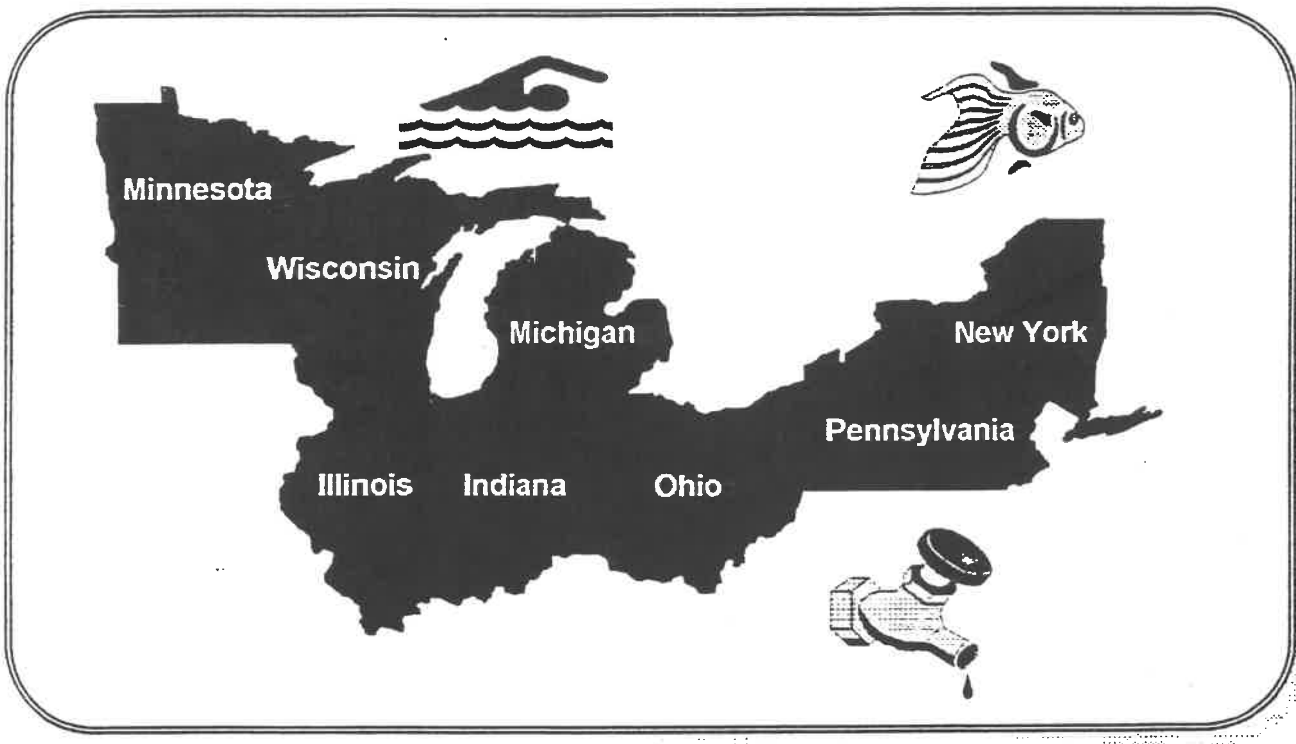
The Following Is A Working Draft For Comment – The Findings Do Not Represent The Position of the Council or Any Individual Governor.

The Great Lakes Water Quality Initiative:
Cost Effective Measures to Enhance Environmental Quality and Regional Competitiveness

Prepared for:

Council of Great Lakes Governors
Chicago, Illinois



July 1993

DRAFT FINAL

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Glossary

BAF	Bioaccumulation Factor
BCC	Bioaccumulative Chemicals of Concern
DNR	Department of Natural Resources
DRI	DRI/McGraw-Hill
EPA	U.S. Environmental Protection Agency
GLI	Great Lakes (Water Quality) Initiative
GLWQG	Great Lakes Water Quality Guidance (also, "Draft Guidance")
IJC	International Joint Commission
LAMPs	Lake-wide Area Management Plans
NPDES	National Permit Discharge Elimination System
PAH	Polycyclic Aromatic Hydrocarbons
PCB .	Polychlorinated Biphenyls
PCS	Permit Compliance System
POTW	Publicly Owned Treatment Work
RAPs	Remedial Action Plans
RIA	Regulatory Impact Analysis
TMDL	Total Maximum Daily Load
WLA	Wasteload Allocation
WQBEL	Water Quality Based Effluent Limit
WQC	Water Quality Criterion

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The Following Is A Working Draft For Comment – The Findings Do Not Represent The Position of the Council or Any Individual Governor.

Executive Summary

At the request of the Council of Great Lakes Governors, DRI/McGraw-Hill (DRI) has evaluated the economic and environmental impact of the Great Lakes Water Quality Initiative (GLI). We based our review on the Draft Guidance released on April 16, 1993.

Our major objectives were to:

- Project the direct costs of compliance for the GLI and the overall economic impact on the eight-state economy of the Great Lakes Region;
- Assess changes in water quality and impacts on beneficial uses of the Lakes that are likely to result;
- Determine which provisions of the GLI are the least cost-effective; and
- Recommend ways to improve cost-effectiveness of GLI without compromising environmental quality.

The purpose of the Great Lakes Water Quality Initiative is to establish uniform water quality standards for toxic chemicals within the Great Lakes basin and to use these standards in negotiating revised water quality objectives with the Canadian government under the Great Lakes Water Quality Agreement as amended in 1987. Hoping that such an initiative would reduce confusion in regulating the discharge of toxic substances and create a more "level playing field" for industry location decisions, the governors of the eight Great Lakes states participated in a Steering Committee that forwarded proposals to the EPA in 1992.

A. The Draft Guidance Contains Several "Cost Triggers"

DRI's estimate of the direct compliance costs attributed to the GLI will range between $710 million and $2.3 billion per year. This range reflects two types of uncertainty, technological and regulatory. *Technological uncertainty* includes the difficulty of predicting how successful dischargers will be in meeting the stricter limits by using inexpensive pollution prevention techniques and changes to cleaner manufacturing processes, versus costly end-of-pipe treatment technologies. *Regulatory uncertainty* refers to the lack of consensus among state and federal officials, let alone permit holders and outside experts, regarding the precise impact of GLI on existing permits. Efforts are currently under way to address both issues, and this report's recommendations are directed specifically toward reducing regulatory uncertainty.

DRI's cost estimate is in sharp contrast to the cost range of $80 to $510 million annually put forth in the EPA cost study.[1] The key differences are that DRI is less optimistic than the EPA about the likelihood of "waste minimization studies" to resolve the technological issues, and secondly our estimates take into account the potential cost consequences of the

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1 SCIENCE APPLICATIONS INTERNATIONAL CORPORATION, April 16, 1993, *Assessment of Compliance Costs Resulting from Implementation of the Proposed Great Lakes Water Quality Guidance.*

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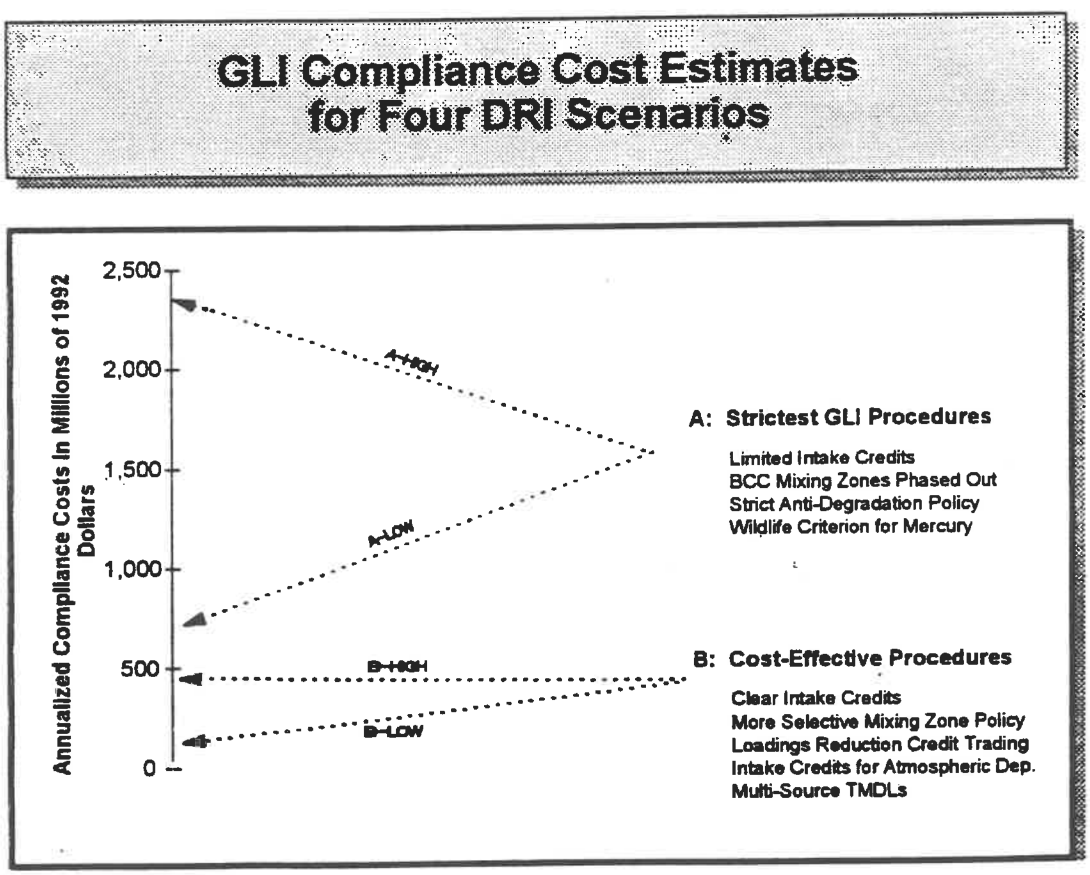
GLI implementation procedures -- the elements of the package that distinguish it most from existing state regulations.

Four specific provisions in EPA's Draft Guidance contain elements that drive up the costs of GLI without delivering commensurate benefits. These include

- lack of a clear, sensible approach to **intake credits**;
- a rigid **anti-degradation** policy that leaves little room for new plants with cleaner processes;
- the phasing out of **mixing zones** for Bioaccumulative Chemicals of Concern (BCCs), and
- the **wildlife criterion for mercury**, which aims at reducing concentrations of this naturally occurring element to below levels found in pristine conditions.

DRI drew heavily from the EPA cost study, which represented the most comprehensive review to date of the universe of existing dischargers, and from five engineering studies funded by trade associations, providing detailed analysis of treatment options for specific sectors. "Worst case" cost estimates provided by the trade association studies, combined with unsupported statements from other sectors total in excess of $10 billion per year. In our assessment, however, the chances that direct costs will rise above the cost range we report are remote.

Exhibit ES-1



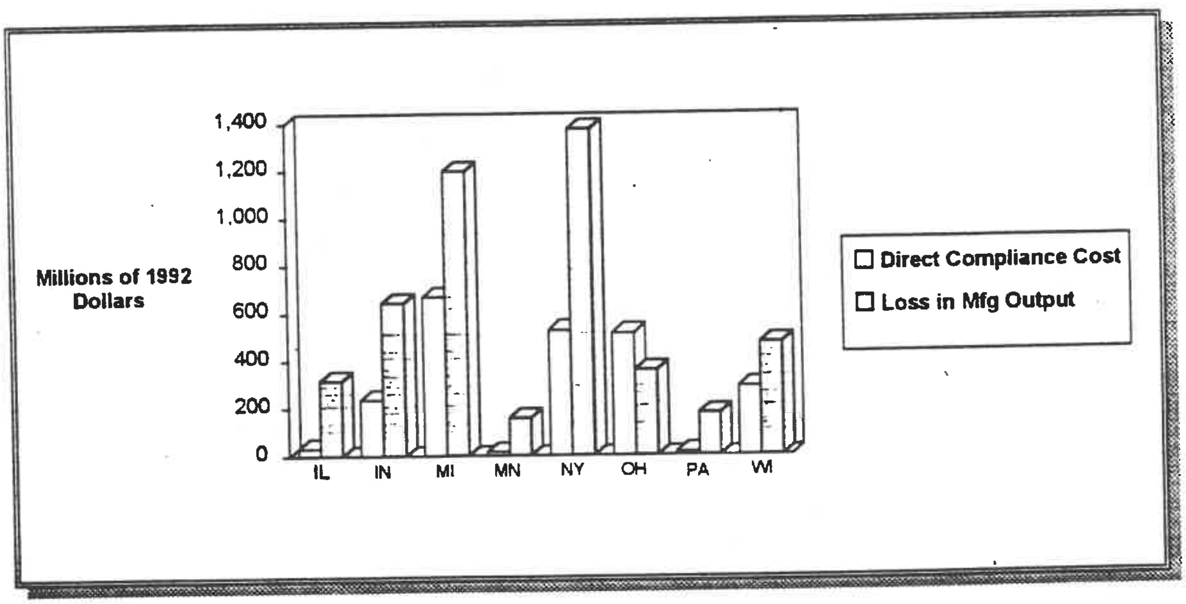
On the other hand, the prospects for reducing costs below the DRI Policy Set "A" projection are excellent. As shown in Exhibit ES-1, if certain GLI provisions can be modified, direct compliance costs for Policy Set "B" correspond closely to the cost range set forth by EPA. The measures proposed to bring the costs down to this range are discussed later in this Executive Summary..

B. No State Will Escape The Economic Impact

To assess the impact of GLI on the region's competitiveness, we built the DRI Regional Model of the Great Lakes Economy, which captures inter-industry linkage effects. This allowed us to track the transmission of economic impacts not only from sector to sector, but from state to state as well. One of the important messages of this research is that **no state will escape the cost impacts of GLI**. States such as Illinois, Pennsylvania and Wisconsin, each of which have fewer than 2% of the dischargers in the Basin, will experience losses in manufacturing output on the order of ten times the direct compliance costs of facilities located in their states (see Exhibit ES-2).

Exhibit ES-2

Comparisons Between Compliance Costs and Loss in Manufacturing Output by State
(Scenario A-High, Year 2005)



New York and Michigan, however, will together account for 55% of the $4.7 billion of industrial output that will be lost each year if DRI's worst case scenario prevails. Not only do these two states contain the majority of the Basin's 588 major dischargers, but their economies are extremely dependent on demand from industries in other states.[2] For example when compliance costs cause firms in the other states to contract, demand for auto parts from Michigan and business services from New York fall. **Therefore it is clear that the eight states need a joint solution that ensures cost-effectiveness, because economic impacts cross state boundaries just as easily as air and water pollution.**

The three sectors that will be hit the hardest are primary metals, transportation equipment, and non-electrical machinery. The iron and steel industry is hardest hit due to its high projected direct compliance costs ($480 million per year), while the other two are affected primarily through higher costs for their key inputs, and charges (or stricter pre-treatment requirements) from their local municipal sewer districts. The paper and pulp industry has compliance costs nearly as high as the steel industry, but it should be more successful in passing on costs to its customers, so output will not fall nearly as much in this sector.

Will GLI significantly reduce the region's competitiveness? The short answer is no, since the absolute magnitude of the effect is small The fall in manufacturing output is at most only one-third of one percent, and the loss in employment is less than 0.1%; these impacts will be nearly imperceptible in all but a few sectors. The drop in personal income will average from $6 to $23 per person per year, surely a small price to pay if the GLI could, for example, return the Lakes to a near-pristine condition.

However, GLI falls well short of that environmental goal, and the economic impacts will represent just one more nick in the region's competitiveness. Good policy demands that not very many regulations with price tags of this magnitude be adopted, because a series of small cuts in efficiency, each one affordable on its own, will collectively spell economic stagnation. On the other hand, making cost-effective modifications to GLI will preserve economic resources and public willingness to tackle other urgent problems in the Great Lakes ecosystem, such as atmospheric deposition, contaminated sediments, and loss of habitat.

