due to U.S. power plants to drop from 11 tons per year to 3.4 tons per year if CAMR is implemented as proposed (EPA 2005b).

EPA also modeled the likely impacts of CAMR emission reductions on Minnesota deposition rates. EPA's estimate is that mercury deposition in Minnesota may be reduced up to 5% (0 - 1 µg m^{-2}) due to CAMR, using the IPM economic model (Figure 14) (EPA 2005b). This small reduction in deposition in Minnesota is primarily because (1) most emission reductions would occur at eastern power plants firing bituminous coal and (2) emission reductions at other closer coal plants would primarily reduce elemental mercury, which currently has only a limited impact on nearby mercury deposition rates.

The main cause of this result (i.e., small decrease in deposition in Minnesota due to implementing the CAMR) is that CAIR results in a very large decrease in reactive gaseous mercury (RGM) emissions from power plants through the implementation of scrubber control technology. RGM is the most readily deposited form of mercury. The implementation of CAMR Option 1 and CAMR Option 2 results in some scattered total mercury deposition reductions beyond CAIR in 2020, but for the most part these reductions are not very significant compared to those obtained by CAIR. Most of the mercury emissions reductions from CAMR are in the form of elemental mercury (Hg0). This form of mercury is not readily deposited, but enters the global pool of mercury. Thus, CAMR will result in a reduction of the transport of mercury to other places in the world.

Based on the IPM modeling for the CAMR rule (EPA 2005c), it may be that in addition to national emission reductions, international emission reductions are also needed to significantly decrease mercury deposition in Minnesota.



(From: http://www.epa.gov/air/mercuryrule/charts.html)

Figure 13. Estimated mercury deposition in the United States and the amount of deposition due to mercury emitted from coal-fired electric generating plants located in the United States.

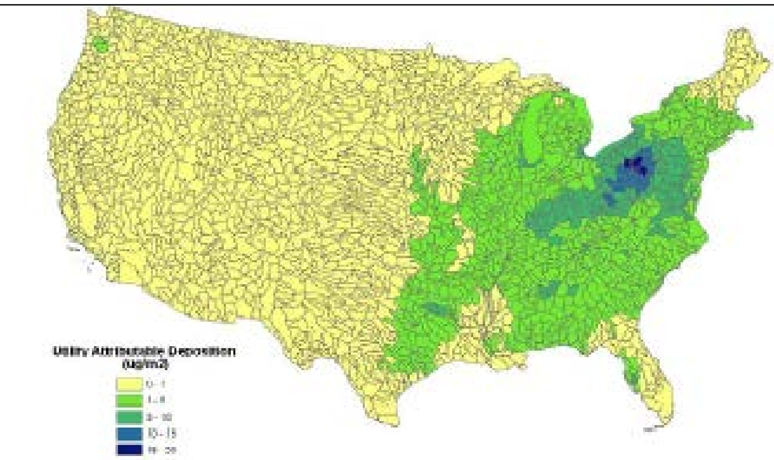


Figure 2.2. Regional Annual Deposition of Mercury Attributable to Electricity Generating Utilities in the 2001 Base Year

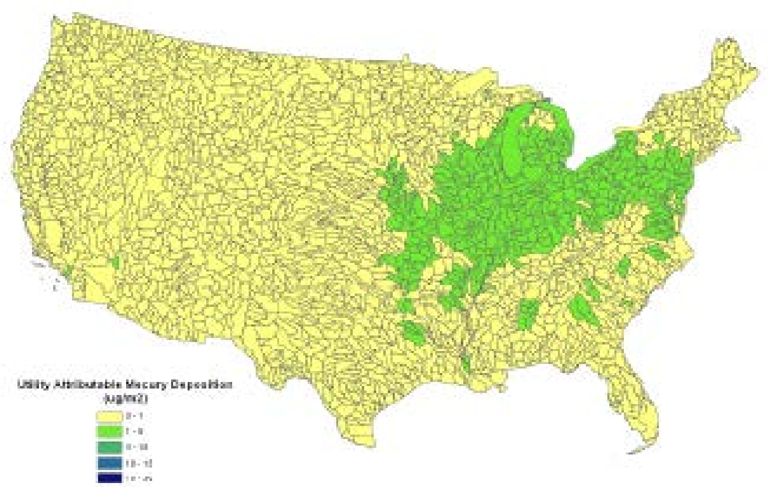


Figure 2.3a. Regional Annual Deposition of Mercury Attributable to Electricity Generating Utilities in the 2020 Base Case With Implementation of the Clean Air Interstate Rule (2001 Deposition Comparison Scale)

(From EPA 2005c)

Figure 14. Estimated decrease in mercury deposition in various parts of the U.S. due to implementation of the Clean Air Mercury Rule.

