PART 10: SUMMARY OF OPTION AND STRATEGY EVALUATION CRITERIA

Committee members adopted a practice of using different criteria at different stages of their work. Readers will find reference here to "phases" of the study process. The phases referred to are described in a figure, the "Strategy development and evaluation procedure," that occurs at the end of this section.

Feasibility:

SRFRS Committee members apply professional judgement on a qualitative basis and gather available information on the following criteria:

- Technical capability ≡ availability of the physical means to reduce mercury releases
- Economical ≡ ability of firms to compete economically
- Reduction potential ≡ likely effect on mercury releases
- Social factors ≡ political acceptability, with "set asides" subject to Advisory Council approval

Applicability: "Feasibility" was used to focus data-collection efforts on a shorter list of reduction options that have the most promise. It is to be used in a similar fashion later to narrow the initial list of reduction strategies.

Cost-Effectiveness = Total annual cost divided by the total annual reductions (pounds)

SRFRS committee members should "describe strategies that encourage implementing the options that are *most cost-effective*...." Cost-effectiveness affects option preferences. Cost-effectiveness data will also likely be used to prepare input data for economic impact models.

Reduction Potential

Reduction Potential estimates cover: a) annual reductions in mercury releases, b) total reductions over 20 years, and c) potential effects that reductions of mercury releases will have on mercury contamination in fish.

Applicability: Data on the potential for reductions in mercury emissions or use have been collected as part of Phase I. These data will play an important role when SRFRS develop strategies designed to reduce mercury releases (Phase II-a). A more in-depth look at the expected results of different strategies, focused on *contamination* reduction potential, will occur as part of Phase II-c.

Permanence

Permanence is the duration of mercury reduction options, taking into account re-emission possibilities and transfer of mercury from one medium to another (e.g., from air to water).

Applicability: SRFRS should give preference to options that are most permanent when developing strategies (under Phase II-a). Facets of this criterion (e.g., re-emission potential) may also be considered during Phase II-c as part of the analysis of the contamination reduction potential of strategies.

Compatibility

Compatibility is a measure of consistency with other programs and initiatives.

Applicability: Although the SRFRS, in developing strategies, should provide comments regarding concerns they have with compatibility of strategies, the decision regarding whether compatibility is a significant issue should be made by the Screening and Evaluation Committee under Phase II-b.

Flexibility

Flexibility includes two considerations: a) can the strategy itself be readily changed in the future, i.e., is it responsive to change in external conditions, and b) does it allow affected sources to decide site-specific details regarding what action to take?

Applicability: SRFRS, in developing strategies, should provide comments regarding the flexibility of strategies. Under Phase II-b, the Screening and Evaluation Committee will rank strategies to identify those that are most flexible. Screening and Evaluation committee members will also consider the flexibility when deciding which strategies to recommend for further analysis.

Comprehensiveness

Comprehensiveness is the extent to which a mercury contamination reduction strategy applies to all emission sources.

Applicability: The Screening and Evaluation Committee, under Phase II-b, will rank strategies to assess their relative comprehensiveness. Applying the “comprehensive” criterion will be a matter of determining how many sources will be affected, or how many will be excluded.

Economic Impact

Economic impact analysis estimates the net effects of a strategy on jobs, personal income, etc.

Cost/Benefit Analysis

Cost/benefit analysis considers the ratio of the economic cost of reducing mercury releases to the economic value of the damage caused by mercury contamination.

Fairness

The fairness criterion considers the distribution of economic burdens among affected sectors. Criteria Committee members agreed that comprehensiveness is an appropriate element of a fairness criterion. Extensive program scope roughly equals fairness. The more emission and contamination sources covered by a program, the fairer the program is. A second element for the fairness criterion is proportionality of the costs incurred and a sector's contributions to environmental mercury contamination. For example:

	Strategy 1		**Strategy 2**	
Sectors:	**Contribution**	**Cost incurred**	**Contribution**	**Cost incurred**
A	20%	25%	20%	50%
B	80%	75%	80%	50%

Under the proposed criterion, Strategy 1 would be considered fairer than Strategy 2.

Applicability: The Advisory Council will consider fairness, along with results of economic impact analyses and other relevant information, when making final recommendations under Phase III.

Political and Social Concerns

Political and social factors are taken into account through qualitative evaluations of political factors and social acceptance, such as impacts on sensitive populations and minority communities.

Applicability: This is an "extra credit" criterion to be considered by the Advisory Council under Phase III, "Fairness." Criteria considered in the previous phases take priority. However, all else being equal, a strategy that has fewer political or social downsides should be preferred.

Transferability:

Transferability is the extent to which a system can be adapted readily in other states.

Applicability: This is an "extra credit" criterion to be considered by the Advisory Council under Phase III, "Fairness." Criteria considered in the previous phases take priority. However, all else being equal a strategy that is more readily transferable should be preferred.

Verifiability

This criterion relates to program enforcement and evaluation. The MPCA is often asked to provide data (for internal use, for legislators, EPA, and others) which shows how effectively a program is meeting its goals. It would be appropriate to call for regular evaluation of mercury reduction strategies to check their effectiveness. Data availability defines the appropriate measure for this criterion.

Applicability: This is an “extra credit” criterion to be considered by the Advisory Council under Phase III, “Fairness.” Criteria considered in the previous phases take priority. However, all else being equal a strategy that is more easily verifiable should be preferred.

Strategy development and evaluation procedure

Committee Tasks

Phase 1: Option Development and Criteria Definition

Criteria Committee (Critters) defines criteria and recommends an evaluation procedure.

Source Reduction Feasibility and Reduction Strategies Committee (SRFRS):

a) produces a comprehensive lists of options for each source
b) prioritizes options to identify the most feasible options
c) gathers data on cost-effectiveness, reduction potential, and permanence of most feasible options; and
d) summarizes data in useful format for developing strategies.