The DRI Great Lakes Regional Model reveals that the loss in personal income will be less than half the foregone manufacturing output for residents of the Great Lakes states (see Exhibit ES-3). This large difference is explained by the fact that building treatment facilities is a fixed cost, hitting industries that are already capital-intensive. Compared with other policies with a similar direct cost, this kind of intervention sheds fewer jobs, and the cycle of income and expenditure losses that normally result from layoffs is suppressed.

Thus, rather than workers, business profits are exposed to greater losses,[3] and except in rare cases where establishments are shut down because of GLI, economic distortions will be relatively minor. For example, costs of abatement of mercury emissions from coal-fired power plants would have a far higher "multiplier effect" via electricity rate hikes. Because

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2 In the scenarios where cost-effective features are added to GLI, Michigan's relative share of the economic impact is far lower, because that version of GLI closely resembles Michigan's already strict regulations.

3 Since many of these firms are national or international in ownership, GLI actually shifts some of the burden outside of the Region.

different pollution reduction methods can have such widely varying indirect impacts, **the total economic cost should always be compared when making policy choices.**

Exhibit ES-3

Summary of Economic Impact Analysis
(Millions of 1992 Dollars)

	Scenarios			
	B-Low	B-High	A-Low	A-High
Direct Compliance Cost	59	381	709	2,286
Loss in Personal Income	43	319	484	1,880
Loss in Manufacturing Output	111	795	1,222	4,694
Employment Loss (# of Jobs)	745	5,402	8,649	33,230

C. The Environmental Benefits of GLI will be Modest

Although the goals of the GLI process are not all matters of tangible benefits and costs.[4] it is nevertheless crucial that policy makers recognize just how limited the impact of GLI will be on actual water quality.

According to the states' biennial water quality reports to Congress and other sources, GLI toxins are **not** responsible for any impairments in drinking water or swimming in the Lakes. However, nearly none of the shoreline miles along the Lakes meet their designated uses for fish consumption. Moreover, current concentrations of toxic substances seriously impair aquatic life, as well as many wildlife species such as cormorants and eagles that depend on fish for food.

Twenty-eight substances have been labeled as bioaccumulative chemicals of concern (BCCs) because they tend to accumulate to increasing concentrations along the food chain, and for this reason GLI procedures are most strict with these substances. Exhibit ES-4 shows the seven GLI contaminants that are responsible for fish consumption advisories.

4 For example, showing progress under the Great Lakes Water Quality Agreement may give the US a valuable bargaining tool in on-going negotiations with Canada, which is responsible for a significant portion of the contaminants in the Lakes.

Exhibit ES-4

The Use of PCBs and Most of the Other Contaminates that Cause Fish Consumption Advisories Is Banned or Severely Restricted.

Contaminants Responsible for Fish Consumption Advisories in the Great Lakes

Water Body	Chlordane	DDT	Dieldrin	Dioxins*	Mercury	Mirex	PCBs
L. Superior	X				X		X
L. Michigan	X	X	X		X		X
L. Huron							X
St. Clair R.					X		X
L. St. Clair					X		X
Detroit R.					X		X
L. Erie	X						X
Niagara R.				X		X	X
L. Ontario				X		X	X

* Dioxins and/or dibenzofurans

Note: Wisconsin has issued advisories due to "pesticides" (chlordane, DDT, dieldrin, or toxaphene) for Lakes Michigan and Superior.

If GLI could make significant progress toward eliminating the fish advisories, a whole host of environmental benefits could be estimated in dollar terms, and contrasted with the costs. Making the fish safely edible for humans and wildlife would lead to increased commercial fishing income, recreational fishing with all its tourism spin-off effects, enhanced enjoyment of the wildlife by residents and park visitors, and possible improvements in health among a small human population that regularly ignores the fish consumption advisories. These benefits are difficult to calculate accurately, but if GLI could achieve them, it would be worthwhile computing them, so that we could compare the benefits with their associated costs.

Alas, of the toxins causing fish advisories, only dioxin will experience a significant reduction in total loadings as a result of GLI. Under the most optimistic assumptions, mercury loadings from municipal and industrial point sources -- the only sources addressed by GLI -- will be cut by 80%.[5] However, known sources of mercury deposition from the atmosphere are estimated at ten times the point source contributions, as shown in Exhibit ES-5, and other sources of this naturally occurring substance may also be significant.

5 And reductions of that magnitude for mercury is a "cost trigger" on the compliance side.

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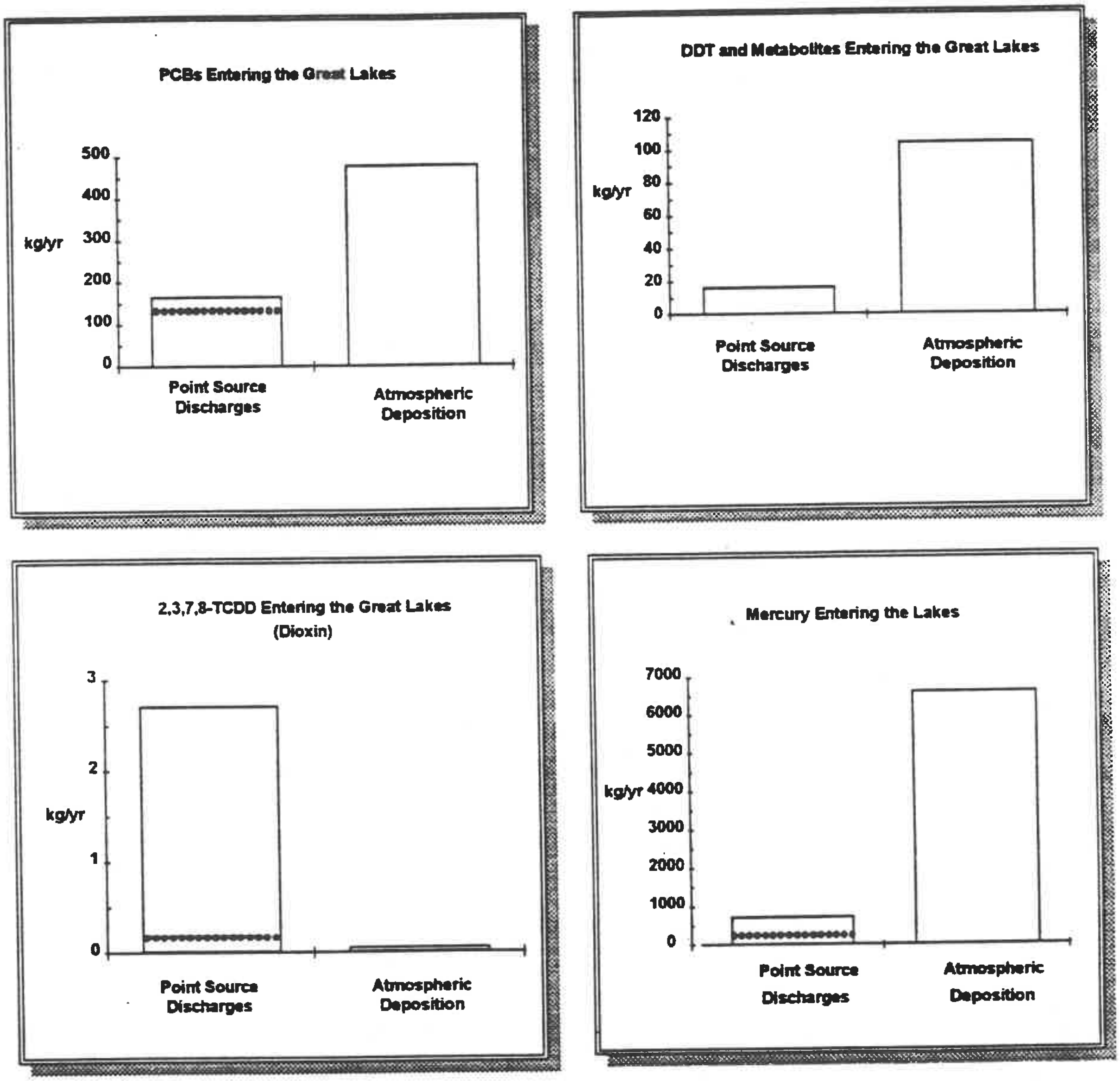
Exhibit ES-5

Point Source Contributions Are Dwarfed for Most BCCs by Atmospheric Deposition



Dotted line indicates estimated point source loadings after GLI
(Maximum potential reduction assuming discharges occur at calculated permit limits)

Sources: Eisenreich & Strachan, 1992; SAIC, 1993; EPA Permit Compliance System, 1991

Thus, GLI's impact on levels of mercury, PCBs and other chemicals of concern will be completely ineffective in isolation. Because of the large quantities of PCBs already in the ecosystem, levels of that pollutant are not expected to fall below the determined thresholds for fish advisories for decades, after which GLI's point source limits will have been fully responsible for the elimination of only one chemical causing fish consumption advisories, dioxin.[6]

This study explores many issues regarding the exact loadings reductions that can be achieved by GLI, and there are many uncertainties and questions that our current scientific data simply cannot answer yet. But the conclusions presented above are solid and accepted by nearly all researchers familiar with the problems of toxic chemicals in the Great Lakes. There is a wider debate about the correct strategy to achieve improved water quality, but even there, all observers agree that the non-point sources, including contaminated sediments, atmospheric deposition, and leaking waste sites, contribute a far greater share of these toxins than point sources contribute.

Partly because Executive Order 12291 required EPA to conduct a full Regulatory Impact Analysis (RIA) of GLI, EPA has estimated monetary values of both costs and benefits. The technical uncertainties involved in putting these dollar values on benefits are an order of magnitude greater than for costs, and the RIA is profoundly ambiguous about whether GLI will account for as much as 50% or as little as 1% of the benefits of a contaminant free fishery.[7] Even using relatively optimistic assumptions about cost and benefits,[8] the RIA concludes that costs have a better than even chance of exceeding monetizable benefits. The Council of Great Lakes Governors wisely instructed not DRI attempt to put monetary values on benefits in our analysis, since that exercise sheds so little light on practical policy questions. DRI believes measuring benefits through loadings reductions and assessing changes in beneficial uses is appropriate for this cost-effectiveness study.

DRI follows many state and federal environmental officials in supporting the application of a true ecosystem approach to developing environmental standards. Such an approach would fully consider all sources and fates of contaminants in the Great Lakes basins, as well as their biological and physical characteristics. This is much closer to the approach taken in Lakewide Area Management Plans (LAMPs), which concentrate on achieving solutions to lake-specific problems no matter what their source.

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6 Due to stringent existing regulations of dioxin, and process changes already under way in the paper industry, it can be argued that GLI itself would not be necessary to achieve this goal.

7 RCG/Hagler, Bailly, Inc., April 15, 1992, *Regulatory Impact Analysis of the Proposed Great Lakes Water Quality Guidance, Final Report*. Prepared for the US EPA.

8 EPA loadings reductions for evaluating benefits assume that current discharges are at the permit limits, while all cost scenarios assume that many facilities discharge at well below their permit limits. In addition, the use of EPA toxic-weighted loadings reductions blurs the distinction between chemicals discharged and chemicals impairing beneficial uses. These discrepancies bias any direct comparisons.

D. Cost Effectiveness can be Achieved with Minimal Loss of Benefits

The alarming outcomes described in DRI's Scenario A need not ever take place, if certain elements of the Draft Guidance can be re-thought and revised. The following list summarizes these elements along with the corrective measures that DRI recommends:

- Procedures governing *waste load allocations*[9] and *reasonable potential to exceed water quality standards* must be revised to allow for a sensible system of **intake credits**. Dischargers who use and return waters to the same water body should be allowed to discharge at the background concentration or between background and criteria. The use of tiny amounts of metal-based algaecides, and slight increases in concentrations due to evaporation should be explicitly addressed.
- The phased *elimination of mixing zones* for BCCs strives for loadings reductions as much as ten times beyond the already conservative wildlife criteria. For BCCs such as mercury and PCBs, whose loadings are predominantly from non-point sources, the benefits of these additional reductions are minute, while removal costs begin to rise exponentially at these concentrations. Granting municipal sewer districts "**intake credits for atmospheric deposition**" may mitigate the problem, since a good case could be made that cities should not be responsible for treating pollutants that literally rain on them from the sky. Instituting **multiple source total maximum daily loads**[10] would provide that dischargers of chemicals with high non-point source contributions are not required to bear a disproportionate share of the burden.
- The *anti-degradation* policy preserves existing water quality when it is better than the standard, by limiting new discharges from new and existing plants. However, in doing so, it freezes the status quo, so that a proposed plant using a cleaner process may be blocked while older plants jealously guard their right to discharge at historical levels. Devising a **scheme for trading of loadings reduction credits** with an offset factor would allow environmental improvements to take place alongside economic growth, changing a zero-sum game to a positive-sum game. Clearer handling of the allowance for higher loadings when there is an *important social or economic benefit* will also mitigate this problem.
- **More than any other substance in the GLI, the criterion set for mercury acts as a cost trigger.** It appears in nearly 50% of the existing permits sampled and is forecast to account for over 30% of the attributable costs of GLI in 1997, but this will only represent the tip of the iceberg in terms of projected costs of compliance. With mercury criteria set at concentrations 1,000 times more sensitive than EPA's current approved detection limits, the detection limits dictate how stringent individual permits will be. However, detection limits will inevitably improve with scientific progress, and coupled with mixing zone elimination, eventual loadings reductions will be literally

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9 In this section, italics indicate terms already defined under GLI; those in bold are DRI proposals.

10 The phrase "multiple source TMDLs" is mentioned in the Draft Guidance twice in Appendix E under Procedure 3 (3A. C. 4 on page 295 and 3B. C.3 on page 299) but is not defined. DRI has assumed a definition supported by discussions with state level permitting officials.

impossible to achieve with any known treatment technology, especially for municipal sewer systems with their enormous flow volumes.

Many of the recommendations made above can mitigate the mercury problem, but there is also scientific grounds to question the criterion itself. To prevent a cost spike where incremental benefits of point source mercury reductions are minimal, DRI recommends that the EPA either **revise the mercury criterion upward**, or set the standard in terms of **methyl mercury** (as Michigan does) to target the biologically damaging form of mercury.

- A final measure that would reduce regulatory uncertainty without significant environmental impact would be to **extend the life of permits** from five to ten years once GLI limits are reflected in permits. Business would be able to make investment decisions with longer time horizons, and further adjustments in permits, while delayed, would still be rapid relative to the ecological processes taking place in the Lakes.

E. Is the Great Lakes Water Quality Initiative Affordable?

Too often in public policy-making the question *"Can we afford ..."* to undertake some laudable goal is the most important question posed. However, this obviously fundamental inquiry can easily obscure the fact that, while we might indeed be able to *afford* a particular remedy, it may be much less effective than many other alternatives. Secondly, a consistent policy of adopting environmental remedies--each of which *"we can afford"*-- that are not the most effective will eventually both leave us short of our overall goal of a cleaner environment and out of resources to tackle the next societal challenge. In other words, if we fail to emphasize the question of cost-effectiveness, ultimately we will *"NOT be able to afford"* the goal of a cleaner Great Lakes Region."

Why in our policy-making is there inevitably more emphasis on *"what we can afford"* than on *"what is most cost-effective"*? A cursory evaluation of policy-making in the U.S. reveals two primary reasons: either the best options (1) are beyond the immediate scope of the regulatory body that must "solve" the environmental problem or (2) require political compromise or leadership that is difficult to muster.

In this analysis, DRI assumes in its cost projections for DRI Policy Set B that the factors causing potential cost spikes will be addressed. Since the EPA cost study did not incorporate these factors, it should not be surprising that DRI's range of cost estimates for Policy Set B corresponds closely to the EPA's range of $80 to $510 million annually. The main difference between the two estimates is that direct costs for Michigan are roughly half their magnitude in the EPA estimates, because DRI took into account the relatively strict nature of Michigan's existing regulations.