5.5.6 Minnesota's Proposed Statewide Mercury Total Maximum Daily Load

As identified by the MPCA (2005b, 2006b), the long-term goal of the mercury TMDL is for the fish in Minnesota's lakes and streams to meet water quality standards; Minnesota's fish-tissue criterion is 0.2 parts per million (ppm; or milligrams per kilogram, mg/kg). About 90% of the mercury deposition in the state originates from outside the state, while Minnesota sources contribute about 10% of the mercury deposited in Minnesota (MPCA 2005b, 2006b). The mercury TMDL identifies that a 93% reduction in emissions from 1990 is needed in order to meet the statewide fish-tissue criterion of 0.2 ppm.

Minnesota's proposed approach to reduce its share of the mercury deposition is to reduce the mass of mercury emitted from Minnesota's sources. In order to reach the 93% reduction goal identified in the draft TMDL, Minnesota emissions will be reduced to approximately 789 pounds per year. The draft TMDL is currently under review by the U.S. EPA and it is uncertain when additional activities associated with the TMDL will occur.

The implementation plan for the TMDL has not yet been developed. The implementation plan will be developed after the TMDL plan is approved by the U.S. EPA. As part of the TMDL, short-term and longer-term actions and check-in points have been identified. For example, short-term actions include an emphasis on voluntary reductions and for new and expanding sources to use state-of-the-art mercury control technology. The longer-term actions include evaluating the impact of federal regulations and reductions on deposition in Minnesota and exploring opportunities for regional state cooperation. Reduction targets and milestones have also been identified in the TMDL that provide the MPCA with set intervals to evaluate progress, review recent developments in controlling mercury emissions and assessing new strategies. A specific timeframe for reductions has not been proposed in the draft TMDL.

5.5.7 Air Emission Reductions From Other Sources

The U.S. and Canada have pursued the control and management of mercury releases through major program areas (e.g., air, water); collectively, these actions place regulatory controls on all of the major well-defined industrial and municipal sources of mercury in the U.S. and Canada.

A number of initiatives are expected to reduce mercury releases even further by the end of 2005. These include Canada-Wide Standards (CWS) for sewage sludge incineration, dental amalgam, and fluorescent lamps. The Great Lakes Binational Toxics Strategy outlines additional goals for reducing air emissions of mercury, including reducing air emissions related to mercury in products and the disposal of those products (EPA 2006).

5.5.8 Summary of Emission Reductions from Foreseeable Regulatory Actions

Currently, statewide total mercury emissions are about 3,341 pounds per year of which about 1,650 pounds are from electric generating units (MPCA 2005a). Under CAIR/CAMR, Minnesota's electric utility mercury emissions are to be capped at 1,390 pounds per year in 2010, and 548 pounds per year by 2018. Assuming that Xcel Energy's MERP project and Minnesota Power's AREA initiative are implemented as planned, electric generating unit reductions will be reduced from about 1,650 pounds per year currently to approximately 1400 pounds per year by

2010. Meeting the CAMR cap in 2018 will likely require additional emission reductions from Minnesota's electric utilities.

Other federal "on the way" regulations such as BART/Regional Haze may result in additional mercury reductions due to implementation of controls to reduce SO_2, NO_x, and/or fine particulate from combustion sources.

Minnesota's proposed mercury TMDL identifies emission reductions from electric utilities as well as from taconite processing. The exact timing for implementation of the TMDL and the specific mechanisms for reducing mercury air emissions are yet to be determined. However, it is apparent from the foreseeable actions, voluntary and regulatory, that mercury emission reductions will be occurring in Minnesota. Therefore, even if all the proposed projects move forward as planned, statewide mercury emissions are expected to decline over the next decade.

6.0 Potential Increase in Mercury Deposition from the Proposed Projects

Available information indicates that in-state emissions sources contribute only a small amount to mercury deposition in northeast Minnesota, particularly to lakes in the Superior National Forest and the Superior Highlands (St. Louis, Lake, and Cook counties) (Engstrom et al. 1999). Approximately 90% of the mercury deposition in Minnesota is estimated to come from out-of-state sources (MPCA 2006b). Given the relatively small emissions from the proposed projects (~ 221 pounds per year) in relation to current state (~ 3,341 pounds per year) and national emissions, it is unlikely that the proposed projects will have a significant effect on mercury deposition and bioaccumulation in fish in northeast Minnesota. However, to provide additional perspective on the potential impact of the proposed projects on mercury deposition and fish mercury concentrations, an estimate of the potential increase in mercury deposition due to the potential emissions from the proposed projects is provided below. Several estimates of potential deposition are provided: within the four-county project area, and within the state as a whole.

6.1 Four-County Project Area Analysis

In formulating the statewide mercury TMDL the MPCA "… looked at possible impacts from large water and air sources and did not see local impacts in elevated fish mercury concentrations compared to the background regional levels. …" (MPCA 2006b). The MPCA therefore concluded that there are no local hotspots for mercury deposition in Minnesota (MPCA 2006b). An assessment by Berndt (2003) of the available sediment core and fish concentration data for northern Minnesota, including the Iron Range area, also indicated that there were no apparent local hotspots of mercury deposition.