Phase II-a: Strategy Development

SRFRS & Critters describe strategies that encourage implementing the options that are most cost-effective and have the highest reduction potential, considering permanence and commenting on flexibility and compatibility.

Phase II-b: Strategy Analysis Stage 1

Screening and Evaluation Committee evaluates strategies and recommends a "short list," using qualitative criteria to narrow the list. SRFRS provide details and revise strategies as needed.

Phase II-c: Strategy Analysis Stage 2: Evaluation subcommittees analyze the contamination reduction potential and economic impacts for a "short list" of strategies, and rank results. (Economic impacts include regional impact analysis and cost-benefit studies.)

Advisory Council Meetings and Tasks

March 31: SRFRS present a summary of information on options and inventory.

May 27:
-Critters present proposed criteria definitions and evaluation procedure, and report on their "trial" evaluation

October 12:
-SRFRS present proposed "long list" of strategies.

November: **Advisory Council** reviews results of first round of strategies evaluation, approves the "short list" of strategies, and determines scope for next stage of evaluation and ranking.

Phase III: Final Strategy Selections

December: **Advisory Council** selects one or more strategies to recommend to MPCA, considering committee evaluations and recommendations.

Criteria

Criterion to be used for Phase I:
Feasibility of option

Criteria to be considered:
- Cost-effectiveness
- Reduction potential
- Permanence

Criteria to be used:
- Comprehensiveness
- Feasibility of strategy (technical, economical, reduction potential, social factors)
- Flexibility
- Compatibility with other regulations and initiatives

Primary Criteria:
- Results of Phase II Analysis
- Fairness

Extra Credit Criteria:
- Political/Social Concerns
- Transferability
- Verifiability

PART 11. SUGGESTED OUTLINE AND QUESTIONS FOR DESCRIBING OPTIONS

The following general outline is to be used for describing different options for various sources.

Source: [e.g., coal-fired electric utility]

Option: [Name/description of the option, and, if appropriate, the "percent reduction" target - 0% (no decrease and no increase), 10%, 60%, 100%, etc.]

A. Reduction Potential

1. How many pounds of mercury release to the environment could be prevented per year? Over the next 20 years?
Note if the reduction would affect ongoing sources or be a one-time reduction.
2. For options involving mercury contained in products, is it likely that all or a portion of the mercury contained in the products would be released to the environment in the absence of this option occurring? In other words, how significantly might this option reduce mercury releases, or the potential for accidental mercury release?
3. Is anything known about the link between decreasing releases from this source and the resulting impact on the concentration of mercury in fish in Minnesota? For example, what is the speciation of the prevented mercury release, or its expected environmental fate?

B. Permanence of Mercury Release Reduction

Discuss the duration of mercury reduction options, taking into account re-emission possibilities and transfer of mercury from one medium to another (e.g., from air to water).

C. Cost and Cost-Effectiveness

What is the estimated cost to implement this option? Include all direct costs. Do not include indirect costs at this time (they will be covered later as part of an economic impact study). Detailed advice for calculating total annual cost and cost effectiveness ($ per pound of mercury releases reduced) is contained in a paper entitled "Proposed Definition of Cost Effectiveness" prepared by staff from MPCA and the Center for Clean Air Policy and approved for use by the Criteria Committee.

D. Implementation Issues

Describe technological hurdles, reliability issues, contractual obligations, etc. which may affect the ability to implement this strategy, and incentives necessary for this option to be utilized.

1. Does the technology needed to implement this option currently exist? If not, in what stage of development is it?
2. What obstacles might constrain implementation?
3. What potential effect does this option have on the environment in addition to mercury?

4. Are there societal impacts beyond environmental or economical?
5. What incentives currently exist for a source to implement this option?
6. What incentives would work best to encourage or require implementation?

D. Historical Information
Has this option been used for this or other sources, for reducing releases of mercury or other pollutants?

E. References
List recommended sources of information requested above (written reports, research institutes, business associations, etc.)

PART 12. LETTER FROM MPCA TO MERCURY RELEASE SOURCES REQUESTING DATA

To: All parties that may be responsible for environmental releases of mercury.
Re: Need to Quantify Environmental Releases of Mercury at your facility.
December 8, 1997

The Minnesota Pollution Control Agency (MPCA) has committed itself to investigating the feasibility of an overall reduction in mercury contamination in Minnesota. The investigation is proceeding: the MPCA obtained a grant from the U.S. Environmental Protection Agency, hired a full-time coordinator (Carol Andrews), and assembled a stakeholder group that has met monthly since May 1997, a group we call the Advisory Council. The Advisory Council will make recommendations to the MPCA as to policies to reduce mercury contamination, taking into account:

- ability to reduce mercury contamination;
- cost-effectiveness; and
- the need for regional, national, and international cooperation.

As part of its deliberations, the Advisory Council has logically decided that it needs a comprehensive accounting of mercury releases to the Minnesota environment, including mercury released to air, land, and water. MPCA staff has been asked to prepare our best estimates of mercury releases (in pounds per year), even though it is not always easy to have a high degree of confidence. We will try to communicate the degree of confidence we have in the estimate by calculating a range of possible values, in addition to our best estimate. The range will be a function of variation in replicate analyses or actual variations in the mercury content of fuels and process materials. Where enough data is available, a standard deviation may be calculated instead of a data range.

We need your help quantifying the mercury released to the environment from your facility so that statewide totals can be calculated. We are especially interested in data that contribute to a mass-balance calculation for a given calendar year, such as mercury in incoming materials and fuels, mercury released to water and air, and mercury in shipped products. Because the statewide total emissions to the air is only about 5,000 pounds a year; we are interested in tracking quantities as small as a few pounds per year.