Given the broad public support for improved water quality in the Lakes, and the tangible and intangible benefits that implies, clearly the GLI process will go forward. The costs per person, ranging from 50¢ to $4 each year if the cost spikes are remedied, do not appear onerous, and future generations may yet thank this generation for taking a conservative approach to toxic levels in this unique ecosystem.

I. Great Lakes Water Quality Initiative: Choices Amid Uncertainties

The Great Lakes Water Quality Initiative (GLI) represents a coordinated effort by the eight states in the region to improve water quality in the Great Lakes. The GLI achieves this by standardizing around relatively strict water quality criteria and regulations for implementing permits. Given the structure of current state and federal laws, the GLI will affect only municipal and industrial facilities whose discharges are already currently regulated. By further restricting existing permits, pollutant loadings into the Lakes will be reduced, but this also imposes costs on those dischargers that install new treatment facilities.

This report, prepared by DRI/McGraw-Hill (DRI), assesses the economic and environmental impact of the Initiative, as expressed in the EPA Draft Guidance released on April 16, 1993.

Our major objectives have been to:

- Project the direct costs of compliance for the GLI and the overall economic impact on the eight-state economy of the Great Lakes Region;
- Assess changes in water quality and impacts on beneficial uses of the Lakes that are likely to result;
- Determine which provisions of the GLI are the least-cost-effective; and
- Recommend ways in which the GLI could be modified to improve cost-effectiveness without compromising environmental quality.

This chapter presents the issues and choices that Great Lakes policy makers face, given the GLI as currently written. DRI has identified several implementation procedures that have the potential to create cost "spikes" without reducing loadings and improving beneficial uses significantly. In some cases, these problems can be remedied by making the language and intent of the Guidance more clear; in other cases, existing procedures need to be altered, or new ones created, to resolve the problem.

DRI has developed four policy scenarios that estimate the range of costs of the GLI assuming different policies. Under the strictest implementation of GLI, the direct compliance costs range from $710 million to $2.3 billion; under more lenient GLI procedures, the direct compliance costs range from $60 million to $380 million. As will be seen in this and subsequent chapters, the projected costs are high in relation to the projected benefits of GLI.

The chapter begins with a summary description of the Initiative, and lays out the framework DRI used to analyze the initiative. The decision not to compare estimates of dollar values of benefits with costs, but rather to use cost-effectiveness as a criterion, is explained. Sections C and D introduce our critique of the key implementation procedures, and our proposed solutions. The final sections summarize the DRI economic impact scenarios, and the estimates of direct compliance cost.

A. History and Purpose of GLI

Intergovernmental cooperation involving the Great Lakes has a long history. The International Waterways Commission was formed in 1905 to advise the governments of Canada and the United States on water levels and flows in the Great Lakes. In 1909, the Boundary Waters Treaty between the United States and Canada was signed. This treaty founded the International Joint Commission (IJC) to resolve disputes over the use of water resources and to carry out studies and provide advice to the signatories.

Studies carried out by the IJC lead to the formulation of the 1972 Great Lakes Water Quality Agreement between the United States and Canada. This agreement aimed at protecting the Great Lakes from the effects of pollution through cooperation between the two countries. The focus of the agreement was the control of nutrient loadings to the lakes. It also provided for joint monitoring and surveillance programs coordinated through the IJC.

Continued research, including the results of these joint programs, identified problems caused by toxic pollutants in the Great Lakes. Based on this work, the Great Lakes Water Quality Agreement was amended in 1978 to expand its scope to include toxic pollutants. The agreement called for the virtual elimination of the discharge of persistent toxic chemicals and set targets for phosphorous loads to each lake. At the same time, the purview of the agreement was expanded to the entire Great Lakes ecosystem.

In 1987, the Great Lakes Water Quality Agreement was amended again, clarifying the roles of the U.S. and Canadian Governments, and the IJC. The governments' stated policy in the agreement is that:

- the discharge of toxic substances in toxic amounts be prohibited,
- the discharge of persistent toxic substances be virtually eliminated,
- a coordinated planning and management process be developed and implemented by each jurisdiction to ensure adequate control of all sources of pollutants.

The agreement includes numerical and narrative water quality standards as minimums for the two countries. The agreement calls for the identification and elimination of Areas of Concern in the Great Lakes basin. (Forty-two have since been identified.) Remedial Action Plans (RAPs) are to be developed and implemented to address the Areas of Concern, and Lakewide Area Management Plans (LAMPs) developed to address impairments in the uses of open and nearshore waters.

The purpose of the Great Lakes Water Quality Initiative was to establish uniform water quality standards within the Great Lakes basin and to use these standards in negotiating revised water quality objectives with the Canadian government under the Great Lakes Water Quality Agreement. The governors of the Great Lakes states, who began work on the initiative in 1989, believed that consistent water quality standards were necessary to reduce confusion and difficulty in regulating the discharge of toxic substances and reduce the possibility of "standard shopping" by industry looking to site a new facility.

The large number of people relying on the Great Lakes as a source of water supply, the threat of toxic contamination to industrial, commercial, and recreational uses of the lakes, and the long retention time for water passing through the lakes were cited as reasons for giving the lakes special protection.

In 1990, Congress passed the Great Lakes Critical Programs Act, which formalized the Great Lakes Water Quality Initiative. The act identified key activities in the Great Lakes Water Quality Agreement between the U.S. and Canada, and imposed deadlines on the U.S. EPA for carrying out activities. The Critical Programs Act required the EPA to published proposed, uniform water quality guidance for the Great Lakes, which is consistent with the objectives of the Great Lakes Water Quality Agreement. The agency published the proposed Great Lakes Water Quality Guidance (Draft Guidance) in April 1993. It is this guidance that is the subject of this study.

B. What Can You Take From This Report?

1. The Economies of the Great Lakes States are Interdependent

DRI has identified the key industries and states that will be affected by the GLI. The economies of the Great Lakes states have strong inter-industry linkages, that do not respect state lines, and the economic system will spread these costs significantly. Certain states with few dischargers will nevertheless experience economic impacts ten times higher than the direct compliance costs incurred in that state. If the extreme scenario comes to pass, no state will escape the cost impact.

The effects of GLI implementation on employment, income, and industrial output are presented from variety of angles, to provide policy-relevant insights. To the extent that states have been perceived as "competing for jobs by offering more lenient environmental regulations," the GLI ensures that such differences will no longer exist and cannot be exploited to the detriment of the Lakes. However, unless the Guidance is modified to reduce regulatory uncertainty, it has the potential to erode the competitiveness of the region's economy. The impact on competitiveness, the specific industries and states that are threatened the most, and the possible remedies are all detailed in this report.

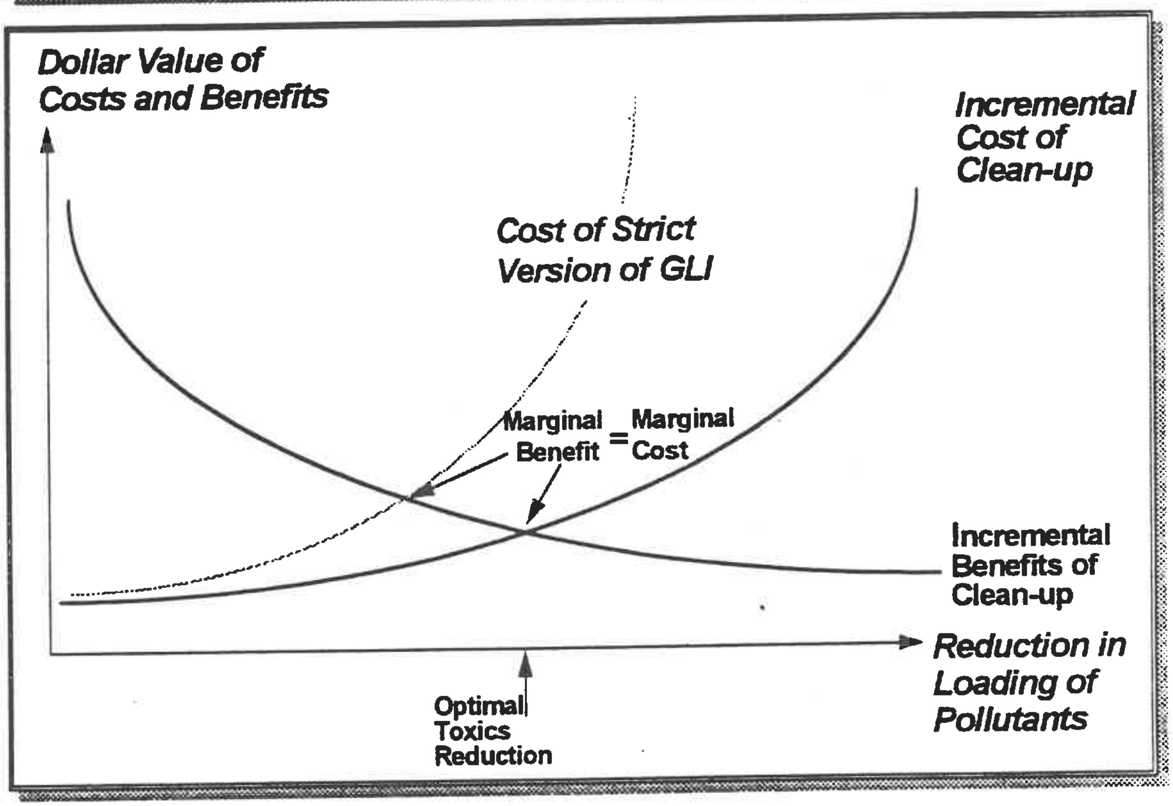
2. The Role of an Efficiency Criterion in Environmental Regulation

This report takes the water quality goals of the GLI as given and points out those provisions of the Draft Guidance that are least cost-effective, and that could be modified without materially impairing benefits. This approach was chosen because the more rigorous cost-benefit framework was deemed impractical given the difficulties associated with valuing environmental benefits in dollars. The wide ranges of cost estimates presented in this report are daunting enough, yet the uncertainty surrounding valuation of benefits is far larger. Even so, changes in pollutant mass loadings *at the margin by GLI's water quality criteria* are sufficient to extract policy-relevant conclusions.

However, to put the discussion into perspective, it is useful to review the Cost-Benefit framework that underlies all conceptual work in this area. Central to this perspective is the concept of diminishing marginal returns. (See Exhibit I-1.)

Exhibit I-1

Cost-Benefit Framework Seeks Balance Point Between Insufficient Clean-up vs. Excessive Clean-up



The earliest stages of environmental clean-up are generally easy to justify, since costs of simple remedial measures are l[illegible], and initial benefits are high. As greater and greater reductions are achieved, it is generally at a higher cost, and at a lower marginal benefit. At some point, the marginal benefits will equal the costs, after which, incremental clean-up will actually yield lower benefits below the value of their cost.

DRI is not suggesting that the level of toxic chemicals in the Great Lakes Basin is currently near the "optimal toxic reduction" point shown in the figure. Rather, the message is that certain elements of the GLI appear to violate assumptions behind the upward sloping cost curve. The assumptions that are violated include:

- the cheapest pollution reduction measures will be tried first, and

- successive clean-up efforts will be sequenced according to the least-cost, or cost-effectiveness, principle.

Since GLI actually ignores the costs inherent in its implementation, it is represented by a radically sloped cost curve that intersects the benefits curve much sooner than necessary (see Exhibit I-1). An extreme example of such inefficiencies is that of ignoring the air pollution of coal-fired power plants, which contribute literally tons of mercury into the atmosphere each year, most of which finds its way into the Lakes. At the same time, the Draft Guidance requires expensive treatment technologies to be applied to the process waters, which contain amounts of mercury measured in micrograms.

3. The Three Least Cost-Effective Elements of GLI Are Identified

Three specific GLI policies have emerged from the analysis as having the greatest potential to generate costs without commensurate benefits:

- Lack of well-defined Intake Credits,
- Elimination of Mixing Zones for BCCs, and
- Adoption of an Anti-Degradation Policy.

In the case of intake credits, DRI has concluded that the EPA does not intend to force facilities using noncontact cooling water to treat these waters prior to discharging; however, the language in the Draft Guidance does not ensure this outcome. The costs associated with such treatment would be exorbitant, and yield no perceptible benefit to the environment. Slight alterations in the wording of the Guidance can remedy this deficiency.

The mixing zone and anti-degradation policies do yield some environmental benefits, but they can also lead to "cost spikes" that are out of proportion with potential benefits. These spikes can be avoided by applying intake credits for atmospheric deposition or a variety of market-oriented mechanisms, such as loadings reduction credit trading, multiple source total maximum daily loads (TMDLs), a better definition of "economic and social development," and "atmospheric deposition credits."

4. GLI Will Hurt the Competitiveness of Great Lakes States

If GLI is implemented in its current form, the "worst case" scenario suggests that up to 33,000 jobs could be lost, and Great Lakes residents would forego $1.9 billion in personal income. This cost impact would fall mainly in Michigan, New York, and Wisconsin. This distribution results from the economic structure of the Great Lakes Region: affected dischargers in Ohio, Michigan and Indiana will reduce their purchases of industrial materials from the main industrial states. For this reason, states such as Illinois and Pennsylvania, despite the small number of affected dischargers, are significantly impacted by the GLI.

In its current form, the GLI will be mandated only for dischargers in the Great Lakes Basin, which covers all of Michigan and only parts of the other seven states. However, many of these states are considering applying the GLI provisions state-wide, in which case the overall costs and benefits will be larger. While analyzing that possibility is not in the scope of this study, industry and state-specific multipliers provided in this report can be used by state officials and other interested parties to convert the compliance cost estimates from adjacent regions into total economic impacts with reasonable accuracy.

C. Regulatory Uncertainty Is a Cost in Itself

1. The Permit Process is Complex and Idiosyncratic--and Thus Unpredictable

All direct industrial and municipal dischargers into the Great Lakes Basin are required to obtain an NPDES permit,[1] which is generated by state environmental administrators[2] and subsequently reviewed by the U.S. EPA. Experts from state and federal agencies have disagreed on the impact of the GLI provisions on permits, largely due to the complexity of the process itself, and due to unresolved ambiguities in the text.

One indication of how difficult it is for outsiders to predict the impact of GLI on permits is the example of U.S. EPA's own cost study. The study was prepared by Science Applications International Corporation (SAIC), a respected consulting engineering firm specializing in analysis of environmental legislation and design of pollution control strategies.

The SAIC study reviewed 25 Michigan permits in their survey of Great Lakes dischargers, and in their "most likely" scenario estimated that immediate compliance costs, not including longer-term procedures,[3] would total $10.2 million. When the Michigan Department of Natural Resources reviewed these same permits, they concluded that *none* of the costs identified by SAIC would in fact be justified, since none of the permit limits would be affected. The main difference appears to have been caused by the treatment of hardness of the receiving waters, which affects the toxicity and thus the water quality criteria for certain metals.

Because Michigan's water quality criteria are already generally as strict or stricter than the proposed GLI criteria, the initial impact on dischargers in this state should indeed be relatively minor. But this example merely underscores the point that environmental professionals can genuinely take significantly different interpretations of the language in the Guidance. Since EPA officials must review and approve each NPDES permit, even the state permit-writers' interpretation is not final, so regulatory uncertainty clearly makes it difficult to project changes in permits. If environmental watchdog organizations or dischargers believe that the final permit is to lenient or too strict, the potential for legal action adds yet another layer of uncertainty.[4]

Thus, even dischargers with dedicated pollution control offices staffed by knowledgeable environmental engineers face huge hurdles in forecasting the effects of the GLI for their

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1 National Pollution Discharge Elimination System.