Primarily elemental mercury is emitted from Minnesota's emission sources. Table 1 indicates that primarily elemental mercury is expected to be emitted from the proposed projects. Therefore, it is expected that the proposed projects would contribute to mercury deposition in northern Minnesota, and in Minnesota as a whole, similar to current emission sources. In other words, the proposed projects are not expected to have hotspots of deposition associated with them. However, it is recognized that the proposed projects do have the potential to emit ionized mercury (Hg(II)) and particle-bound mercury (Hg(p)) to air, the species that tend to deposit near an emission source. The following calculations provide an indication of the potential increase in mercury deposition near the proposed projects in the four-county project area.

The speciation of potential emissions from the proposed projects is presented in Table 1. The speciation of emissions in Table 1, approximately 99.3% elemental mercury, 0.5% oxidized mercury and 0.2% particle-bound mercury, is the basis for the first estimate of potential mercury deposition in the four-county project area. A second estimate of potential deposition in the four-county project area is obtained when it is assumed that 5% of the estimated 221 pounds per year of potential emissions from the proposed projects is ionized mercury and 2% is particle-bound mercury. Both estimates of potential deposition are detailed below.

As part of this exercise, consideration of the uncertainties in the relationships between mercury emissions, deposition, mercury methylation and subsequent uptake by biota were excluded. In addition, this calculation is made without taking into account any emission reductions that have occurred (e.g., the LTVSMC plant closure) or will likely occur (e.g., Minnesota Power's AREA project) in the project area or in the state as a whole (e.g., Xcel Energy's MERP; the Minnesota Mercury Reduction Act of 2006).

Estimate #1

This estimate of the potential mercury deposition related to the proposed projects is based on the speciation information from Table 1 which shows that almost all of the mercury potentially emitted from the proposed projects will be elemental mercury. Very little ionized (Hg(II)) or particle-bound mercury is expected to be emitted. Therefore, for this calculation, the amount of mercury available for depositing within the four-county project area is as follows: 1) ionized (Hg(II)) mercury emissions from the proposed projects represents 0.5% of the total mercury emissions; 2) particle-bound mercury (Hg(p)) represents 0.2% of the total mercury emissions.

The calculation of a potential deposition increase due to the proposed projects is as follows:

1. The current estimated total mercury deposition in northern Minnesota is 12.5 µg m^{-2} yr^{-1}.

2. The proposed projects are estimated to potentially emit approximately 221 lbs/yr.

3. Ionized and particle-bound mercury tend to deposit locally; the estimated amount of mercury that could potentially be deposited in the four-county project area is as follows:

    a. Ionized mercury represents 0.5% of the potential mercury emissions from the proposed projects = 1.11 pounds.

    b. Particle-bound mercury represents 0.2% of the potential mercury emissions from the proposed projects = 0.44 pounds.

    c. Pounds/year of mercury were converted to micrograms/year (one pound = 453.6 grams; 1 gram = 1,000,000 micrograms) = 703,080,000 µg yr^{-1}.

4. The four-county area of Itasca, St. Louis, Lake, and Cook Counties encompasses 8,675,851 acres. This acreage was converted to square meters (one acre = 4,046.87 square meters) and = 35,110,041,136 m^2.

5. The amount of mercury potentially deposited in the four-county area is divided by the area encompassed by the four counties = 0.02 µg m^{-2} yr^{-1}.

    Based on the above assumptions, the potential mercury emissions from the proposed projects are estimated to potentially increase deposition in the four-county area by approximately 0.02 µg m^{-2} yr^{-1}.

6. With 0.02 µg m^{-2} yr^{-1} in mercury deposition potentially associated with the proposed projects, the total mercury deposition is estimated to increase from 12.5 µg m^{-2} yr^{-1} to approximately 12.52 µg m^{-2} yr^{-1}.

    a. Based on the above assumptions, the proposed projects are estimated to potentially increase total mercury deposition by approximately 0.16%.

Estimate #2

This estimate of the potential mercury deposition due to the proposed project's mercury emissions is based on an two assumptions that over-estimate the amount of mercury available for depositing within the four-county area: 1) ionized (Hg(II)) mercury emissions from the proposed projects represents 5% of the total mercury emissions; 2) particle-bound mercury (Hg(p)) represents 2% of the total mercury emissions.

The calculation of a potential deposition increase due to the proposed projects is as follows:

1. The current estimated total mercury deposition in northern Minnesota is 12.5 µg m^{-2} yr^{-1}.

2. The proposed projects are estimated to potentially emit approximately 221 lbs/yr.

3. Ionized and particle-bound mercury tend to deposit locally; the estimated amount of mercury that could potentially be deposited in the four-county project area is as follows:

    a. Ionized mercury represents 5% of the potential mercury emissions from the proposed projects = 11.1 pounds.

    b. Particle-bound mercury represents 2% of the potential mercury emissions from the proposed projects = 4.4 pounds.

    c. Pounds/year of mercury were converted to micrograms/year (one pound = 453.6 grams; 1 gram = 1,000,000 micrograms) = 7.0308 E+09 µg yr^{-1}.