Given that detailed information will take time to assemble, we request that you place the highest priority on quantifying air emissions for 1995 and 1990. The Advisory Council is interested in data over time because they will be considering the idea of credit for facilities that have already reduced releases. We would be interested in information on other years, especially if your process changed and mercury releases increased or decreased (please provide a brief explanation of what changed). The Council is also interested in projected emissions in the future, and would appreciate a guess at emissions for the year 2005 considering growth and any other process changes such as the addition of control equipment.

In addition, the Advisory Council is interested in quantifying mercury contained in devices at each facility, and the potential for removing this mercury from service. We are therefore interested in receiving information about the number of mercury devices, the type, the estimated mercury content, and information on phase-out, recycling, or substitution of these devices since 1990 and plans on into the future. Between now and the year 2005, how much mercury in devices will you dispose of?

Attached is a figure titled, “Generic Schematic for Environmental Releases of Mercury” that provides a conceptual framework for quantifying environmental releases of mercury. We are not providing more detailed forms to fill in because the very creation of a form presumes that we know how your process works. In fact, if you have a flow diagram for your facility, please attach a copy to your information submittal. One way of providing mercury release information to us is to write summary data (averages and ranges) for each year on a copy of the Generic Schematic, and use reference numbers to refer to attached calculations. (To help us understand how each facility arrives at their emission estimates, please include worksheets or a description of how calculations were made, and note the source of the numbers used in the calculations. Where laboratory data sheets are available, please attach copies--for stack tests, please provide copies of the cover sheet, results, data for each impinger, Orsat, and moisture analyses.) Our order of preferences for calculating mercury emissions from fuel combustion is outlined in the attached Table A. Please note which option you choose and indicate the reasons for that choice.

Your fuel supplier may be able to provide you with an average concentration of mercury in your fuel. If you cannot obtain data on the mercury content of the fuels that you use, you may wish to use mercury emission estimates made by the Electric Power Research Institute (EPRI) in a 1996 report, *Mercury in the Environment -- A Research Update*. EPRI estimated that combustion of fuel oil emits 0.46 pounds of mercury per trillion Btu and combustion of natural gas emits 0.0008 pounds per trillion Btu (Table 2-6), and combustion of subbituminous coal emits 3.2 pounds per trillion Btu and combustion of bituminous coal emits 6.4 pounds per trillion Btu (Table 2-7). If in the future you obtain more accurate data on your fuel, the estimates for your facility can be changed. If your facility produces bottom ash or fly ash, please provide data on the quantities of each produced per year even if you do not have measurements of the mercury concentration. Please call me if you have questions on any of these requests.

The Advisory Council is not only interested in pounds per year, but the average concentration of the mercury in the water, air, ash, etc. that is introduced into the environment, because dilute forms of mercury are usually more difficult to control than concentrated forms. All of this information will be valuable to the Advisory Council as it proceeds in its discussion.

On behalf of the Mercury Advisory Council, I thank you and your company for making data available for discussion. We recognize that there is no law or rule requiring you to submit this information, but in the absence of submitted data the Pollution Control Agency will have to make estimates of environmental releases. This accounting of mercury releases to the environment is important because policy recommendations will, in part, rely on it.

Because we are interested in maximizing the accuracy of mercury release estimates, if at any time more accurate data become available, please submit updated estimates directly to me. If not all data requested is immediately available, feel free to submit the requested information, as it becomes available. In recognition that time is money, we are interested in how much time it takes to prepare the information and an estimate of how much time it would take to prepare an annual update in the future.

In summary, our highest priority request is air emissions for 1995, and our next-highest priority is air emissions for 1990 -- this data would be most useful if we received it by January 16, 1998. Data on mercury contained in devices at your facility (switches, manometers, etc.) would be most useful if we received it by February 13, 1998. We would appreciate the other information requested as soon as it is available. (Please contact me with any questions you have concerning this request. I can be reached at (612) 296-7800, or (800) 657-3864, or by email at edward.swain@pca.state.mn.us. Information in response to this request should be mailed directly to me.

Edward B. Swain, Ph.D.
Research Scientist
Air Quality Division

PART 13. TACONITE PROCESS DESCRIPTION

Taconite is a low-grade magnetic iron ore (a hard, dense, fine-grained, highly abrasive rock composed of varying proportions of magnetite (Fe3O4), chert (SiO2), hematite (Fe2)3), and several iron-bearing silicates and carbonates). This ore must be processed to concentrate the iron content and create a pellet that can be readily shipped for use in blast furnaces. Taconite is mined only in the Mesabi Range in Minnesota, extending from Babbitt on the east 110 miles southwest to Grand Rapids. The active mine areas currently extend from Babbitt (Northshore Mining Co.) to Keewatin (National Steel Pellet Co.). The conversion to taconite mining versus natural ore mining on a large scale took place in the 1950s (natural ore mining commenced in 1892).

Key steps in taconite mining are removal of the surface; drilling and blasting of the lean ore; drilling and blasting of the taconite ore; and hauling the taconite ore to the crusher. Key steps in taconite concentrating are crushing (stages based on mineral hardness); magnetite separation (again, may be more than one stage); and chemical flotation (not at all facilities). Key steps in the pelletizing/indurating process are dewatering; addition of binders and/or limestone; balling; and indurating (heat hardening and conversion of magnetite to hematite).

Between 65 and 74 per cent of the taconite ore crushed is rejected as tailings, which are placed in enclosed basins. Bentonite is mainly used as a binder to allow the pellets to be balled. Limestone is used both to make a flux pellet (7-11 per cent limestone, by weight) and to provide increased quality to acid pellets (0.1-1.0 per cent, by weight). Natural gas is the primary fuel used to indurate the pellets. Coal, fuel oil, petroleum coke and wood are also used as alternative fuels. The final pellet contains from 63 to 55 per cent iron and 4 to 6 per cent silica.