2 Referred to as DNRs, short for Departments of Environmental Resources, throughout this report.

3 Such as future elimination of mixing zones, lowering of detection limits or costs of anti-degradation restrictions.

4 While this section has focused mainly on the 3,000 direct dischargers in the region, the 7,000 facilities that discharge into municipal sewer systems (POTWs) also face an added layer of regulatory uncertainty: based on changes in the POTWs permit, through pre-treatment programs they may face reductions in their permitted loadings, or monetary charges for the POTWs treatment costs -- a fourth layer of regulatory uncertainty.

corporate management. Any prudent, risk-averse corporation will take this uncertainty into account when deciding on new investments, expansions, reductions, or shutdowns.

In light of this, any measure that makes the permit process more predictable, even if the outcome is slightly stricter, will on balance reduce the cost of doing business, and therefore make the region more competitive.

2. Estimates of GLI Costs and Benefits Have Wide Margins for Error

If costs end up in the lower end of a forecast range because permits do not turn out to be strongly affected by GLI, benefits will also be in low end of their range---and vice versa. The preceding example of the wide range of differences in predicting the costs of Michigan's compliance with GLI has an important corollary: where there are no compliance costs, because permits will not change, there will also be no loadings reductions, and therefore no benefits.

As a general rule, where we hope to realize the greatest loadings reductions, we must also expect to pay a significant cost. Interestingly, the GLI offers many instances of high costs with no "real" loadings reductions (for example, no intake credits for once-through cooling water) and low costs for significant loadings reductions (for example, direct-source pollution minimization programs, such as weekly mercury collection from dental offices rather than letting them pour it down the drains).

3. GLI Itself Will Only Marginally Improve "Standardization" Across States

One of the original rationales for the GLI was the perception among state officials that potential investors were engaged in "standards shopping"—searching among the states and building facilities where environmental standards were most lenient, thus rendering ineffective the stricter regulations of neighboring states. While the GLI will reduce this practice, states are still left with wide discretionary powers. DRI does not intend to suggest that, after GLI, some states will be effectively more stringent than others. But potential investors attempting to chose sites for industrial activities will still face a thicket of individual, highly idiosyncratic procedures for implementing these regulations.

GLI will have narrowed the *environmental outcomes* across states, but it will not appreciably reduce the *regulatory uncertainty* faced by U.S. firms attempting to adapt to a dynamically changing economic landscape.

D. DRI Scenario Descriptions Have Been Chosen to Highlight Policy Choices:

In its choice of scenarios to analyze, DRI has been guided by two criteria: the need to bracket the reasonable range of potential outcomes and the desire to appropriately emphasize the policy choices available, and their impacts.

1. DRI's Four Policy Scenarios

This DRI/McGraw-Hill study reports two distinct sets of cost estimates:

a. **Policy Set A: Stringent Policies (no mixing zones, strict intake credits, etc.)**

   i. *Scenario A-Low: Uncertain costs end up in low end of range*

   ii. *Scenario A-High: Uncertain costs end up in high end of range*

b. **Policy Set B: Lenient Policies (mixing zones, easier intake credits, etc.)**

   i. *Scenario B-Low: Uncertain costs end up in low end of range*

   ii. *Scenario B-High: Uncertain costs end up in high end of range*

Policy Set A represents our best estimate of the range of costs if GLI is implemented today; the stricter options are chosen where EPA has provided options in the Draft Guidance. Under this scenario, direct compliance costs range from $710 million to $2.3 billion annually. The total economic impact, including indirect effects, will be to reduce personal income by between $480 million and $1.9 billion per year, and to eliminate from 8,600 to 33,000 potential jobs.[5]

Policy Set B presents the cost consequences of adjusting the GLI to clarify intent and/or eliminate cost-ineffective provisions. These steps include:

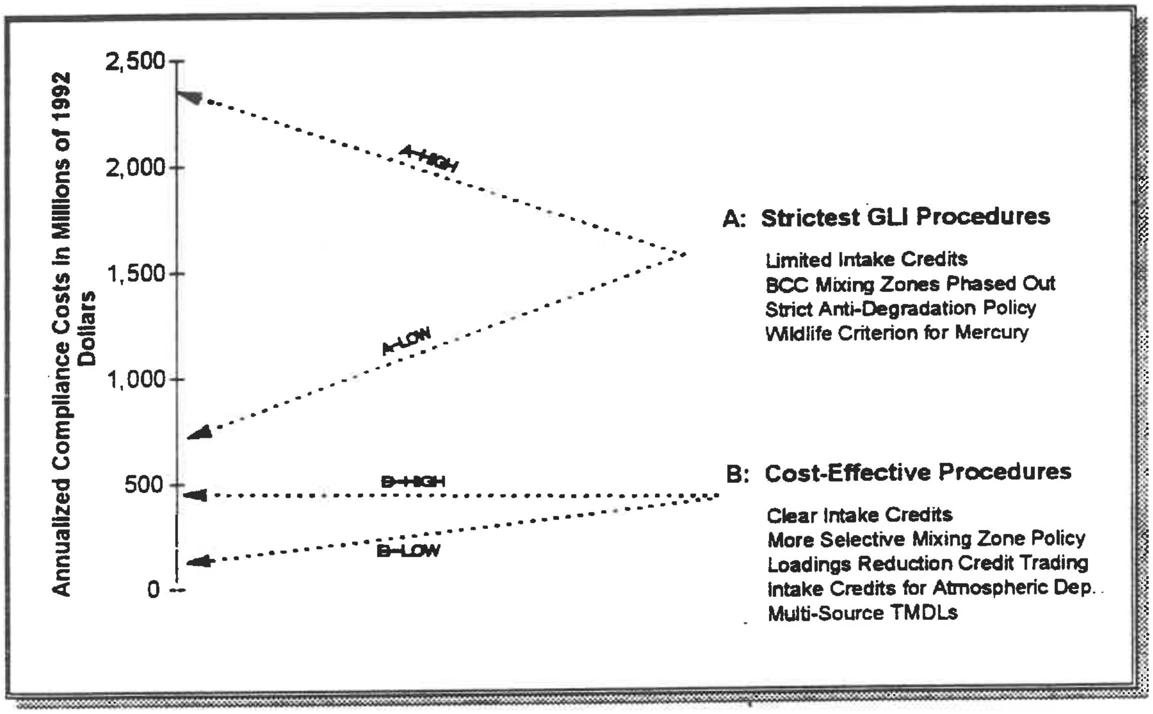
- Lenient interpretation of Intake Credits,
- Allow Mixing Zones for Mercury (or equivalent), and
- Soften or re-define Anti-Degradation Policy.

These policy changes, or their equivalent, will reduce the compliance costs of GLI to a range between $60 million and $380 million per year. Between 750 and 5,400 jobs would be eliminated, and the total economic impact in terms of lost manufacturing output ranges from $110 million to $800 million per year (see Exhibit I-2).

5 Note that, over this period, the region is expected to gain over 3,780,000 jobs. In this context, the loss from Scenario A-High is only slightly less than one percent of the projected employment growth in the region. While some portion of this loss represents jobs that will be eliminated, most of the effect will be expressed as a slower rate of creation of new jobs.

Exhibit I-2

Compliance Cost Estimates for Four DRI Scenarios



2. EPA Cost Study Scenarios #2 and #3

In order to facilitate computations of equivalent total impacts on the Great Lakes Region, DRI has also simulated the two most relevant scenarios provided by the EPA.

The EPA cost estimates, prepared by SAIC in 1993, were presented as four scenarios, highlighting the varying impact of assumptions about how GLI changes would be applied to individual permits. EPA considers Scenario #2 the "most likely" scenario. In the expectation that the EPA estimates will be of continuing interest to students of GLI, DRI has used those estimates as the basis for a series of simulations on the DRI Regional Model.

This methodology effectively converts the EPA assumptions regarding compliance costs into estimates of the total economic impact on employment, income, and competitiveness. While DRI believes EPA's cost findings are optimistic, the assumption behind their Scenario #3 -- that POTWs may not be able to pass all treatment limits onto their indirect dischargers, necessitating a more aggressive treatment POTW treatment program -- is plausible. Therefore, we have also reported this scenario in Appendix B, for comparison purposes.

3. Each DRI Policy Set Has a High and a Low Scenario

Due to remaining regulatory and technological uncertainty, the total range of uncertainty in these cost estimates remains large. DRI believes that a focus on achieving balanced implementation, especially in the three policy areas noted above, will reduce the range of uncertainty. We also believe that achieving this balance represents one of the most important goals for policy makers. As a consequence, these policies will be analyzed in detail throughout the chapters that follow.

II. Cost Effectiveness Can Be Achieved With Minimal Loss of Benefits

In this chapter, we examine ways in which the GLI can be made more cost-effective. We also give a more fully developed picture of the uncertainties surrounding the GLI and of ways to deal with these uncertainties. Finally, we explore the impact on the Great Lakes Region's industrial competitiveness.

Given the uncertainties arising from the initiative, the Council should proceed with caution. In general, the regulatory approach reflected in the GLI works better when the costs and benefits are more precisely quantifiable. The wide range of projected costs and the complexity of forecasting the effect of the Guidance on facilities increase the range of uncertainty. Technological uncertainty surrounding GLI is also high. It is difficult to foresee the extent to which facilities will be able to comply with the initiative by means of low cost measures or will instead be required to utilize high-cost treatment technologies.

Despite all this uncertainty, the risks to policy makers, including the Council of Great Lakes Governors, are fairly clear. The following two risks are chief among them:

- The public may easily be oversold on the GLI. The initiative will not solve even half "the problem" in the Great Lakes because toxic substances covered by the Guidance account for only one-half of the pollution and the Guidance addresses only point-source contributions. Point-source pollution itself represents far less than half of total loadings. Certainly, if the public is oversold on the potential of GLI and it does not deliver, the result could be a public backlash on environmental policies in general.
- The GLI will negatively impact the industrial competitiveness of the Great Lakes Region. This is not a simple case of "business never likes regulation," but, again, one of cost-effectiveness: are the losses---even small losses---of industrial output, jobs, and income necessary for the region to get the benefits of improved water quality? DRI's believes that they are not.

These risks can be managed through changes to the GLI implementation procedures. Three GLI measures have the greatest potential to generate costs without commensurate benefits:

- lack of well-defined intake credits,
- elimination of mixing zones for contaminants, and
- adoption of an anti-degradation policy.

In this chapter, we suggest ways of changing the GLI to address its shortcomings in these areas. We also explore measures relating to mercury criteria, detection limits, and potential contaminants.

A. Regulatory and Technological Uncertainty: Proceed with Caution

One of DRI's goals in this study was, through technical analysis, to narrow the range of cost estimates in order to improve the basis for policy making on the Great Lakes Water Quality Initiative (GLI). During the course of the study, new studies have increased the range of cost estimates quoted in public; the worst-case scenarios now portray annual compliance costs in the tens of billions of dollars. Meanwhile the DRI study has narrowed the estimated range considerably.

Despite these new studies and DRI's efforts to associate costs with various policy mixes, considerable uncertainty remains. This uncertainty stems from the very nature of the GLI process. The uncertainty surrounding the GLI can be usefully divided into *regulatory uncertainty* and *technological uncertainty*.

The term regulatory uncertainty describes the inability of permitted dischargers, legislators, state permitting authorities and even the U.S. EPA to predict the impact of GLI on permit limits. For example, the EPA cost study's detailed review of 25 Michigan facilities was completely reversed by an equally detailed review conducted by the Michigan Department of Natural Resources. Similarly, widely differing interpretations of the impact of GLI emerged when the U.S. EPA and the eight state Departments of Natural Resources (DNRs) were requested to submit estimates of changes in permits for three hypothetical facilities.

This uncertainty is driven by the complexities and built-in ambiguities of the permit process. Given these characteristics, it should come as no surprise that managers of private and public facilities have great difficulty forecasting the impact of GLI on their permit limits.

Technological uncertainty compounds the regulatory uncertainty. It is nearly impossible to predict the degrees to which industry will be able to meet GLI limits through cost-effective means (such as waste minimization studies and earlier investment in process changes that were inevitable) or through expensive end-of-pipe treatment technologies. The EPA cost study was quite optimistic on this score, predicting that nearly all loadings reductions could be achieved by small adjustments in materials or procedures used, and that dischargers would seldom resort to expensive treatment. However, given the steep reductions in loadings that will be required once analytic detection methods have improved and mixing zones have been eliminated, the plausibility of the EPA's treatment assumptions breaks down. Such issues are the main reasons for technological uncertainty.

1. GLI: Old Fashioned Approach to Regulation

Such uncertainties can be frustrating and may even prompt questioning of the benefit of economic analysis in this context. However, DRI believes that genuine uncertainties should be acknowledged so that strategies can be developed to deal with them:

- First, the regulatory uncertainty is a problem in its own right, and should be addressed by eliminating ambiguities and streamlining procedures in the Guidance itself; DRI has recommended specific changes along these lines.

- Second, policy makers should proceed with caution when outcomes are this uncertain. The projected benefits of GLI are modest, yet the costs are potentially significant. Adopting a more flexible policy that immediately implements the known cost-effective solutions, while aggressively investigating areas of uncertainty, is preferable and places no unnecessary burdens on the economy. For example, establishing market-based incentives for loadings reductions, such as credit trading schemes and cost-based regulations, ensures progress without risking "cost spikes."

The regulatory style employed by the U.S. EPA for GLI is better suited to situations where costs and benefits are more precisely quantifiable and there is consensus on goals and on the means of obtaining them.

The federal government and the public want concrete action now to improve the Great Lakes, and they will surely be pleased with effective action in the form of market-based, site-specific, risk-prioritized approaches. Genuine ecosystem approaches, such as the Lakewide Area Management Plans (LAMPs),[1] represent the latest thinking in environmental regulation---inside and outside U.S. EPA---and constitute genuine improvement over the water quality based approach embedded in the GLI. While water quality criteria are a vital defense against environmental degradation, such criteria are already in force in existing federal standards. The issues here are how much beyond federal standards the Great Lakes states go to improve the lakes, and what methods should be used to achieve this higher standard.

2. GLI Alone Can't Do the Job

Another reason to proceed with caution is that much remains to be done in the water quality arena, and expectations must be managed accordingly. If the public and their non-technical policy makers believe that by supporting GLI they will solve "half the problem" in the Great Lakes, they will be deceived. Toxic substances covered in the GLI are only one of many classes of problems facing the lakes, and point-source contributions of even those substances represent far less than half of the total loadings.