4. The four-county area of Itasca, St. Louis, Lake, and Cook Counties encompasses 8,675,851 acres. This acreage was converted to square meters (one acre = 4,046.87 square meters) and = 35,110,041,136 m^2.

5. The amount of mercury potentially deposited in the four-county area is divided by the area encompassed by the four counties = 0.2 µg m^{-2} yr^{-1}.

    Based on the above assumptions, the potential mercury emissions from the proposed projects are estimated to potentially increase deposition in the four-county area by approximately 0.2 µg m^{-2} yr^{-1}.

6. With 0.2 µg m^{-2} yr^{-1} in mercury deposition potentially associated with the proposed projects, the total mercury deposition is estimated to increase from 12.5 µg m^{-2} yr^{-1} to approximately 12.7 µg m^{-2} yr^{-1}.

    Based on the above assumptions, the proposed projects are estimated to potentially increase total mercury deposition by approximately 1.6%.

6.2 Statewide Analysis

This estimate of the potential mercury deposition related to the proposed projects is based on the assumption that mercury emissions from all Minnesota sources in general are responsible for about 10% of the mercury deposition in northeast Minnesota (Engstrom et al. 1999). The emission profiles for the proposed projects in Table 1 indicate that primarily elemental mercury is expected to be emitted. The emission profiles of the proposed projects are similar to existing emission sources in the state whereby primarily elemental mercury is emitted (MPCA 2006b).

It is assumed that there are no local “hot spot” contributions due to these industrial or Iron Range point sources of air emissions based on the findings from Engstrom et al (1999) and Berndt (2003) and the conclusions by the MPCA (2006b). Consideration of the uncertainties in the relationships between mercury emissions, deposition, mercury methylation and subsequent uptake by biota are excluded. In addition, this calculation is made without taking into account any emission reductions that have occurred (e.g., the LTVSMC plant closure) or will likely occur (e.g., Minnesota Power’s AREA project) in the project area or in the state as a whole (e.g., Xcel Energy’s MERP; the Minnesota Mercury Reduction Act of 2006).

The calculation of the potential mercury deposition from the proposed projects is based on the MPCA’s “proportionality concept” that was described and used by the MPCA (2005b) in the draft mercury TMDL. The calculation of potential deposition increase due to the proposed projects is as follows:

1. The current estimated total mercury deposition in Minnesota is 12.5 µg m^{-2} yr^{-1}.

2. Minnesota sources contribute 10% to the current mercury deposition; 1.25 µg m^{-2} yr^{-1}.

3. Current mercury emissions in Minnesota (2005) are approximately 3,341 pounds per year.

    a. The proposed projects are estimated to potentially emit approximately 221 lbs/yr.

    b. Statewide emissions are then estimated to increase to 3,562 pounds (3,341 + 221).

4. The following ratio was set up to estimate deposition in Minnesota associated with the potential increase in mercury emissions from the proposed projects:

$$\frac{1.25\ \mu g\ m^{-2}\ yr^{-1}.}{3{,}341\ \text{pounds/yr}} = \frac{X\ \mu g\ m^{-2}\ yr^{-1}.}{3{,}562\ \text{pounds/yr}}$$

    Solving for “X”: X = 1.33 µg m^{-2} yr^{-1} of mercury deposition potentially associated with potential future Minnesota mercury emissions of approximately 3,553 pounds per year.

    Based on the above assumptions, the potential mercury emissions from the proposed projects are estimated to potentially increase Minnesota’s contribution to deposition by approximately 0.08 µg m^{-2} yr^{-1} (a potential increase from approximately 1.25 µg m^{-2} yr^{-1} to 1.33 µg m^{-2} yr^{-1}).

5. With the 0.08 µg m^{-2} yr^{-1} in mercury deposition potentially associated with the proposed projects, the total mercury deposition is estimated to potentially increase from approximately 12.5 µg m^{-2} yr^{-1} to approximately 12.58 µg m^{-2} yr^{-1}.

Based on the above assumptions, the proposed projects are estimated to potentially increase total mercury deposition by approximately 0.6%.

6.3 Conclusion

Two estimates of potential deposition from the proposed projects were calculated. Both estimates are conservative in that they likely over-estimate the potential deposition associated with the proposed projects. Both estimates assume that all of the proposed projects move forward to full operation and there are no mercury emissions reductions (past or future). In actuality, 68% of the emissions from the proposed projects have already been offset by the past reductions associated with the LTV closure and the proposed future reductions from Minnesota Power's AREA project.