The mining of natural ore (non-magnetic) is relatively minor (two per cent of total product shipped). It occurs in small, short-term scram operations, currently located near Eveleth-Virginia.

PART 14. DESCRIPTION OF MINNESOTA'S PUBLIC REVIEW PROCESS FOR PROPOSED NEW ELECTRIC GENERATING FACILITIES

In 1993 the Minnesota Legislature enacted Minnesota Statute § 216B.2422. This statute requires the Minnesota Public Utilities Commission (MPUC) to "quantify and establish a range of environmental costs associated with each method of electricity generation." In its Order Establishing Environmental Cost Values (Docket No. E-999/CI-93-583) the MPUC found that the level of existing knowledge surrounding the environmental effects, transport and cost impacts associated with mercury emissions from fossil fuel electric power plants was not adequate to formulate practicable, *quantitative* eternality cost values.

However, although the MPUC declined to formulate a *quantitative* eternality cost value for mercury, the Commission did recognize that mercury in the environment is a significant concern and directed utilities to *qualitatively* explain how mercury emissions are considered in proceedings before the MPUC involving resource selection. Resource selection proceedings before the MPUC include resource plan filings, certificate of need applications, competitive service rider requests and, in the case of Northern States Power Company (NSP), competitive bidding for new generation resources.

The MPUC requires regulated electric utilities to file resource plans every two years. Resource planning consists of a process of evaluating all potential resources to provide for the needs of customers. The resources can include generation, purchases, demand-side management programs that reduce customer needs. The purpose of the resource planning process is to develop an integrated plan that will provide the greatest flexibility and lowest cost over a range of potential future situations. Resource plans include:

- an evaluation of multiple scenarios over a 15 year period,
- identification of likely resources to be used to meet customer needs,
- a five year action plan that details necessary implementation steps and deadlines,
- a 25-page non-technical summary,
- estimated impacts of the plan on rates, and
- least cost plans to meet customer needs in which 50 per cent and 75 per cent of all new capacity is renewable and conservation based.

A Certificate of Need is required from the MPUC in order to construct large energy facilities. Large energy facilities include power plants, high voltage transmission lines, pipelines for gas and liquid energy products, liquefied natural gas storage facilities, underground natural gas storage, facilities designed to convert any material into combustible fuel processing facilities, and nuclear waste storage or disposal facilities.

The Legislature (Minn. Stat. 216B.2422, Subd. 4) has established a state preference for renewable energy facilities over nonrenewable energy facilities, to wit: "The commission shall not approve a new or refurbished nonrenewable energy facility in an integrated resource plan or a certificate of need...., nor shall the commission allow rate recovery ... for such a nonrenewable energy facility, unless the utility has demonstrated that a renewable energy facility is not in the public interest."

PART 15: ECONOMIC IMPACT ANALYSIS OF THE SEC'S "SHORT LIST" OF MERCURY REDUCTION STRATEGIES

Summary

Economic impact analyses estimate the economic results of implementing the mercury reduction strategies selected by the Screening and Evaluation Committee. Net production cost increases in Minnesota's electrical utility, iron ore mining and government service sectors and increases in state and local government spending are assumed to be the primary financial effects of proposed strategies. No significant economic impacts are expected. Findings indicate that net, per sector, production cost increases will be less than 0.001 per cent of economic output in the affected sectors.

Inputs to the model were based on the estimated costs for six of the product-related strategies. In addition to these six strategies, the final "short list" of recommendations includes one additional product-related strategy. Some sectors are also expected to incur costs as a result of the proposed "negotiated voluntary agreements" strategy. The economic impact of these additional strategies has not been estimated, but is not expected to change the result of the economic impact analyses. It is assumed that firms will not voluntarily undertake activities that would cause them significant economic impact.

Some other findings are:

- *a broad financial cost distribution helps to keep economic costs down*
- *affected sectors can absorb, without significant loss, the economic costs associated with the recommended mercury reduction strategies*

INTRODUCTION

Economic impact analyses estimate the economic effects of mercury reduction strategies that the Screening and Evaluation Committee (SEC) has selected. Environmental regulations and other programs generally increase production costs for affected firms. For example, conventional regulations require manufacturers to install and operate pollution control equipment. Fees impose direct costs on waste dischargers. Trading systems generally operate from a regulatory basis that imposes costs, which are redistributed as traders exchange pollution allowances. Administrative costs accompany nearly all environmental policy changes.

Cost changes are generally the first effects considered in an economic impact analysis. They are the most obvious economic effects, especially for the communities and firms that confront new regulations. However, market activity spreads direct cost impacts beyond the point of initial contact. (Recent analyses indicate that dynamic responses to market change tend to dampen direct impacts.) When business firms incur new costs, they must find financial means to cover the new costs. Five options are generally available:

- increase prices,
- cut expenses in some other area of business activity,
- accept reduced profits,
- make productivity-enhancing changes that will lower production costs, or
- a combination of the first four options.

All of the options imply secondary economic effects for customers, competitors, suppliers, employees or investors. Moreover, policy changes that influence government spending and taxes affect taxpayers and those who benefit from government programs. It is not unusual to find that secondary effects, on consumers for example, exceed the value of direct effects on producers.

Cost increases are not the only economic effects of environmental policy changes. Often, costs imposed on one firm mean increased sales for other firms. When regulations require installation of pollution control equipment, manufacturers, designers, installers, monitoring and analytical firms may all sell goods or services to regulated firms. A thorough economic impact analysis takes into account <u>all</u> economic effects - direct and indirect, costs and increased sales - and evaluates the net effects expected from a change in environmental policy. Some economic benefits may also occur as a result of environmental improvements, however, these indirect effects are not covered in this analysis.[*] Brief descriptions of the models used to simulate environmental policy changes takes up most of the next section. Readers who are not interested in the models' internal structures can skip to the following section, titled "APPLICATIONS," which describes how the models were used to forecast economic impacts of the proposed mercury reduction strategies.