There is considerable risk of backlash after the public accepts the economic costs and elected officials accept the political costs involved and later hear of additional sacrifices to pay for items such as reducing mercury emissions from coal-fired power plants, or altering agricultural practices to reduce pesticide run-off. Ironically, because these strategies have not been pursued with vigor to date, the first round of elimination of these pollutants would likely be *far more cost-effective* than most of the GLI provisions selected by DRI for reconsideration.[2]

Exhibit II-1 illustrates the impact of the GLI on the main beneficial uses associated with the Great Lakes and their tributaries. DRI has used the chart below to justify the

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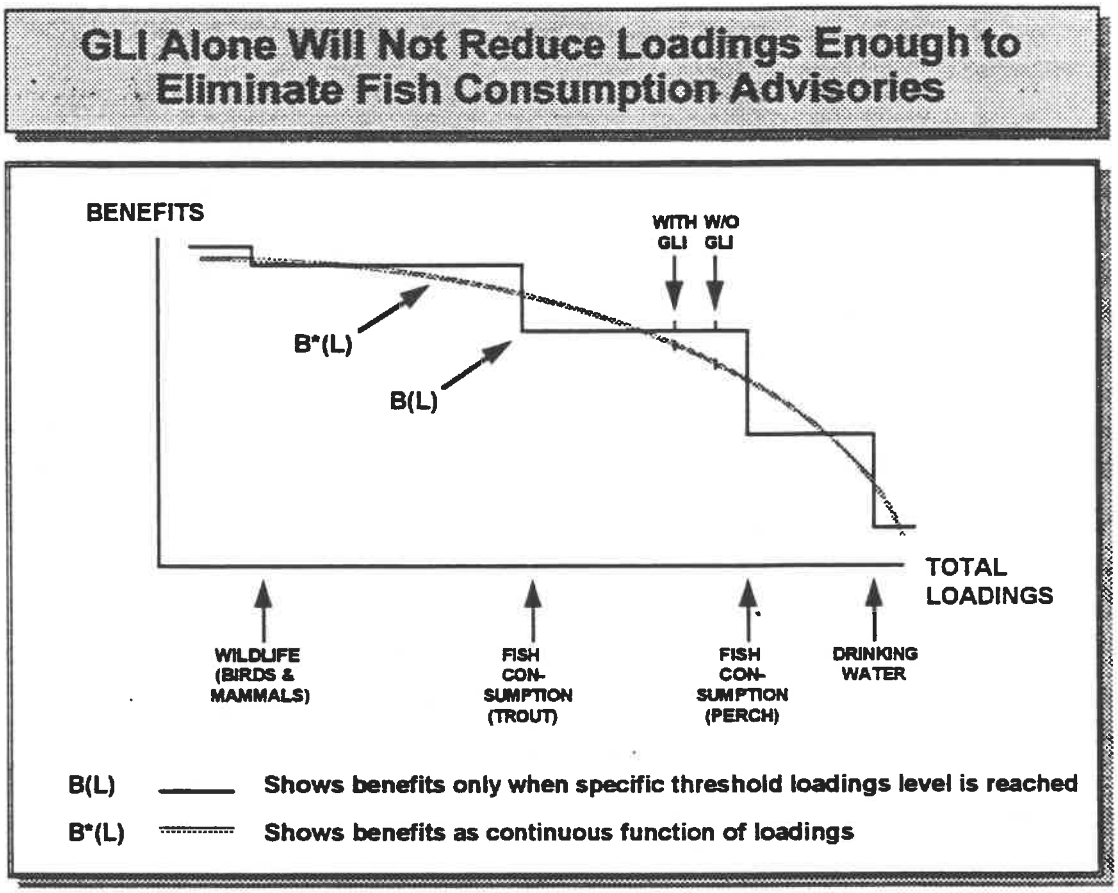
1 Discussed in Chapter 5 Section E.

2 See Figure I-1, which illustrates the principle that the first rounds of pollutant reductions are generally easily considered worthwhile — only when the incremental value of benefits begins to approach costs do the truly difficult choices need to be made.

treatment of loadings reductions as a benefit in and of themselves, even where no clear change in uses is directly caused by the adoption of the Guidance. The rationale is that, in a dynamically changing policy environment, it is impossible to predict how successful the states and the EPA will be in reducing non-point source pollutants, which are the main contributors to impaired use of water bodies in the Great Lakes Basin today. However, assuming that significant progress can be made, it is possible that the point-source reductions will contribute just enough to the total reduction to "push us over the edge," and achieve an improved level of beneficial uses.

Exhibit II-1

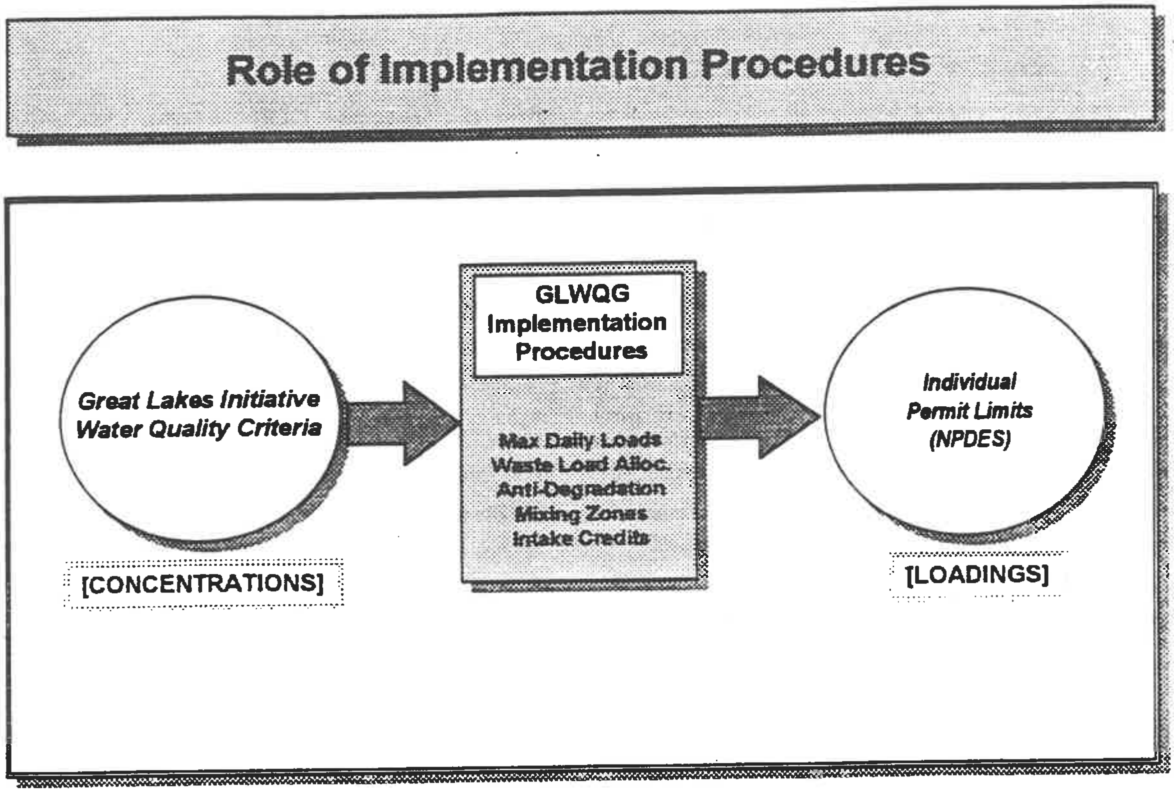


This argument is valid, but the fact remains that if point sources are responsible for only 10% of the loadings reductions, but constitute 40% of the total cost, and *if that same level of clean-up could have been achieved at significantly lower cost by another means*, the public will have been ill-served.

B. Some Implementation Procedures Don't Make Sense

Most states in the Great Lakes region can claim that their water quality criteria are nearly as stringent as the GLI criteria. If this were the whole story, then incremental benefits and costs of GLI would be nominal, and the main accomplishment would be a common standard, which is a worthy goal in its own right.

Exhibit II-2



However, as Exhibit II-2 illustrates, water quality criteria establish maximum pollutant concentrations, while *implementation procedures* must be used to derive individual permit limits. Implementation procedures vary considerably from state to state, and by adopting procedures that are as strict or stricter than the strictest states, the GLI represents a quantum jump in regulatory severity.

1. Advantages and Disadvantages of Specific Implementation Procedures

DRI has taken as given the GLI objectives to reduce toxic chemicals in the Great Lakes Basin to levels that will be harmless to humans, wildlife and aquatic life. This report seeks to answer a specific question: does the Draft Guidance, released April 16, 1993, achieve that objective in the most cost-effective manner?

DRI's most conservative (that is, highest) estimate of annualized compliance costs under Scenario B is $2.3 billion, while the highest estimate for Scenario B is $380 million. The difference underlying these two estimates is the treatment of three key implementation procedures embodied in GLI:

- Intake Credits,
- Elimination of Mixing Zones for BCCs, and
- Anti-Degradation Policy.

Materials provided to DRI, primarily by industry-sponsored trade associations, have enabled us to distinguish, to some degree, the cost implications of these three policies.

a. Intake Credits Should be Expanded

While the term "intake credits" is not used in the Draft Guidance, the concept generally means the degree to which permit-writers will take into account toxins present in the discharge that were not added by the discharger. This issue is most clearly highlighted in the case of "once-through cooling water," used in many industries, including electric utilities and steel mills. For toxins such as mercury, whose background concentrations currently exceed the water quality criteria, environmental administrators do not want to be placed in the position of mandating clean-up of the lakes by filtering lake waters—a Herculean and extremely cost-ineffective task. Clearly, industry would find the prospect equally unappealing.

In the Guidance, the procedures covering "waste load allocations" and "reasonable potential to exceed water quality standards"[3] are the sections that are most relevant to the question of intake credits. After examining these sections in light of submissions by trade associations, DRI has concluded that industry has justifiable fears: strict interpretation of the Guidance could force them to apply end-of-pipe treatment technologies to their cooling waters. Officials of state Departments of Natural Resources (DNRs) have indicated that, in such a situation, they would not impose a total maximum daily limit (TMDL) because they could not demonstrate a "reasonable potential to exceed water quality standards."

However, Procedure 5 [Reasonable Potential] states that a facility must demonstrate that it:

- *E. 1.b. does not contribute any additional mass of the identified intake water pollutant to its wastewater; and*
- *E.1.d. does not increase the identified intake water pollutant concentration at the edge of the mixing zone, or at the point of discharge if a mixing zone is not allowed, as compared to the pollutant concentration in the intake water.*[4]

Specifically, since many facilities use a copper-based algaecide in their cooling waters, permit holders are concerned that, given a strict reading of the Guidance, state agencies could face third-party legal action if they find "no reasonable potential" under these circumstances. Similarly, since cooling waters are subject to evaporation, concentrations of pollutants in water re-entering the lake waters will be higher than those in the lake waters; a strict reading of the Guidance suggests that this would constitute a violation.

Several of the reports that DRI received, notably from the Utilities Water Act Group, cited costs due to clean-up of cooling waters that, in the aggregate, would bring the annual compliance costs into the tens of billions of dollars. These costs were not included in any of the scenarios because DRI is confident that the EPA would not knowingly launch

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3 Procedures 3 and 5 of Appendix F in the Draft Guidance.

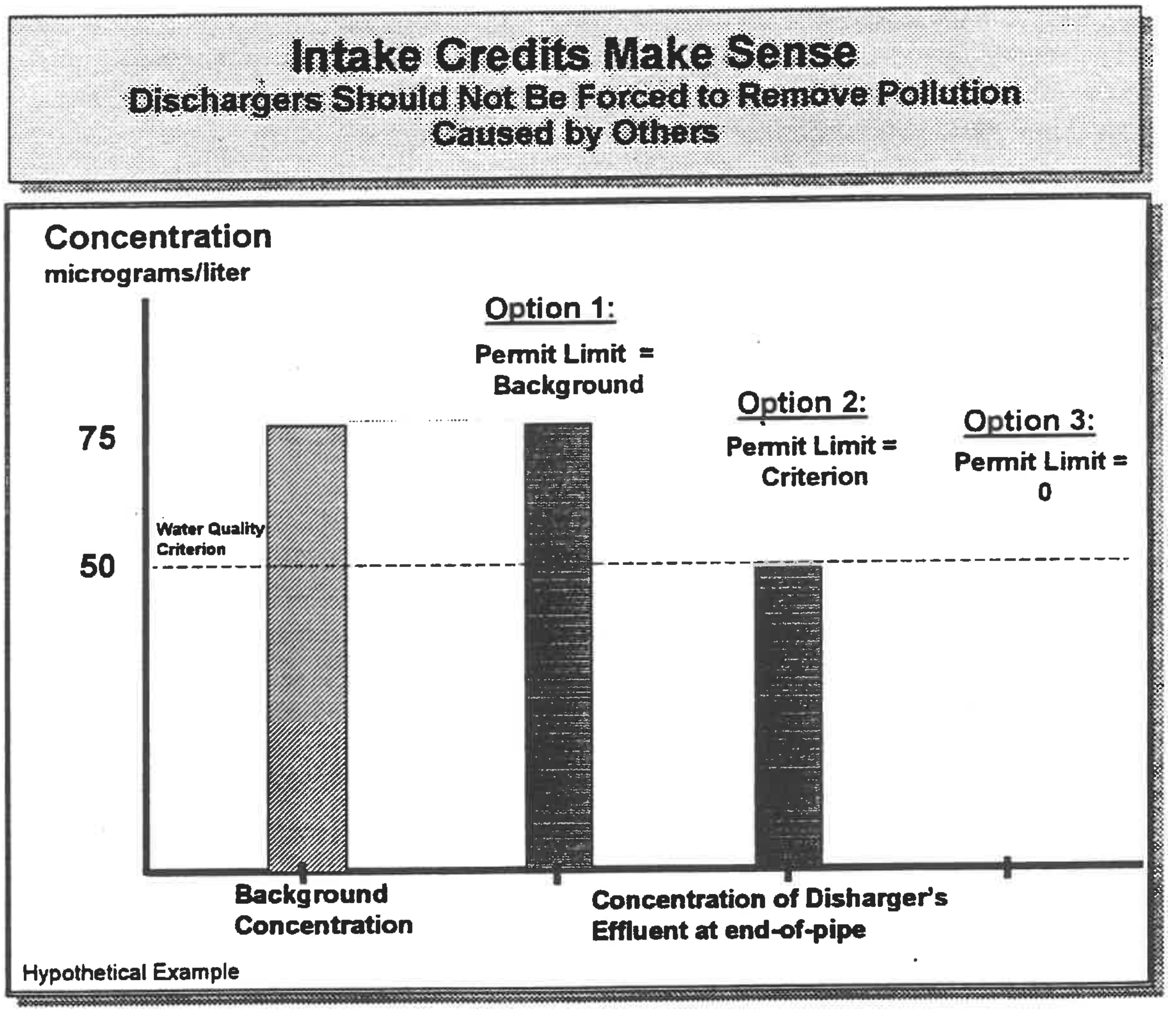
4 GLWQG Unofficial Prepublication Copy / March 31, 1993, Page 303 [Appendix F, Procedure 5.E.1.].

a regulation that could force this outcome. A small portion of those costs, representing the "borderline" cases, have been incorporated in Scenario B-High.

Regulators could considerably reduce the level of uncertainty experienced by industrial dischargers by clarifying the language of Procedure 5. The clarification should unambiguously provide that discharges should not be responsible for pollutants that they did not add to the water body. Roughly 40% of the difference between DRI's Scenarios A and B could be eliminated by modifying the language in the GLI accordingly.

A more subtle issue regarding intake credits is raised by the language of the Draft Guidance. When the background concentration of a particular pollutant exceeds the water quality criterion, and the facility uses that pollutant in its process, should the discharger be required to clean up the pollutants that were already present in the lake water?

Exhibit II-3



A numerical example, as shown in Exhibit II-3, will illustrate this point. Suppose the background concentration of a toxin x is 75 µg/l, and the water quality criterion is 50 µg/l.

The facility uses *x* in its process, and if it discharged its waters untreated, the concentration of *x* would exceed 75 µg/l. If the facility is assigned a negative waste load allocation (WLA), then it will be forced to remove *not only the toxins it introduces, but also some of the toxins that were already in the intake waters.*

A sensible approach to intake credits suggests that dischargers should only be responsible for toxins they themselves are potentially introducing into the ecosystem.

b. Elimination of Mixing Zones for BCCs

Mixing zones allow dischargers to exceed chronic water quality criteria at the end of their discharge pipes,[5] while ensuring that within a certain distance from the outfall pipe (or in some states following a certain time period after discharge) the discharge will have been diluted by the receiving waters sufficiently to meet chronic water quality criteria.

Bioaccumulative Contaminants of Concern (BCCs) are recognized as a special hazard to the Great Lakes ecosystem. Given this, the Draft Guidance presents arguments that loadings for BCCs should be reduced by whatever means possible, even where this means becoming more stringent than the water quality criteria. The effect of eliminating mixing zones will be a reduction in loadings of BCCs of up to 75%, depending on the dilution factor previously allowed for each facility.

This raises a question as to whether the GLI is aimed at "virtual elimination" of BCCs or at reaching the water quality criteria. The Guidance is currently ambiguous on this issue, and there are associated cost implications.

While this policy will undoubtedly reduce loadings for BCCs, it is not clear that the additional loadings reduction could not be obtained much more cost-effectively from other sources. It represents a rather crude tool for achieving the reductions, without taking into account whether site-specific health or wildlife considerations are involved, nor whether benefits will be commensurate with compliance costs.