Based on these estimates, for the four-county project area, the proposed projects may increase mercury deposition by at most 0.16% to 1.6% above current background levels. On a statewide basis, the proposed projects are estimated to increase mercury deposition by 0.6% above current background levels. Given the "noise" and variability in measuring or calculating mercury deposition, the small potential increase in mercury deposition associated with the proposed projects in full operation, whether within the four-county project area or within the state as a whole, is not likely to be measurable.

Based on above calculations, and given the fact that only a small portion of deposited mercury is transformed into methylmercury (MPCA 2005b), it is highly unlikely that the small amount of mercury potentially deposited in Minnesota from the proposed projects would measurably increase mercury bioaccumulation in fish. This conclusion is reached without accounting for known or expected decreases in mercury emissions from sources in the project area which result in a much lower "net increase" in emissions potentially associated with the proposed projects. Those emissions decreases would further minimize any potential impacts.

7.0 Summary Findings and Conclusions

The proposed new and expansion projects are located in northern Minnesota where there are numerous lakes that are important for sport fishing, subsistence fishing, and other recreational opportunities. A primary concern is the potential for adverse impacts to the lake resource in this area from the proposed projects. However, the following findings indicate that emissions from the proposed projects are not expected to have a measurable effect on current mercury deposition and bioaccumulation in fish in northeast Minnesota or adjoining states.

- Proposed Cumulative Emissions:
    - Potential mercury air emissions from reasonably foreseeable projects are estimated to be approximately 221 pounds per year, primarily as elemental mercury (93-99% elemental). Statewide 2005 mercury emissions are estimated at 3,341 pounds, with emissions from taconite mining and coal-fired power plants estimated to be approximately 2,329 pounds (MPCA 2005a).
    - While the new projects may emit up to 221 pounds of mercury per year by 2015, emission reductions from Iron Range sources offset this potential increase:
        - Mining-related emissions have decreased by approximately 138 pounds per year since 1985 (shutdown of the Butler Taconite facility at 55 pounds per year and shutdown of the LTVSMC facility at 83 pounds per year).
        - When 2000 is used as a baseline, the following reductions have occurred: the shutdown of LTVSMC in 2001 reduced emissions by about 83 pounds per year; Minnesota Power's use of lower mercury coal reduced emissions by about 70 pounds per year (MPCA 2005a); the planned reductions at Minnesota Power's Taconite Harbor electric generating plant should further reduce nearby emissions by about 64 pounds per year (MPCA 2006a); Clay Boswell Unit #3. When these reductions are taken into account, there is a net decrease of approximately 1 pound per year in mercury emissions in the four-county project area of Itasca, St. Louis, Lake, and Cook Counties by 2015.
        - Implementation of the Minnesota Mercury Reduction Act of 2006 could reduce emissions from Minnesota Power's Clay Boswell Plant an additional 400 pounds per year by 2014.
    - The potential mercury emissions from the proposed projects are further offset by Xcel Energy's MERP which reduces emissions by 170 pounds per year.
- Potential Cumulative Deposition
    - The proposed projects are not expected to measurably increase mercury deposition to northern Minnesota; therefore, the proposed new projects are not expected to cause an increase in bioaccumulation of mercury in fish in northeast Minnesota lakes or streams.

- The proposed projects will primarily emit elemental mercury, which does not tend to be deposited locally near an emission source (MPCA 2005b; EPA 2006). As a result, the proposed projects are expected to have little effect on the current or future level of mercury deposited in northeast Minnesota.

- Mercury deposition and fish bioaccumulation rates in northeastern Minnesota are primarily driven by national and global emission rates, not by in-state or local emissions. Approximately 10% of the mercury deposition to Minnesota is due to in-state sources; approximately 90% comes from outside the state (MPCA 2005b).

- Sediment core data indicate that mercury deposition in the Great Lakes region (EPA 2006) and in parts of Minnesota, including Itasca County and Voyageurs National Park, has declined since the 1970s (Engstrom et al. 1999). Recent data indicate that mercury concentrations in fish in Minnesota and in the Great Lakes as a whole are declining in response to emission reductions (MPCA 2005b; EPA 2006).

- Mercury deposition to northeast Minnesota lakes in St. Louis, Lake, and Cook Counties does not show a decline (Engstrom et al. 1999). However, sediment core studies conducted in northern Minnesota indicate that lakes located near the Iron Range and taconite processing facilities that primarily emit elemental mercury have mercury deposition rates similar to other Minnesota lakes that are distant from emission sources (Engstrom et al. 1999). Mercury fish concentrations in lakes immediately adjacent to the Iron Range are similar to fish concentrations in other lakes that are more distant from the Iron Range (Berndt 2003; MPCA 2006b). The available data indicate that Iron Range emission sources do not appear to affect mercury deposition to northeast Minnesota lakes.