Before proceeding with a description of economic models, a word of caution is in order:

> Models are analogous to maps. Like maps, they have many possible purposes and uses and no one map or model is right for the entire range of uses. It is inappropriate to think of models or maps as anything but crude (but in many cases absolutely essential) abstract representations of complex territory, whose usefulness can best be judged by their ability to help solve the navigational problems faced. Models are essential for policy evaluation, but are often also misused since there is '... the tendency to use such models as a means of legitimizing rather than informing policy decisions. By cloaking a policy decision in the ostensibly neutral aura of scientific forecasting, policy-makers can deflect attention from the normative nature of that decision ...'
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> Costanza, Robert, "Ecological Economics: Reintegrating the Study of Humans and Nature," <u>Ecological Applications</u>, 6(4), pp. 978 - 990

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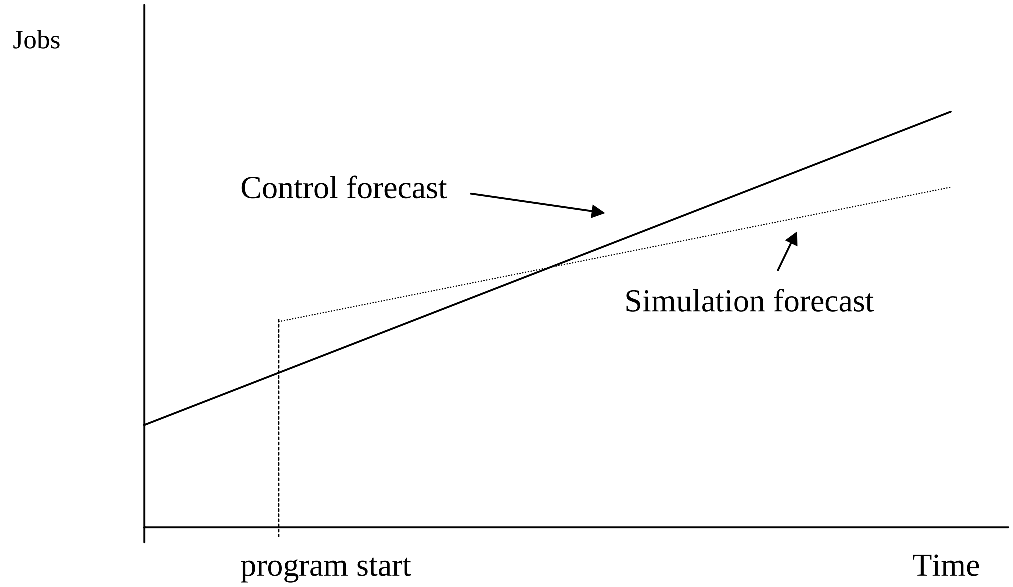
[*] For a complete analysis see: Hagen, Daniel A., James W. Vincent and Patrick G. Welle, "Economic Benefits of Reducing Mercury Deposition in Minnesota," a report done on behalf of the Minnesota Pollution Control Agency and the Legislative Commission on Minnesota Resources, 1998.

SIMULATION OF ECONOMIC IMPACTS

Simulation of the economic effects related to proposed rule changes is a three-step process. First, economic models calculate "control forecasts" that provide baseline values. Next, variables within the models are changed to simulate the effects of the proposal in question and the models' estimates are recalculated under the changed conditions. This step yields a "simulation forecast." Finally, models calculate differences between the control forecasts and the simulation forecasts. These differences define the economic impacts of the simulated changes. The graph below shows a picture of an impact analysis that focuses on employment effects:



The difference between the simulation forecast and the control forecast estimates the impact of the proposed change on statewide employment. When the simulated effect is above the control forecast value, higher employment is expected. Lower employment is expected when the simulation drops below the control forecast. Comparing simulation and control forecast results yields an estimate of *net* impacts.

Estimates of economic impact cover a range that is, at first, constrained to directly affected economic sectors and then broadens out to include all of the state's economic sectors. Two mathematical models of the state's economy make this sort of analysis possible.

A. IMPLAN

This model simulates economic impacts by solving a set of equations that describe the interrelated activities of the state's economy. National data compiled by federal agencies comprise IMPLAN's statistical foundation. Input/output (I/O) tables, developed by the U.S. Commerce Department's Bureau of Economic Analysis, provide a foundation structure for the model's description of Minnesota's economy. The I/O tables describe how economic sectors relate to each other.

An economy, like a natural system, consists of identifiable groups that interact in complex and dynamic ways. Business firms, nonprofit organizations and governments produce goods and services (supply) to meet the consumption needs (demand) of people and their organizations. A firm's output can satisfy either final demand (e.g., groceries) or intermediate demand (e.g., paper stock), in which case the product is used to make new goods or provide new services.

Each economic sector in the I/O tables relates to every other sector in a way that is based on the resources it demands from other sectors in the form of goods or services. Likewise, each sector supplies some part of its final output to other sectors and/or to final demand. The strength of these relationships varies, depending on the specific conditions of each sector. Consider an example:

HYPOTHETICAL INPUT/OUTPUT TABLE

	Agr.	Mfg.	Svcs.	Final demand	Gross output
Agriculture	60	60	20	60	200
Manufacturing	40	25	90	80	235
Services	10	70	55	105	240
Value Added	90	80	75	245	
Gross output	200	235	240		

Rows in the I/O table show the units of output from one sector that provide intermediate inputs (e.g., raw materials used to manufacture goods) for itself and other sectors along with output of finished goods and services. The service sector in this table provides 10 units to agriculture, 70 units to manufacturing, 55 units to itself and 105 units to final demand. This adds up to 240 units, which is called gross output. Columns show each sector's demand for goods and services, and the "value added" produced in each sector. The service sector buys 20 units of agricultural output, 90 units of manufacturing output and 55 units of its own output. Value added is the measure of the extra value that economic activity within a sector has added to the inputs it buys. Notice that the value added is equal to gross output less the sum of the inputs demanded by the sector. In the example, value added for the service sector is 240 - (20+90+55) = 75.