DRI estimates that this provision accounts for some 25% of the cost difference between Scenarios A and B. Possible remedies include allowing mixing zones for BCCs, implementing multiple source TMDLs (so that mixing zones are only eliminated in cases where point sources are the predominant source of the BCC), credit trading, or atmospheric deposition credits.

c. Anti-Degradation Policy Needs More Flexibility

Since many states have already implemented anti-degradation policies, the GLI anti-degradation policy is more an attempt to standardize procedure across states than a brand-new procedure. Essentially, it ensures that facilities will not decrease water quality by adding toxins, even where such addition would still meet the water quality criteria and/or permit limits. It establishes the principle that water quality criteria are not a ceiling under which facilities are free to maximize their discharges; rather, existing water quality, if it is better than the criteria, acts as a ceiling, and prevents further degradation.

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5 Dischargers are still prevented from discharging above *acute* water quality criteria, however.

One of the great strengths of the GLI anti-degradation policy is the introduction of the *de minimus* provision. Essentially, if a discharger can show that the additional lowering of water quality represents 10% or less of the available assimilative capacity, the additional discharge will be allowed. This is an example of the kind of flexibility that lowers administrative costs for both regulators and dischargers, and, by making the actions of regulators more predictable, lowers the costs of regulatory uncertainty.

However, one major source of regulatory uncertainty is not addressed by the Draft Guidance: the demonstration of *important social or economic development.* [6]. This provision empowers the head of the state environmental agency to consider degradation of water quality due to "employment, financial or social services contributions." State environmental administrators have stated that local input in such determinations tends to view the loss of a single job or even minimal loss of income as grounds for suspending the anti-degradation policy.

This creates a situation in which the final decision will be reached by an arbitrary method, and communities will employ increasing ingenuity in pleading their cases. Far more preferable would be an economic cost/benefit-based criterion, incorporating site-specific risk-based analysis, thereby allowing dischargers and permit-writers to predict with greater certainty under what conditions a waiver would be granted. Nevertheless, the *Social or Economic Development Demonstration* is one of the few examples of building flexibility into the GLI using economic cost as a criterion. Thus, the intent here is not to criticize this effort, but to suggest that it be made more detailed and specific.

The anti-degradation policy, as written, will tend to inhibit the dynamic process of facility shut-down and start-up that naturally characterizes efficient economic systems. For the industries most directly affected by GLI, Exhibit II-4 shows projected annual growth rates through 2015. Roughly half of this growth can generally be met through expansion of existing facilities; the other half will most likely come from establishment of new facilities. To the extent that the anti-degradation policy inhibits this process, it represents a foregone economic opportunity—a very real cost.

DRI estimates that growth-inhibiting aspects of the anti-degradation policy are responsible for 35% of the cost gap between Policy Sets A and B. The anti-degradation policy itself should not be eliminated, but there is a clear need for a better defined economic development exception. In addition, this is an ideal opportunity to permit an evolution from dirtier to cleaner processes by introducing a credit trading scheme.

6 Defined in Appendix E, Section IIID of GLI Draft Guidance

Exhibit II-4

Growth Rates of Key Great Lakes Industries

Sector	Projected Annual Growth Rate 2000 - 2010	Projected Output Growth 2000 - 2010 Millions of 1992 $
Food & Products	1.2%	17,968
Paper & Allied Prod.	1.3%	7,232
Print & Publishing	1.8%	17,003
Chemicals	1.7%	17,842
Primary Metals	-0.8%	-4,581
Non-Elec. Machinery	2.6%	46,979
Elec. Machinery	2.4%	25,590
Transportation Equip.	2.3%	56,507

2. Other Factors Causing Reduced Cost-Effectiveness

a. Mercury is a "Cost Trigger"

Meeting the mercury criteria appears to be the single most difficult task imposed by the GLI. Aside from dioxin, which is a by-product of some paper mill and certain combustion processes, none of the other BCCs responsible for impaired use of the Lakes is commonly used in industrial processes. Mercury, however, is a prevalent substance in industrial, commercial, and residential use, and has significant natural sources as well.[7]

An examination of the EPA Technical Background Document[8] to the cost study reveals that mercury limits were assumed to be stricter under GLI for 21 of the 50 facilities in the EPA sample, including five of the eight POTWs.[9] All but two of these facilities are expected to require some form of treatment, which suggests that current loadings are at or above the allowable loadings under GLI given current analytical detection methods. Over

7 The mercury criterion has been set so low, at 180 picograms per liter, that it is possible that this level is actually *below* the levels found in nature before humans came to America.

8 SAIC, Technical Background Document for the Great Lakes Water Quality Guidance Implementation Procedures Compliance Cost Study, April 16, 1993.

9 Also, in a sample of 36 permits reviewed by the Ohio EPA, 22 were found to contain mercury in their permits, 13 of which were POTWs.

30% of the attributable compliance costs are attributed to mercury, making it the single highest cost pollutant in the sample.

Furthermore, two factors will inevitably drive the costs attributable to mercury even higher. First, mercury is the only BCC currently in widespread use, and therefore it is virtually certain that the elimination of mixing zones for BCCs within ten years will drive up the costs for mercury controls the most. Second, mercury is one of four GLI chemicals that must meet the wildlife criteria, which are currently five orders of magnitude lower than current EPA-designated detection limits. When GLI becomes effective, facilities will only be required to bring effluent concentrations in line with current detection limits, and *already* they are the largest single attributable cost of GLI. Once detection methods improve, permit limits will inexorably decline, driving up costs exponentially.

Without a doubt, regulators should provide dischargers, particularly POTWs, strong incentives to remove mercury; because its use is so widespread, a number of inexpensive pollution prevention options for achieving initial loadings reductions exist and should be exploited. However, reducing mercury loadings to 1/10,000 of their already regulated levels will certainly be expensive and may in fact be technically impossible.

There are several measures that could mitigate the mercury "cost trigger" problem. While most of these measures involve adjustments to existing GLI procedures, DRI is recommending a novel approach as well: "intake credits for atmospheric deposition."

Municipal sewer districts face a unique problem in that much of the mercury, PCBs and banned pesticides (such as DDT) present in their discharge are due to atmospheric deposition that washes these substances into the sewer system. These substances are essentially "background" pollutants over which the POTW has no control, in the sense that, even if the cities of Milwaukee, Detroit, or Erie had never been inhabited, the same amounts of mercury and other deposited substances would have made their way into the Great Lakes. In keeping with the principle that municipalities should not be required to treat wastes they did not generate, especially when it may trigger an inappropriately expensive treatment program, they should be granted credits for these substances similar to the intake credit policies discussed above.

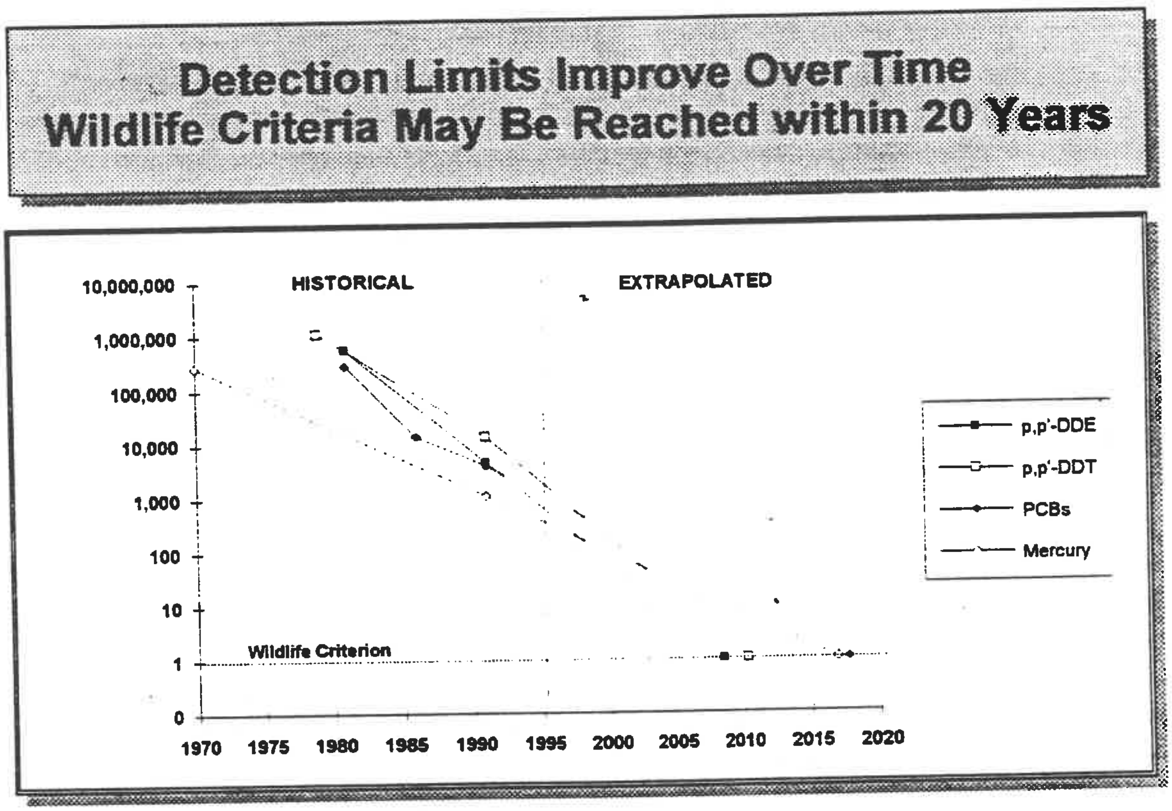
Great Lakes officials should review whether basing permits on the wildlife criterion is a reasonable goal in view of its high cost and the fact that point sources account for at most 10% of the total mercury loadings. While setting a less stringent criterion would delay the drive towards virtual elimination, loadings data suggest that raising the mercury criterion by a factor of ten would not jeopardize our ability to remove mercury from the list of substances causing fish advisories. Michigan uses a more sophisticated approach, setting the standard for mercury in its harmful form, that of methyl mercury.

Finally, allowing for multiple source TMDLs, as discussed in Chapter I, also raises the permissible loadings by a factor of ten, until such time as non-point source contributions have been successfully reduced, and the relative source contribution of point sources begins to climb.

b. Detection Limits Will Improve Over Time

One of the leading discrepancies between the EPA's cost estimates and those of industry arises from the treatment of detection levels. Assuming that dischargers will not be required to reduce their discharges below *current* detection limits suggests that, indeed, the burden on dischargers would not be severe. However, detection limits have in fact improved over time, and if recent trends continue, the extremely low concentrations for wildlife criteria will be measurable and therefore mandated by the year 2015, well within the time frame of this study. (See Exhibit II-5.)

Exhibit II-5



Thus, one of the major premises behind the argument that GLWQI will not significantly change permit limits appears to be valid only over the near-term. Over the medium term, dischargers will have to meet a moving target, and within a decade or two, the actual criteria will be the driving force behind costs.

c. Potential BCCs

There are 10 compounds included in the Draft Guidance as potential BCCs. They would be classified as BCCs if the Bio-Accumulation Factor (BAF) is revised upward, and all 10 are considered to be close to this borderline at this time. Several of these compounds, such as phenol, toluene, and the polycyclical aromatic hydrocarbons (of which benzo[a]pyrene is one), are present in the petroleum refining process. If these compounds are classified as BCCs, with the attendant elimination of mixing zones and other consequences, additional compliance costs not estimated in this report would be borne by dischargers

d. Tier II Values

The GLI establishes *tier I criteria* for *37* substances[10] whose potential to cause harm to humans or wildlife is relatively well-understood. An additional 101 substances may eventually qualify as Tier I substances, but at present the environmental data on these chemicals is insufficient to allow the Tier I procedures to be applied. The EPA proposes that conservative criteria, to be known as Tier II values, be imposed until such time as Tier I criteria can be developed.[11] Under the proposal, permit holders wishing to increase their permit limits would bear the cost burden of developing the Tier I criteria, and EPA estimates that this development process will cost at least $120,000 per substance.

Since the potential Tier II values have not been finalized, and because for many of these substances very little information is available about the possible presence of these substances in discharges, this report does not evaluate the potential costs. However, allowing industry to initiate the scientific research to establish more lenient values is an innovative solution to the problem that dischargers should not bear the cost of bureaucratic delays on the part of EPA as it decides how much money to allocate to the criteria development process, and which substances are worth analyzing first. The approach is conservative, and EPA expects that industry trade associations will pool their resources to ensure that no individual discharger bears an unreasonable burden.

C. Choices Available to Policy Makers:

1. Provide Flexibility Where Point Sources Are Marginal Contributors to Lake-Wide Concentrations

Among the key conclusions of this report is that, for those GLI pollutants that are most responsible for impairing the lakes, point sources generally account for far less than half of the total loadings.[12] Other important sources include contaminated sediments, atmospheric deposition, and leaking waste sites. In addition, loadings from Canada are unaffected by this legislation. GLI is officially "source-blind," in that it applies to any U.S.-based pollution source but currently is only binding on regulated water pollution sources. Thus, most sources of atmospheric deposition, sediments, and many leaking waste sites will remain unaffected until GLI II, while point sources will be affected, in some cases dramatically.

EPA officials have stated that there is no harm in allowing point sources to absorb the brunt of the burden initially, because they are confident that other sources will be addressed in relatively short order. However, this strategy gives rise to two dangers:

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[10] GLI covers 138 substances in total (28 BCCs, 10 potential BCCs, and 100 non-BCCs), but only a subset have criteria to date.

[11] EPA expects that in most cases the eventual tier I criteria will be more lenient.

[12] Dioxin is the only exception to this statement. See Chapter V for details.

- The first danger is that with a water quality based regulation such as GLI, if one class of permit-holders is reviewed before another class, they will always bear a disproportionate share of the clean-up burden. Stricter water quality criteria will reduce or eliminate the available loadings, so the point-source discharger will find his permit sharply reduced or eliminated. In contrast, an approach that requires facilities contributing 20% of the pollution to be responsible for 20% of the reductions would be viewed as more **fair**. Also, from an economic viewpoint, it would be more **efficient** to target reductions where they are most cost-effective, and work up the "cost curve" to the point where the desired level of loadings reduction is achieved. Since NPDES permit holders have already been regulated for more than a decade, and have already adopted the "easier" methods of loadings reductions, it is likely that initial reductions in non-point sources will turn out to be more cost-effective. The water quality based regulatory approach embodied in the GLI provides neither the fairness nor efficiency in the sense discussed above.
- The second danger is that, unless the public has an accurate impression of the role of point-source discharges, the GLI runs the risk of being "oversold." When the public discovers that those expenditures only address a small part of the problem, there may be a backlash against strict environmental standards. Such a backlash would hamper the difficult steps necessary for a truly comprehensive solution.

These dangers could be averted by drafting GLI provisions that explicitly address the potential balance between point source and non-point source loadings. One such provision, hinted at but not explained in the Draft Guidance,[13] would incorporate a "multiple source" TMDL. While the Guidance do not spell out the meaning of this term, the implication that each source would be allotted loadings proportional to its contribution is encouraging.

A more challenging but ultimately more rewarding path would be to alter the fundamental approach embodied in the GLI to adhere more closely with the Lake-wide Area Management Plans (LAMPs). These plans develop solutions customized to individual lakes, whose characteristics differ widely. These plans also provide the flexibility to determine the source of each pollutant and target the reduction strategy to the most cost-effective reduction methods. While LAMPs may lack the dramatic sweep of the GLI, they do offer a greater likelihood of addressing the most serious problems first, while avoiding the costly and ineffective anomalies in the GLI.