- Two estimates of potential deposition from the proposed projects were calculated. Both estimates are conservative in that they likely over-estimate the potential deposition associated with the proposed projects. Both estimates assume that all of the proposed projects move forward to full operation (~ 221 pounds/year of potential emissions) and there are no mercury reductions to offset the potential emissions from the proposed projects. Section 6.0 of this report provides additional details on the calculations.

    - Within the four-county project area, it is estimated that the proposed projects could potentially increase mercury deposition by 0.16% to 1.6%; from 12.5 µg m^{-2} yr^{-1} to 12.52 to 12.7 µg m^{-2} yr^{-1}, respectively.

    - Based on the proportionality concept used by MPCA in developing the statewide mercury TMDL (MPCA 2006b), it is estimated that emissions of 221 pounds per year from the proposed projects could potentially increase mercury deposition by 0.6%, from 12.5 µg m^{-2} yr^{-1} to 12.58 µg m^{-2} yr^{-1}.

        - In both cases, this potential increase in mercury deposition is not expected to be measurable given the inherent variability in measuring and calculating mercury deposition.

- Future Actions to Reduce Emissions
    - Additional reductions in Minnesota's mercury air emissions are expected to occur due to foreseeable regulatory actions (Minnesota Mercury Reduction Act of 2006 and possibly from implementation of the Taconite MACT and BART/Regional Haze requirement, CAIR, CAMR, and the statewide mercury TMDL).
    - Because of the importance of out-of-state emissions to mercury deposition in Minnesota, the overall impact of the in-state emission increases or reductions on the deposition of mercury in northeast Minnesota and subsequent bioaccumulation in fish is likely to be small.
    - Implementation of the TMDL and the measured response, or lack of a response, in mercury deposition and fish concentrations will determine the extent of national and global emission reductions needed in order for Minnesota to comply with the mandates of the TMDL program.

Based on the findings presented above, the cumulative potential emissions from the proposed projects do not have the potential to cause or significantly contribute to mercury deposition and bioaccumulation in fish in northeast Minnesota lakes or streams.

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Abbreviations, Acronyms and Selected Definitions

Abbreviations and Acronyms

AREA	Minnesota Power's Arrowhead Regional Emission Abatement Project
BACT	Best available control technology as defined at 40 CFR 52.21(b)(12)
BART	Best Available Retrofit Technology
BWCA	Boundary Waters Canoe Area (Wilderness); located in northeast Minnesota
CAA	Clean Air Act
CAIR	Clean Air Interstate Rule
CAMR	Clean Air Mercury Rule
CFR	Code of Federal Regulations
DRI	Direct Reduced Iron
EIS	Environmental Impact Statement
EPA, or USEPA	United States Environmental Protection Agency
Hg	mercury
IPM	Integrated Planning Model used for estimating impacts from CAMR
kg	kilogram
L	liter
LTVSMC	LTV Steel Mining Company
m^2	square meter
MACT	Maximum Achievable Control Technology
MDNR	Minnesota Department of Natural Resources
MERP	Xcel Energy's Metropolitan Emission Reduction Project
mg	milligram
MDN	Mercury Deposition Network
MPCA	Minnesota Pollution Control Agency
MPUC	Minnesota Public Utilities Commission

MW	Megawatt (1 megawatt equals 1,000,000 watts, or 1,000 kilowatts)
NESHAP	National Emission Standards for Hazardous Air Pollutants
NO_x	Nitrogen oxides – including all of the oxides of nitrogen
NP55	standard length Northern Pike – 55 cm
ppm	parts per million
PSD	Prevention of Significant Deterioration
PTE	Potential-to-emit as defined at 40 CFR 52.21(b)(4)
SO_2	Sulfur dioxide
SOx	Sulfur oxides – including all of the oxides of sulfur
SRB	sulfate reducing bacteria
TMDL	Total Maximum Daily Load
ton	Short ton = 2,000 pounds
ton, long	Long ton = 2240 pounds
ton, metric	Metric ton = 2204.6 pounds
µg	microgram
$\mu g\ m^{-2}\ yr^{-1}$	micrograms per square meter per year
U.S.	United States
VNP	Voyageurs National Park; located in northeast Minnesota
yr	year

Selected Definitions (from MPCA 2005b)

Anthropogenic Mercury Emissions – the mobilization or release of geologically-bound mercury by human activity that results in a mass transfer of mercury to the atmosphere.

Atmospheric deposition – the mass transfer of gaseous, aerosol, or particulate contaminant from the atmosphere to the earth's surface (see mercury dry deposition and mercury wet deposition)

Bioaccumulation – increase in contaminant concentration through a food web; includes uptake through food and water or air.

Bioconcentration –uptake and increase in contaminant concentration only through the water or air, not food.

Biomagnification – increase in contaminant concentration between trophic levels.