The example is kept simple for instructive purposes. IMPLAN's basic I/O tables have over 500 economic sectors. The value of the I/O tables for this analysis is that any change made in one sector has effects in all other sectors. This feature means that the IMPLAN model provides a comprehensive way to take indirect effects into account. The model also takes into account the relative strengths of intersectoral impacts, which depend on the extent to which some sectors rely on other sectors for productive inputs or economic demand. Thus, changes induced in one specific sector will have only slight effects on another sector that either demands little of the changed sector's output or supplies few of the changed sector's inputs. Conversely, a heavily dependent sector will be strongly affected by induced changes. A Social Accounting Matrix extends IMPLAN's I/O foundation to include the "institutions" (e.g., households, government) that demand final goods and services from business firms.

Results from modeled simulations are defined in terms of a set of standard economic variables. Usually, policy makers are interested in employment, output, income, trade and perhaps productivity measures. Findings in this evaluation will be described in these terms. Other measures of economic impact are also available (e.g., value added), but they will be provided only if they are called for later on.

B. Economic and Demographic Forecasting and Simulation Model

An Economic and Demographic Forecasting and Simulation Model (EDFS-53) is used to forecast the economic effects of proposed mercury reduction strategies. IMPLAN does not estimate time-specific forecasts. It has two time periods - today and tomorrow. EDFS-53, however, can forecast economic effects from 1996 to 2035. (1996 through 1998 have forecast values because the model's historical data end in the year 1995.) Using EDFS-53 along with IMPLAN allows evaluations of the effects proposed changes will have over an extended time period.

EDFS-53 consists of a series of linked equation systems. For example, a variable of primary concern in economic impact studies, employment, is linked to other variables such as wage rates, demand and production costs. Three groups of linkages form the model's basic structure.

1. Demand and Supply Linkages Local and external demand determine gross state output, or the total value of goods and services produced within the state. Output thus depends on the strength of consumers' desires for the goods and services that can be offered in the state. The EDFS-53 takes into account the goods and services each economic sector demands from all other sectors. Sectoral demands are further subdivided into the familiar elements of macroeconomic studies: consumption, investment, government spending and trade. A simple picture of gross state output would look like this:

Total consumption	C
Total investment	+I
Total government spending	+G
Total exports	+Ex
Total imports	-Im
Gross state output	Y

2. Cost Linkages Costs of goods and services have important effects on supply and demand. Every good and service competes, in some degree, with all other goods and services for a share of the consumer's budget. If all other things remain equal and the price of a product rises, consumers will demand less of the product. They will either find substitutes or they will make do with less. The availability (measured as relative cost) of substitutes and the strength (measured as "elasticity") of demand also matter.

Costs are taken into account because people often care about issues other than total output. They want to know what changes in total output mean in terms of investment and employment as well. For example, increases in labor costs (e.g., new payroll taxes) may lead employers to substitute capital for labor.

Economic variables enter the EDFS-53 through the use of statements made in functional form (Cobb-Douglas) that describe the relationship between output and production costs. Firms buy labor and capital in order to produce goods and services. These purchased inputs are called factors of production. The amount of each factor that a firm hires depends on factor costs and the strength of demand for the firm's product(s). Variables in the EDFS-53 production functions include: sectoral demand, the relationship of local wage rates to national wage rates, the relative cost of capital, fuel costs, and the output/employment ratio (i.e., labor productivity). Production values further depend on relationships determined within the EDFS-53 that are referred to as Regional Purchase Coefficients (RPCs). The RPC measures the amount of total demand that is supplied by local firms. Local production depends on production costs relative to the rest of the nation; local industry growth trends and the strength of export demand.

3. Wage Determination Linkages Wage rates influence relative factor costs. The EDFS-53 includes a separate set of relationships that determines wage rates. Wage rates are estimated for each industrial sector, depending on wages for each occupational group within the industry (weighted by each occupation's share of industry employment), local trends and wage factors not related to occupational supply and demand. Local wages for occupational groups depend on demand for labor in that occupation, population, and a wage growth factor that takes into account current and past wages.

Linked equation systems describe the framework of the EDFS-53 and relate this framework to the conventional description of how mature economies work. The next analytical step is to use this framework to forecast development and to measure the effects of specific changes. National survey data are compiled so that they can be used within the EDFS-53 system of equations. Adjustments to national forecasts bring estimates down to the local (state) level.

EDFS-53 forecasts can be extended to the year 2035. Output measures resemble those available in IMPLAN, with a few exceptions. Results can be defined in summary or in quite specific detail. Intermediate-level results have estimates for the 53 economic sectors on:

Employment, by occupation	Profits, relative to the U.S.
Occupational wage rate changes	Labor intensity
Private, non-farm employment	Proportions of local demand supplied by local output
Various secondary employment effects	Total demand
Sales prices, relative to the U.S.	Total imports
Input costs, relative to the U.S.	Various export measures
Labor costs, relative to the U.S.	Total output

Fuel costs, relative to the U.S.
Capital costs, relative to the U.S.
Productivity, relative to the U.S.
Gross regional product
Wage and salary disbursements

Some examples will show how the simulation model is used. Consider a proposal to increase income taxes. The amount of the increase would be introduced into the model through a single policy variable, “Personal Taxes.” The likely effects of this change would include a decrease in statewide demand leading to lower employment and income. Increased government spending, another set of variables in the model, would offset (at least partially) the decline in consumer demand. Consider another example under which a large manufacturer proposed to build a new plant in the state. This change could be simulated through increases in the demand for construction services, followed by employment increases in the manufacturer’s sector.