2. Define Stricter Definition of Social or Economic Need as Applied in Anti-degradation Policy.

The Anti-Degradation Policy as described in the Draft Guidance is vague on the criteria to be used in deciding the elements of a successful *Social or Economic Development Demonstration*, which can be used to relax the anti-degradation constraints. Since a

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13 Appendix F, Procedure 3A. C. 4. and 3B, C. 3 states:
"In cases where background concentrations exceed criteria or values, WLAs shall be set equal to zero or a <u>multiple source TMDL</u> shall be established that ensures attainment of criteria or values and control of BCCs pursuant to section B of this procedure." [underlining added]

dynamic economy requires some existing plants to expand and some to be replaced by newer plants, maximum clarity and predictability on this point is vital. This is especially true given that newer processes are generally designed with stringent environmental restrictions in mind. As written, the anti-degradation policy is not a mechanism that encourages the replacement of older, dirtier processes with more modern, clean ones.

A more explicit set of criteria for determining the precise nature of the trade-off between social or economic needs, on the one hand, and environmental concern on the other, would alleviate this problem to some degree.[14] A site-specific, analysis of costs versus benefits using a sample methodology provided by U.S. EPA would be the ideal criterion.

3. Allow Trading of Loadings Reduction Credits.

Air pollution emissions reduction credits have been advocated by economists for several decades as a means of employing a market-based approach to reducing pollution. Over the past several years, such schemes have been implemented nationally and in several states. These schemes promote efficiency by allowing plants with high emissions-reduction costs to "under-comply" with pollution reduction goals, as long as other plants, with lower marginal costs, make up the difference. The result is that overall emissions abatement goals are met[15] at a lower overall cost to the economy.

Water pollution has generally been considered a less viable candidate for trading credits, since most conventional water pollutants, such as nutrients, are generally highly site-specific, and trading even between facilities that are as little as 10 miles apart would be counterproductive. However, in the case of GLI there is an opportunity, explained immediately below, that has not been widely recognized.

There are two types of problems associated with toxic pollutants:

Situation "A"	Site-specific "hot-spots" where local exceedances pose risks to humans, wildlife, or aquatic life, and
Situation "B"	Lake-wide or even basin-wide accumulation of loadings that find their way into fish tissue and bioaccumulate up the food chain.

In Situation A, the trading of credits *among facilities that use the same outfall pipe* will be effective, and this is exactly the case in municipal sewer districts. POTWs can use credit schemes to encourage their indirect dischargers to reduce their joint costs by meeting an aggregate loadings reduction goal; this is possible and practical because indirect dischargers have widely divergent cost-effectiveness.[16]

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14 Point 3 in this list, "trading of loadings reduction credits," addresses this problem even more directly.

15 In fact, some programs include a x:1 offset (where $x>1$) such that facilities must buy up x units of emissions reduction from other plants for every additional unit they emit — thus the environment benefits each time a transaction takes place.

16 The EPA cost study reports incremental cost-effectiveness (in $/lb.-equivalent removed of toxic and non-conventional pollutants) ranging from $1.39 for pharmaceuticals to $559.94 in the electronics industry. See page 4-9, Table 4-5 of SAIC, 1993.

Since much of the emphasis in the GLI is on Situation B, the scope for trading credits is actually quite large. In general, the risks associated with pollutants such as mercury are lake-wide; therefore, the basic remedy is to control total loadings.

Using a credit trading scheme to reduce total loadings would help minimize the economic impact of the criteria themselves. Also, using an offset ratio of 2:1 would generate benefits similar to those anticipated from the anti-degradation policy and the elimination of mixing zones. The potential cost reduction could range from 20% to 50% of the total economic impact of GLI.

4. Extend Life of Permits From Five to Ten Years.

The possibility of doubling the period during which NPDES permits remain valid has already been discussed informally. This would reduce regulatory uncertainty for the regulated community and reduce the administrative burden on state agencies. Assuming that the 10-year permit life did not take effect until the first round of permit renewals incorporating GLI restrictions took effect (we are assuming 1997-2003), the only environmental benefits at risk would be the changes in detection limits. Although DRI has not analyzed the costs and benefits of this proposal in detail, the trade-off between reduced regulatory uncertainty and slower reductions in pollutant loadings appears reasonable.

5. During the Permit Process, Devote More Attention to Collecting and Analyzing the Economic Characteristics of Dischargers.

In the course of conducting this study, the data-gathering implications of the 1960's-style environmental regulations were made apparent. For example, the team utilized the EPA Permit Compliance System, a "comprehensive" data base containing hundreds of variables covering each NPDES facility in the region. Despite millions of pieces of data, regulators have no way to link the establishments' environmental characteristics, such as effluent flow and loadings, to economic characteristics, such as number of employees, plant capacity, or value of output.

Until regulators can readily access and analyze this kind of data, they will be unable to anticipate the economic impact of new policies on the regulated community.

D. Impact of the GLI Standards on Regional Competitiveness

1. Major Impact on the Region's Competitiveness if Initiative is Adopted in its Most Stringent Form.

In the strict sense of the term, the Great Lakes Region can *afford* the Great Lakes Water Quality Initiative. The goals of standardizing across the states, strengthening our negotiating position with Canada, and nearly eliminating dioxin and a few other toxic chemicals are worthy goals, and area residents and their progeny will benefit.

If the annual costs can be brought as low as $100 million, it is clearly worth doing. Even if the costs run as high as $2 billion, despite some localized displacement effects and lost jobs, the impact on the average pocket book would be only $23 per year, (see Exhibit II-6 and, by most criteria that is *affordable*.

Exhibit II-6

Putting the Economic Impact into Perspective

Costs of GLI Relative to Great Lakes Economy For the Year 2005

	Scenarios			
	B-Low	B-High	A-Low	A-High
Percentage Loss in Manufacturing Output (Relative to Base)	0.008%	0.057%	0.088%	0.337%
Percentage Loss in Personal Income (Relative to Base)	0.002%	0.016%	0.024%	0.094%
Loss in Personal Income per Resident (1992 dollars).	$0.55	$3.90	$5.91	$22.95

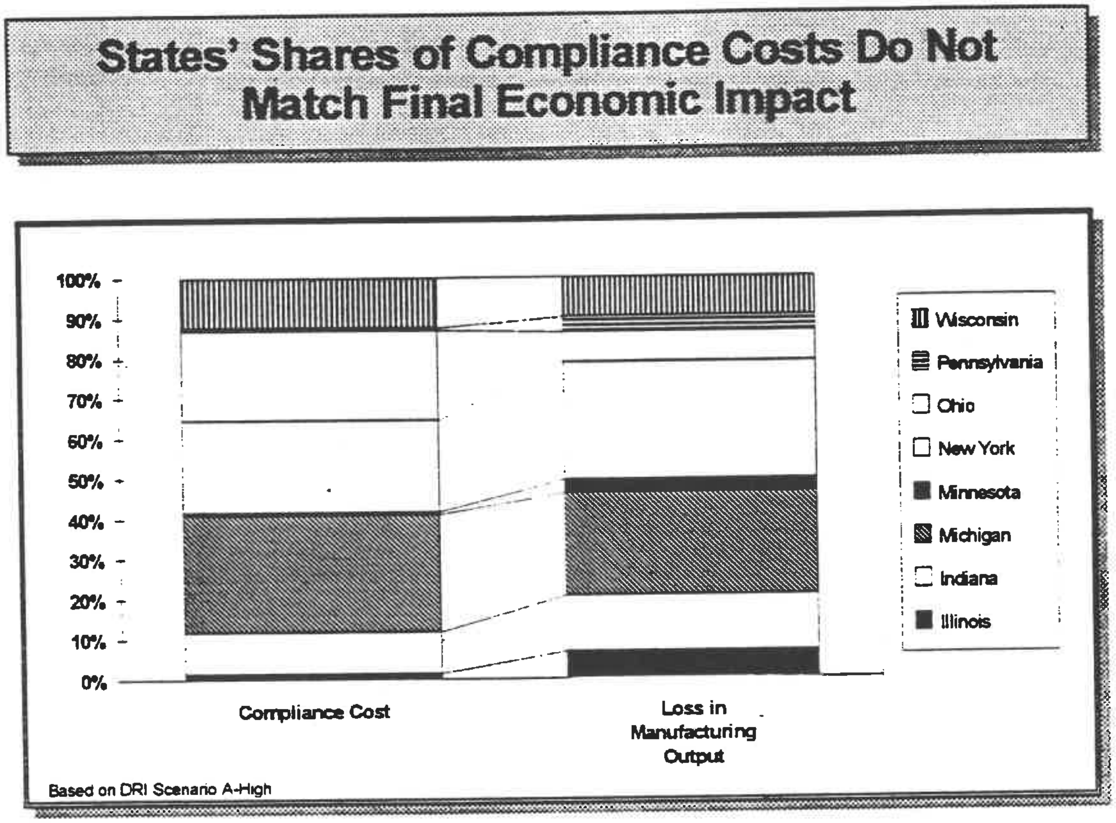
However, good policies are not just affordable, they are also cost-effective, and they should nudge society closer to its stated goal without the loss of significant resources. As currently written, the GLI is not cost-effective, and there are strong indications that a newer generation of regulations, reflecting market-based mechanisms, featuring genuine ecosystem approaches, and building on the Lakewide Area Management Plans would be more effective solutions in the long run.

Alone, the Initiative will not cripple the Region's ability to compete in the global economy. Rather, it will represent one more nick in the Region's competitiveness, and in the context of the dozens of similarly inefficient policy packages that are considered in these states each year, adopting one will not impact competitiveness, but adopting three or four each year will make itself felt.

The DRI Great Lakes Regional Model reveals that even states with low compliance costs will not escape the impact of GLI if other states are hit with high costs. Exhibit II-7 shows this to be especially relevant to Minnesota, Illinois and Pennsylvania.

Stephen Meyer recently set out to determine the cost in terms of economic growth and competitiveness of strict environmental standards across the US, and was surprised to discover that those states with the highest environmental quality were generally the fastest growing ones. He found that "if environmentalism does have negative economic effects they are so marginal and transient that they are completely lost in the background noise of much more powerful domestic and international economic influences."[17]

Exhibit II-7



This finding is consistent with the framework embodied in Exhibit I-1, in which the first efforts toward pollution reduction (perhaps corresponding to the period from 1968-1981 in the US) have low costs and high benefits. This framework suggests that, as society approaches the "optimal" toxics reduction point, choices become harder, and the potential to hamper economic growth rises unnecessarily. A researcher working at the macro level in the year 2020 will be unable to isolate the impact of GLI even if the "worst case" cost scenario prevails. But states with well-designed, cost-effective regulations will find themselves at the top of Professor Meyer's list of states with enhanced environmental quality *and* economic prosperity.

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17 Meyer, Stephen, M., "Environmentalism and Economic Prosperity: Testing the Environmental Impact Hypothesis," October, 1992. Dept. of Political Science, Massachusetts Institute of Technology, page 42. A second paper released in February 1993 determined that the positive correlation was due to a third, confounding variable (the degree to which individual states are concentrated in extractive industries), and concluded that economic growth and environmental effort were essentially causally unrelated. Another potential explanation, consistent with DRI's findings, is that states that first embrace higher compliance costs are best able to "export" them to other states. However, as the region over which the regulation apply grows, it becomes more difficult to shift the burden of environmental regulation.

III. The Permitting Process is Complex and Unpredictable

Among the studies conducted by the US EPA, private industry, and environmental groups that served as raw materials for this report, there is a disturbingly large range of estimates and forecasts of the costs and benefits of the GLI. Although DRI has narrowed the range of estimates considerably, one of the persistent factors that has maintained the gap has been the unpredictability of the permit process itself.

Because our analysis of costs and benefits, contained in Chapters IV and V respectively, depend on our assumptions regarding GLI's impact on permits, this chapter will first review the basics of the permit process, and highlight the aspects that drive the uncertainties.

The main policy conclusion of this analysis is that the lack of transparency in the permit process is itself a cost — although it is difficult to measure directly, it does impact economic behavior. Measures designed to reduce the uncertainty and improve predictability for permit holders will reduce the regulatory burden on regional competitiveness.

The GLI works in two directions in this regard: on the one hand, by standardizing procedures across states, it reduces the complexity of the process; however, since many of the provisions detailed below enhance uncertainty, the GLI has reduced the ability of industrial and municipal permit-holders to predict their costs of compliance, and this is a serious drawback in itself. If living with this type of regulatory uncertainty were necessary to achieve tangible, significant improvements in beneficial uses of the Lakes, the cost would be worthwhile, but as will be argued in Chapter V, the benefits are surprisingly modest.

A. Why the Permit Process is so Complex

The permitting process involves a large number of factors, which vary from state to state. Ambient water quality criteria and implementation procedures, the means by which water quality criteria are translated into permit limits, are the two major areas responsible for this variability. In both areas, the federal government provides guidance, but states are allowed some degree of latitude in establishing their programs.

Water quality criteria are developed to protect bodies of water for various uses and to protect the health of various species. Numerical criteria are intended to protect human health, aquatic life, and fish-consuming wildlife. For aquatic life, criteria are developed to protect against acute (short-term) exposures to high pollutant concentrations and chronic (long-term) exposures to lower concentrations. Criteria to protect human health are developed to minimize the risks of contracting cancer, as well as to protect against non-cancerous health disorders.

Implementation procedures define how the permit authority considers various factors when calculating the allowable discharge of pollution (or wasteload allocation) from a facility. These factors include items such as the stream dilution flow and the background concentration of a pollutant in the receiving water. Because allowable dilution flows vary with the water quality criterion to be met, wasteload allocations are calculated for each of the relevant water quality criteria, and the most stringent becomes the permit limit.

Current EPA guidance for deriving wasteload allocations is based on the following equation:

$$WLA = \frac{WQC\,[Q_d + (1-f)Q_e] - C_b Q_d}{Q_e} X$$

WLA = waste load allocation. mass/ time

WQC = water quality criterion mass/ volume

Q_d = dilution flow. volume / time

f = fraction of effluent flow from receiving water

Q_e = effluent flow. volume / time

C_b = background concentration in receiving water mass/ volume

X = factor to convert concentration limit to mass loading limit volume / time

For a sample facility taking all of its water from the same body of water into which it discharges, the WLA depends on the water quality criterion to be met and the dilution flow used in the calculation. Both of these parameters vary among the Great Lakes states, which represents one source of the complexity and variability of the permit process.

The WLA calculation shown above may not, however, actually become the basis for the permit limit for several reasons: technology-based effluent limits may be more stringent, anti-degradation regulations may apply, or the calculated permit limit may be below the lowest detection limits for approved analytical methods for the pollutant.

B. Factors that Increase Permit Stringency

1. Technology Based Limits

Water quality regulations that require specific control technologies have been promulgated for many industries. In situations where the effluent quality yielded by the required technology is better than the water quality based effluent limit, the technology-based limit applies. Therefore, comparisons of calculated WLAs alone do not reveal how discharges may vary from state to state.

2. Anti-Degradation Policies

The term "degradation" in its most general sense refers to the lowering of existing water quality. Anti-degradation policies are intended to counter this effect for waters that already meet their designated uses.

The current national anti-degradation policy takes a tiered approach:

- The first tier applies to all waters. It states that all existing uses of a water body and the level of water quality necessary to protect those uses must be maintained and protected. In other words, water quality can be lowered only to the extent that all existing uses are protected and maintained.

- The second tier applies to high-quality waters—those that are fishable and swimmable, in which limited degradation may be allowable if necessary for social and economic development, but only after public involvement and only if the waters remain fishable and swimmable.
- The third tier applies to Outstanding National Resource Waters, the quality of which must be maintained and protected. Lowering of water quality is allowed only for some temporary activities.

The national anti-degradation policy establishes a minimum that all states must meet. However, states can and do adopt anti-degradation policies that are more stringent than the national policy. This, too, contributes to the differences among permit limits for various states. As with the technology-based permit limits, anti-degradation may override the permit limit established using the WLA procedure. Thus, anti-degradation policies must also be considered when comparing permit limits among different states.