Class I Area – Under the Clean Air Act, a Class I area is one in which air quality is protected more stringently than under the national ambient air quality standards; Federal Class I areas include national parks, wilderness areas, monuments, and other areas of special national and cultural significance. Mandatory Federal Class I areas include certain national parks (over 6,000 acres), wilderness areas (over 5,000 acres), national memorial parks (over 5,000 acres), and international parks that were in existence as of August 1977.

Federal Class I Areas in Minnesota – Boundary Waters Canoe Area Wilderness and Voyageurs National Park.

Global Scale – refers to emissions transported on a global scale; it does not refer to the sum of all emissions on Earth, but rather that portion of total emissions that are transported around the globe.

Local scale – The area within which emissions can travel in one diurnal cycle (generally within 100 km of a source). Local influences are characterized by measurable concentration gradients with relatively large fluctuations in air concentrations caused by meteorological factors such as wind direction (Expert Panel 1994).

Mercury dry deposition – mass transfer of gaseous, aerosol, or particulate mercury species from the atmosphere to the earth's surface (either aquatic or terrestrial, including trees and other vegetation) in the absence of precipitation.

Mercury wet deposition – mass transfer of dissolved gaseous or particulate mercury species from the atmosphere to the earth's surface (either aquatic or terrestrial) by precipitation.

Mercury Methylation (Methylated) **–** process of adding a methyl (CH_3-) group to a mercury ion (Hg^{2+}). Methylation can occur either biotically or abiotically, but sulfate-reducing bacteria are considered the primary methylators in aquatic systems (i.e., wetlands and lakes).

Methylmercury – CH_3Hg^+ or MeHg **–** a cation that is the biologically active form of mercury; it has a very high affinity for sulfur-containing compounds, such as the amino acid cysteine; this is the form of mercury that accumulates in fish and is toxic to humans and wildlife.

Natural mercury emissions – mobilization or release of geologically-bound mercury by natural biotic and abiotic processes that result in mass transfer of mercury to the atmosphere.

Regional scale – the area requiring more than one diurnal cycle emission transport time (about 100 to 2000 km from a source). The regional scale describes areas sufficiently remote or distant from large emission sources so that concentration fields are rather homogeneous, lacking measurable gradients (Expert Panel1994).

Standard length fish – a set total fish length that is used to compare mercury concentrations among lakes and over time. The standard lengths used by the MPCA are 55 cm northern pike (NP55) and 40 cm walleye (WE40). Mercury concentrations for a standard length fish are determined from a linear regression of measured mercury fish tissue concentration versus fish length.

Taconite – low-grade iron ore processed by crushing and concentrating to yield a pellet for use in iron smelters. Taconite has low mercury concentrations but large volumes of the ore are heated during the pelletizing process, which releases ore-bound mercury into the atmosphere or scrubber water.

TMDL – Total Maximum Daily Load. The maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. TMDL also refers to the process of allocating pollutant loadings among point and nonpoint sources.