Historical data provide the foundation for the forecasting model’s policy simulations. Comparison with federal sources shows less than a one per cent difference between the model’s most recent historical entries (1992 through 1995) and employment statistics from the Department of Commerce’s Bureau of Economic Analysis. So the EDFS-53s historical basis fits reasonably well with relevant and broadly accepted empirical data.

APPLICATIONS

Current EDFS-53 model estimates have control forecast values for Minnesota’s total employment, which range from 3.1 million in the year 2000 to 3.2 million in 2004. Total personal income in the year 2000 is forecast at $138 billion, increasing to $162 billion in 2004. The table below has control values for other economic variables.

Table 1
Control forecast (EDFS-53)

Summary statistics	2000	2001	2002	2003	2004
Employment (1,000s)	3,153	3,177	3,204	3,226	3,248
GRP ($billions, 1992)	$ 146	$ 148	$ 151	$ 154	$ 157
Personal income ($billions, nom.)	$ 138	$ 144	$ 149	$ 155	$ 162
PCE - Price index '92 dollars	118.578	121.394	124.307	127.302	130.381
Real disposable personal income	$ 99	$ 100	$ 102	$ 103	$ 105
Population (1,000s)	4,713	4,725	4,737	4,749	4,762

Estimates from the IMPLAN model show 1995 values for employment and economic output in the industrial sectors directly affected by strategies that the Screening and Evaluation Committee selected.

Table 2
Control Values (IMPLAN 1995)

Sector	Output ($ millions)	Employment (1,000s)
Iron ore mining	$ 1,301	6.1
Electrical Utilities	$ 3,353	9.7
Government enterprises	$ 959	5.0

Before the Screening and Evaluation Committee selected its recommended strategies, a preliminary economic impact analysis was made for the strategies that became known as the Nike ("Just Do It!") list. These strategies' cost estimates derived from values included in the Source Reduction Feasibility and Reduction Strategies committee's report.

Table 3
Annual estimated cost for six product-related strategies

Description	Average Cost	Reduction Potential	Total Cost
Increase recycling infrastructure	$1,300	150 lbs.	$195,000
Reduce installed mercury	$1,400	120 lbs.	$168,000
Product labeling	$600	360 lbs.	$216,000
Education programs	$200	500 lbs.	$100,000
Change state purchasing policy	$10,000	17 lbs.	$170,000
Label installed products	$6,400	145 lbs.	$928,000

Screening and Evaluation Committee members added strategies to the Nike list. For example, a new local strategy calls for "negotiated voluntary agreements" to reduce mercury emissions. Cost estimates for the new strategies are roughly two million dollars per year. This is not enough to make a significant difference in the findings of the preliminary economic impact analysis. Readers should bear in mind that: a) the current analyses exclude cost estimates for the more recent strategies added by the Screening and Evaluation Committee and b) findings from the preliminary analysis probably would not change if costs for the new strategies were added.

Direct costs, as noted above are not the only economic effects to be expected from mercury reduction programs. When payments to cover costs are made, money shifts from one sector to another, leading to indirect effects. Some relevant examples will help explain this process:

1. New programs or responsibilities for the MPCA may have to be paid for by tax collections. Taxes affect all households and business sectors in the state. Our economic models simulate likely transactions by increasing state government spending and decreasing disposable income.

   On the other hand, new program costs could be covered by program cuts in other areas, with no net change in taxes. A program shift of this sort presumably would impose some loss on people who benefited from programs that are cut. However, this analysis will not simulate a tax-neutral program shift because: a) there is no reasonable way to describe likely future program cuts and b) a conservative assumption - that new taxes will cover new programs - is more likely to yield a significant economic impact.

2. New emission control requirements will likely cause plant operators to pay for new equipment, supplies and services. Plant operators will incur new cost and the firms that sell the required equipment, supplies and services will get some new business. Our models simulate these transactions as production cost increases for some firms, with offsetting sales increases for other firms.

One of the recommended strategies calls for increasing the scope of household hazardous waste programs so that they accept mercury-bearing discards from business firms. Cost estimates for this strategy cover:

-	increased state and local government spending	+ $125,000 per year
-	increased waste disposal (production) cost for business firms	+ $ 25,000 per year

Offsetting entries in the economic simulation are:

-	reduced disposable income (tax increases)	- $125,000 per year
-	increased sales for hazardous waste management firms	+ $ 25,000 per year

Costs and relevant offsets were estimated for all strategies on the list. Input values for the EDFS-53 simulation derive from a sum of all estimated costs and their related offsets are shown in Table 4. “Production costs” include increased waste disposal, labeling, or reporting costs. Estimated cost increases are distributed to all businesses for strategies that affect many sectors.

<u>Table 4</u>
Input values for EDFS-53

Variable	Amount
Disposable income (tax increase)	- $1.3 million
State & local government spending	+ $ 0.7 million
Sales: hazardous waste management	+ $ 0.1 million
Sales: advertising	+ $ 0.1 million
Production costs (all sectors)	+ 0.001 per cent

Simulated effects were estimated for a period extending from 2000 to 2004. Results indicate the following impacts for the state's general economy:

<u>Table 5</u>
EDFS-53 simulation results

Variable	Percentage change
Total employment	- 0.003%
Total output	- 0.003%
Total personal income	- 0.003%
Price index	+ 0.001%

Economic output, employment and personal income estimates are only slightly lower than control forecast values. The differences are not significant. Note the slight price increase that is also forecast. A price increase of this size fits well with the other results.

A finding of insignificant general economic impact is not enough to conclude that impacts in individual sectors will also be insignificant. Environmental programs tend to focus on specific sectors. Large parts of the economy (e.g., trade) seldom incur direct costs because of environmental regulations. Individual sectors may incur relatively high cost, but leave the general economy only slightly affected. There is a sense in which the general economy supports individual sectors and helps to minimize sector-specific shocks.

IMPLAN's classification system for economic sectors offers a closer look at economic impacts in the sectors that would be directly affected by the proposed mercury reduction strategies: electrical utilities, taconite plants, wastewater treatment plants, and waste incinerators. (IMPLAN includes the treatment plants and incinerators in a single, government enterprise sector.) Changes estimated, in 2004, in final demand for directly affected sectors are:

Table 6
Input values for IMPLAN simulations (nominal $)

Sector	Final demand change
Iron ore mining	- $19,430
Electrical utilities	- $84,350
Government enterprises	- $ 4,000

Results from IMPLAN resemble those from the EDFS-53 simulation:

Table 7
IMPLAN results

Sector	Estimated impact
Output	
Iron ore mining	- $19,871
Electrical utilities	- $86,900
Government enterprises	- $ 4,409
Total for all sectors	- $159,210
Employment	(number of jobs)
Iron ore mining	- 0.1
Electrical utilities	- 0.2
Maintenance & repairs - misc.	- 0.1
Total for all sectors	- 1.0
Total Personal Income per Sector	
Iron ore mining	- $ 5,090
Electrical utilities	- $16,041
Government enterprises	- $ 932
Total for all sectors	- $40,374

Relative differences (simulation - control) amount to thousandths, or less, of percentage points. No significant economic impacts, neither statewide nor sector-specific, are likely to result from using the mercury reduction strategies that the Screening and Evaluation Committee recommends. Estimated costs are too small and their burden is spread too widely to expect much economic change if the strategies are put into practice.

Some Advisory Council committees planned that this analysis would take into account the economic value of benefits realized if mercury contamination is reduced. Committee members spoke variously of: higher tourism revenue, improved human health, reduced threats to wildlife populations, and a generally improved quality of life for all Minnesotans. Methods are available to add such “secondary benefits” to the analysis. Unfortunately, committee members never had a chance to discuss different estimating methods and choose the most appropriate one. Since the economic impact estimates are so slight, secondary benefit estimates seem unnecessary. They would only serve to reduce impact estimates that are already pretty small.

Appendix: Remaining Issues

As noted in the Forward, time limits did not allow enough committee meetings to develop full consensus on all parts of this report. Among committee members who reviewed the final draft, some disagreements remain.

1. Stacey Davis, Center for Clean Air Policy

I have made some revisions to the first two sections of the SRFRS Report. Mostly the changes are to increase clarity, etc. The few changes of greater significance are as follows:

- Up front recognition that we look at cost-effectiveness just for mercury and that if we looked at other pollutants the cost-effectiveness numbers would come down.
- Specify additional benefits of acting at the state level under the Regional Context section.
- A sentence from Ed (Swain) saying that it is reasonable to think that reductions in mercury emissions will lead to reductions in contamination towards in the Option Development Process section.
- Under Options for Reducing Mercury Releases, note that the option information was current as of fall 1998.
- Listing of activated carbon injection and amalgam capture equipment under both the medium and high cost options to account for the full range of cost-effectiveness estimates.

E-mail communication, March 1, 2000.

2. Tim Hagley, Minnesota Power

It appears that the MPCA has decided to make substantive changes to the report content in some situations (one prime example is the very first section, before the TOC, that sets the tone for the report, and biases the report content). It would be very difficult at this point to try to address these changes to the satisfaction of all those on the SRFRS committee. One approach (which I would recommend) would be to put a disclaimer at the front of the report that states that this is in essence a report from the MPCA, the MPCA considered input from the SRFRS committee, but made the final decisions on report content, and that this report does not necessarily reflect the views of the members of the SRFRS committee. I suggest that you run the disclaimer by the SRFRS committee prior to inclusion in the report.

The second table 6-2 (options sorted by cost effectiveness) does not reflect the original matrix of cost effectiveness vs. reduction potential that was agreed to. It this table is going to remain, I don't know if it adds value to divide by low cost, medium cost, and then high cost, particularly because it is totally arbitrary and can be misinterpreted.

E-mail communications, March 13, 2000.

3. Patti Leaf, Northern States Power Co.

Attached are my comments on the SRFRS Final Draft Report. I have reviewed through the utility options and some of the strategies on a general basis. My comments are highlighted in the attached documents in blue. It is, of course, very difficult to go back two years and recall all the discussions and decisions that were made. I must say, for the record, that I am disappointed in the current form of the report. I anticipated some minimal changes to the report but this version has some, what I would consider, major changes. I do not feel that it is appropriate to include new options not originally written up by the SRFRS committee (such as cooling) or to reference events which have happened since the disbanding of the SRFRS sub-committee (e.g., references to reports which have come out or conferences that have been held). A lot of time and effort was put into the report for writing and review (numerous times) and committee members were left with the belief that the report, as last distributed, was near final form. It appears however, that certain write-ups have reverted to their original form, or very near it and some major changes have occurred. Considering the amount of time that was spent by individuals to review and comment on the report, this is disheartening, to say the least. Where I could, I have tried to address these issues in my comments.

E-mail communication, April 29, 2000.

Ms. Leaf also suggests:

a. deleting the third paragraph under § 8.1 Utilities because it is, "Inappropriate to include commentary on topics which occurred after the fact."

b. deleting the "Lowering Exhaust Gas Temperature" option because, "This was not discussed as an individual option during the SRFRS process."

c. adjusting the cost-effectiveness estimate for the Intense Conventional Coal Cleaning option by not taking into account the value of SO_2 credits. "No other estimates include the value of SO_2 credits. For consistency, they should not be included here either."