Appendices

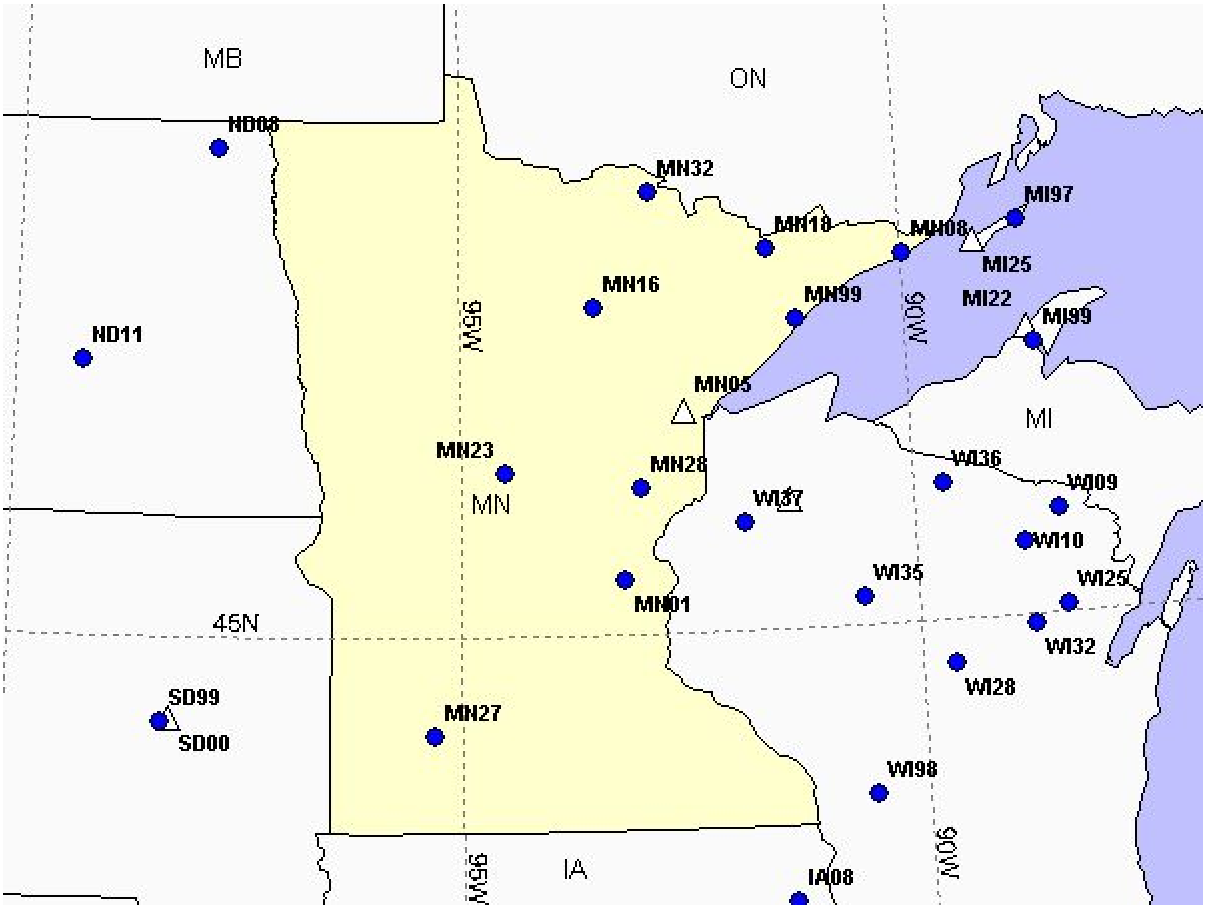
Appendix A

Figures:

A1. Location of NAPD monitoring sites in eastern North Dakota, Minnesota, Wisconsin, and the Upper Peninsula of Michigan.

Tables:

A1. Data from Mercury Deposition Network (MDN) monitoring sites in northern Minnesota for the 1996 through 2004 time period. Data from NADP (at http://nadp.sws.uiuc.edu/, accessed 1 November 2005).



(from http://nadp.sws.uiuc.edu/sites/sitemap)

Mercury Deposition Network sites in Minnesota: MN18, MN16, MN23, MN27

Figure A1. Location of NADP monitoring sites in eastern North Dakota, Minnesota, Wisconsin, and the Upper Peninsula of Michigan.

Table A1. Data from Mercury Deposition Network (MDN) monitoring sites in northern Minnesota for the 1996 through 2004 time period. Data from NADP (at http://nadp.sws.uiuc.edu/, accessed 1 November 2005).

Site	Year	Hg [1]	Hg [1]	Precipitation	Latitude	Longitude	Elevation
		ng L^{-1}	:g m^{-2} yr^{-1}	cm	degree	degree	m
MN16	1996	10.54	8.31	78.8	47.531	-93.469	431
MN16	1997	13.40	10.03	74.9	47.531	-93.469	431
MN16	1998	11.31	9.01	79.7	47.531	-93.469	431
MN16	1999	12.10	10.97	90.7	47.531	-93.469	431
MN16	2000	12.83	9.40	73.3	47.531	-93.469	431
MN16	2001	8.96	7.29	81.4	47.531	-93.469	431
MN16	2002	11.37	8.31	73.1	47.531	-93.469	431
MN16	2003	11.00	6.87	62.5	47.531	-93.469	431
MN16	2004	8.98	6.87	76.5	47.531	-93.469	431
MN18	1996	14.35	10.23	71.3	47.946	-91.496	524
MN18	1997	10.16	4.34	42.7	47.946	-91.496	524
MN18	1998	13.42	8.38	62.4	47.946	-91.496	524
MN18	1999	11.33	8.63	76.2	47.946	-91.496	524
MN18	2000	15.14	9.79	64.6	47.946	-91.496	524
MN18	2001	11.69	8.87	75.9	47.946	-91.496	524
MN18	2002	10.19	5.71	56.1	47.946	-91.496	524
MN18	2003	11.83	6.94	58.6	47.946	-91.496	524
MN18	2004	10.98	7.55	68.8	47.946	-91.496	524
MN23	1996	9.33	6.11	65.5	46.249	-94.497	410
MN23	1997	11.74	6.93	59.0	46.249	-94.497	410
MN23	1998	14.11	9.78	69.3	46.249	-94.497	410
MN23	1999	16.75	12.48	74.5	46.249	-94.497	410
MN23	2000	12.49	9.01	72.1	46.249	-94.497	410
MN23	2001	12.94	11.49	88.8	46.249	-94.497	410
MN23	2002	11.22	8.63	76.9	46.249	-94.497	410
MN23	2003	11.64	7.79	66.9	46.249	-94.497	410
MN23	2004	10.54	7.04	66.8	46.249	-94.497	410

[1] Volume-weighted concentration based on all valid weekly samples for the site and year. Deposition (in :g m^{-2} yr^{-1}) calculated from volume-weighted concentration and annual precipitation.