3. The Issue of Detection Limits

The calculated WLA and corresponding limits on the concentration of a pollutant in an effluent may also not apply as a permit because the calculated limit is less than standard analytical detection limits can achieve. In this situation, two states may calculate different permit limits, but if both are below the analytical detection limit, the permit limit would be designated as non-detectable in both cases. In effect, the enforceable permit limits are the same. However, it is likely that in the future, as analytical methods become ever more sensitive, the detection limits will approach many of the water quality criteria that are now below detection. (See section B.4., following.) Permit limits that today are effectively equal because they are given as non-detectable may not be in the future.

In summary, ambient water quality criteria and wasteload allocation determinations alone do not represent a sufficient basis for comparing existing state water pollution control programs for point source discharges. The other factors described above, and, perhaps equally important, the interpretation by permit writers of their state's regulations and policies, can have an overwhelming effect on the limits written into the permit.

Given their complexity, state permitting polices and procedures are rarely transparent to those outside office writing the permits for the state. For this reason, the exercise requested by Senator Levin, in which each of the Great Lakes states would calculate permit limits using their existing procedures represents the best comparison of how facilities are currently regulated.

The results of this exercise and a comparison of the state permit limits with those calculated by the U.S. EPA based on the GLWQG are discussed in depth in Chapter V.

4. Improvements in Detection Limits Will Lead to Stricter Permit Limits

The ambient water quality standards for many of the pollutants addressed by the Great Lakes Water Quality Guidance (GLWQG) are below the corresponding analytical detection limits. This is especially true for the chemicals for which water quality standards intended to protect wildlife have been established; it is also true for many other bioaccumulative chemicals of concern (BCCs) considered to be carcinogens.

In situations where calculated permit limits are lower than analytical detection limits, the permit limit is typically designated as "non-detectable" based on a specified analytical method. As analytical methods improve, we expect their use to be required in new permits or when existing permits are renewed. Thus, while the permit limits may remain as "non-detectable," the definition of non-detectable becomes more stringent over time.

Exhibit III-1 illustrates the trend in detection limits for three of the four chemicals for which the GLWQG establishes criteria to protect wildlife. The 1991 values are the limits given in the Pennsylvania Code for accepted EPA analytical methods, and the earlier detection limits are taken from studies of water quality in the Great Lakes.

Exhibit III-1

Reported Detection Limits, µg/l

Year	Compound				
	Unspecified	p,p'-DDE	p,p'-DDT	PCBs	Mercury
late 1950's	50,000				
1970-1971					50
1979			1		
1981		0.5		5	
1986				0.24	
1991		0.004	0.012	0.068-0.8	0.2
GLWQG Wildlife Criteria		8.7×10^{-7}	8.7×10^{-7}	1.7×10^{-5}	1.8×10^{-4}

Source: The Conservation Foundation of Washington. DC: Environment Canada/Department of Fisheries and Oceans/Health and Welfare Canada; Commonwealth of Pennsylvania Code

In the late 1950's, 50 parts per million (ppm) (50,000 µg/l) was considered to be effectively zero given the analytical techniques of the time. Today, standard analytical techniques yield detection limits six orders of magnitude lower. Furthermore, with more sophisticated analytical methods, larger sample sizes, or an absence of interfering substances in the sample, detection limits can be much lower than those of standard methods.

Given the foregoing, we expect detection limits—and thus permit limits—to decrease significantly in the future, possibly to the extent that the detection limit will be below the calculated permit limit.

IV. The Economic Impact of Complying With the Great Lakes Water Quality Initiative

This chapter presents findings regarding the costs of GLI for the Great Lakes states, including estimates of ***direct compliance costs***, an accounting of ***indirect effects***, and an evaluation of the ***overall economic impact on output, employment and income.*** The compliance cost estimates are based primarily on the US EPA cost study, conducted by Science Applications International Corporation, and a number of engineering studies commissioned by industry trade associations. The total economic impact was derived from DRI's Model of the Great Lakes Economy, an econometric model built specifically for this study.

DRI's estimate of the direct compliance costs attributed to the GLI will range between $710 million and $2.3 billion per year. This range reflects two types of uncertainty, technological and regulatory, both of which are addressed in this chapter. Three specific GLI Implementation Procedures are identified as cost drivers, along with the wildlife criterion for mercury. If these provisions are modified, the study finds that the annual compliance cost range could fall to between $60 million and $380 million.

The study assumes that GLI will begin to affect permits starting in 1997, and that by the year 2003, more than 90% of permits will reflect GLI limits. If so, by the year 2005, the "worst case scenario" (A-High) will lead to the loss of $1.9 billion in personal income, 33,000 jobs, and $4.7 billion in manufacturing output compared to the DRI model's base case.

The economic system works to spread such costs, through inter-industry and inter-state linkages, so no single industry or state is forecast to register a severe shock. However, to the extent that much of that cost can be avoided without meaningfully changing its environmental impact, the GLI currently does not meet the criterion of cost-effectiveness.

We start with a summary of the main conclusions regarding costs, followed by an analysis of compliance cost estimates. The method used for converting these estimates into economic impact is explained, followed by a detailed presentation of the effect of GLI on the economy and competitiveness.

A. DRI Findings: The Economic Impact of GLI

DRI's estimates of annual compliance costs for GLI range from $64 million to $2.3 billion. These estimates are based on an analysis of the EPA cost study[1] and several studies released by industry trade associations. While the sum of the high-end estimates of the industry studies runs into the tens of billions of dollars, DRI has incorporated only those estimates that appear to be well-supported with engineering analysis and plausible in view

1 "Assessment of Compliance Costs Resulting from Implementation of the Proposed Great Lakes Water Quality Guidance," SAIC, April 16, 1993.

of the language and intent of the Draft Guidance. The economic consequences of the four DRI scenarios are summarized in Exhibit IV-1.

Exhibit IV-1

Summary of Economic Impact Analysis
(Millions of 1992 Dollars)

In the Year 2005	Scenarios B-Low	B-High	A-Low	A-High
Direct Compliance Cost	59	381	709	2,286
Loss in Personal Income	43	319	484	1,880
Loss in Manufacturing Output	111	795	1,222	4,694
Employment Loss (# of Jobs)	745	5,402	8,649	33,230

To account for regulatory and technological uncertainty, we have grouped the cost estimates into four scenarios that can be used to evaluate the impact of specific policy actions on the cost-effectiveness of GLI. These compliance cost estimates, along with estimates from two of EPA's scenarios, have been run through DRI's Model of the Great Lakes Economy, to derive the indirect economic impacts of the scenarios.

The main conclusions of this chapter are:

- Direct costs for **GLI compliance could run as high as $2.3 billion per year.** This would occur if high-cost implementation procedures are left in the Guidance, and if dischargers are not successful in finding innovative, low-cost solutions to loadings reduction requirements.
- **Policy makers could cut costs by as much as 80%** by providing clear, lenient language on intake credits, and either eliminating the mixing zone and anti-degradation policies, or adopting flexible, market-based provisions that mitigate the most costly potential effects of those policies.
- By the year 2005, the **"worst-case" scenario (A-High) could lead to the loss of $1.9 billion in personal income**, 33,000 jobs, and $4,700 billion in manufacturing output in the eight Great Lakes States. New York and Michigan together would absorb over half of the loss in income, followed by Wisconsin and Indiana.

- Despite the low number of affected dischargers in Pennsylvania and Minnesota, these states will lose $8 in personal income for every $1 in direct compliance costs, due to their economic interdependence on the other Great Lakes states. This effect is slightly less powerful in Illinois, which faces a 3:1 ratio. The overall lesson is that **no state will escape the costs of GLI** because of the strong linkages inherent in modern manufacturing.
- Although these figures appear high, they represent a tiny fraction of the Great Lakes Economy, and would be imperceptible in the aggregate even if the "worst case" scenario came to pass. In the worst case, the employment and personal income losses amount to less than 0.1% of their base values, and manufacturing output losses are no more than 0.34% of total industrial output. Because the sectors affected are capital intensive, and compliance costs are lump sum costs, most industries will "take the hit" without generating the large layoffs that would be associated with a tax of similar magnitude. **The loss in personal income will average $23 per resident in the worst case, or as low as 52¢ per resident if the Guidance is made more lenient** and technological factors work in our favor.
- Clearly, the residents of the Great Lakes States can afford to pay the price of point-source reductions. However, **efficiency and fairness suggest that the bulk of that $2.3 billion can and should be saved**; the impact on reductions in toxic chemical loadings into the Lakes would be imperceptible and could be compensated for through aggressive regulation of non-point sources.

This study goes beyond the EPA cost study in explicitly accounting for indirect economic impacts and for implementation procedures such as anti-degradation, mixing zone elimination and detection limits; however, other GLI provisions have received less scrutiny by DRI and other researchers. These gaps in our knowledge include the additivity restrictions, and treatment of Tier II values and potential BCCs.

B. EPA and Industry Trade Association Estimates Vary Widely

As noted, Science Applications International Corporation (SAIC) conducted a study on the cost of industry compliance with the GLI for the U.S. Environmental Protection Agency (EPA).[2] In addition, various industry trade groups have also studied the costs of compliance for their specific industries.

The cost estimates produced by the SAIC and industry trade association studies vary widely. The SAIC study puts the annual cost of industry compliance with the GLI in the $50 to $500 million range---a range that clearly reflects the above-mentioned uncertainties surrounding the GLI standards. Taken collectively, the trade association estimates reviewed for this study put the annual compliance cost in the $1 to $2 billion dollar range (see Exhibit IV-2).

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2 Science Applications International Corporation, April 16, 1993, *Assessment of Compliance Costs Resulting from Implementation of the Proposed Great Lakes Water Quality Guidance.*

Exhibit IV-2

Comparison of SAIC and Trade Association Estimates of Annual Compliance Costs
(Millions of 1992 Dollars)

Sector	SAIC Estimates			Trade Association Estimates	
	Low	*Medium*	*High*	*Low or Expected*	*High*
Pulp & Paper	10	17	27	302	302
Chemicals				23	133
Petroleum	17	32	35	44	112
Metals Manufacturing	1	2	2	n.a.	n.a.
Iron & Steel	n.a.	n.a.	n.a.	15	400
Metal Finishing	2	3	4	n.a.	n.a.
Electric Utilities	1	2	3	33	493
Misc.	44	95	81	40	91
POTWs	5	41	353	252	756
Total	80	192	505	709	2286

With estimates varying by a factor of four to 20 times, one may well ask why the variation is so wide. The study by SAIC and those by the trade associations assume similar technologies and costs for treating effluents. Therefore, the wide disparity in estimates reflects differences in assumptions regarding the number of plants, the amount of effluent needing waste removal, and the cleanup technologies themselves.

For example, the pulp and paper industry study contends that nearly all mills will need sophisticated cleanup facilities. Their study reasons that, given background concentrations of mercury that in many cases now exceed the GLI limit, the small amount contributed by a typical pulp and paper mill would almost always violate the standard. However, in certain cases SAIC judged that, in light of the extremely small size of the mercury exceedances, paper mills and some other plants would satisfy the mercury standard by means of relatively inexpensive pollution minimization techniques rather than expensive end-of-pipe treatment facilities.

In addition, some of the trade association studies we reviewed infer costs for a full universe of plants on the basis of very small samples of respondents. This makes the results vulnerable to self-selection bias. For instance, the Chemical Manufacturers Association (CMA) developed industry-wide estimates by scaling up the results of a sample of only eight out of 95 plants in the Great Lakes basin. In developing the industry-wide costs, they assumed that non-respondents have compliance costs similar to those of respondents. However, it could be that the CMA received responses only from plants facing high costs and that the non-respondents anticipated minimal costs and thus did not bother to respond to the survey due to lack of interest.

The SAIC estimates assume compliance with the initial set of GLI Guidance, which allow mixing zones for bioaccumulative chemicals of concern (BCCs). Also, SAIC estimates costs by considering compliance only for the 34 chemicals that have explicit Tier I limits. On the basis of the available documentation, it appears that the lower values (the expected or optimistic values) reported in the various trade association studies usually reflect similar assumptions regarding compliance (that is, compliance with the initial GLI Guidance for the 34 chemicals that have explicit Tier I limits). The more pessimistic values presented in each trade association study typically assume more restrictive standards; these in some cases include no mixing zones, and the mandated use of end-of-pipe treatment for even small deviations from standards. Furthermore, the cost-estimation procedures sometimes incorporate Tier II standards for some compounds.

Neither the SAIC nor industry studies consider future industrial developments in detail, and therefore do not explore the effects on new or expanding plants. The estimates from these sources consider only present facilities and effluent flows. However, new facilities will be built and many existing facilities will be expanded, giving rise to new and larger wastewater flows. These new sources of pollution will need to comply immediately with the GLI limits without mixing zones for BCCs. They also will need to comply immediately with anti-degradation standards. These factors will raise compliance costs for new plants relative to those of existing plants.

On the other hand, new plants will benefit from older plants going through the experience of learning to remove pollutants economically. Also, the new plants should be able to structurally incorporate the cleanup processes in a convenient and economical manner, whereas older plants must make do with retrofitting. Thus, one can make a case for either higher or lower costs for new plants. Our estimates of overall regional costs assume that new and expanding facilities will face the same costs as current facilities.

C. Estimates for Specific Industries Vary

Below we present estimates for five major industries that would be impacted significantly by the GLI.

- Pulp and Paper
- Chemicals
- Petroleum
- Iron and Steel
- Electric Utilities.

Other sectors, such as the automobile industry, will be affected as well, but engineering studies detailing the likely costs for these industries are not yet available. A conservative procedure for incorporating the costs of these industries is described in Section E of this chapter.

1. Pulp and Paper Industry

A study sponsored by the National Council of the Paper Industry for Air and Stream Improvement (NCASI) estimates that the GLI would cost the pulp and paper industry about $450 million (1992 dollars) annually (see Exhibit IV-3).[3] About $150 million of this total, however, represents costs that publicly owned treatment works (POTWs) would incur and charge back to the pulp and paper mills. To avoid double counting, we treat these costs as part of the POTW total estimated below rather than as a separate charge to the pulp and paper industry.

Excluding these POTW expenses, the NCASI study suggests that the GLI would cost the pulp and paper industry about $300 million annually. Note, however, that all the affected states except Pennsylvania have announced that they would apply the GLI standards state-wide, not just in the Great Lakes basin. If the estimate includes pulp and paper mills outside the basin for all states other than Pennsylvania, the annual cost swells to about $1 billion, including associated POTW charges, and to about $750 million annually excluding those costs.

Exhibit IV-3

NCASI Estimates of Costs of Complying with the GLI Guidelines

Treatment or Processing Option	Mills in the Great Lakes Basin			Mills in the States		
	Direct	*Indirect*	*Total*	*Direct*	*Indirect*	*Total*
Controlling mercury and other effluents at end of pipe	242	116	358	604	169	773
Recycling mills closing of process water	49	12	61	94	22	116
Bleaching mills converting processing	9	18	27	48	18	66
Monitoring	2	0	2	4	1	5
Total	302	146	448	750	210	960

Source: *Preliminary Estimated Costs to the Pulp and Paper Industry Due to the Great Lakes Water Quality Initiative*. National Council of the Paper Industry for Air and Stream Improvement, Inc.(NCASI), December 8, 1992

As indicated in the chart above, the NCASI estimates include costs for:

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3 See *Preliminary Estimated Costs to the Pulp and Paper Industry Due to the Great Lakes Water Quality Initiative*. National Council of the Paper Industry for Air and Stream Improvement, Inc., December 8, 1992. This study also draws on *Projected Impact of the Great Lakes Water Quality Initiative on Four Paper Mills* and *Potential Treatability Options and Associated Costs for Low Levels of Mercury*, EA Engineering, Science and Technology, September 1992 and October 1990.

- controlling mercury and other effluents at end of pipe,
- closing process water systems at recycling mills,
- converting processing at bleached chemical pulp mills, and
- monitoring effluents.

While the first category above refers to end-of-pipe treatment, the second and third represent process changes that recycling mills and bleached chemical pulp mills would typically implement in preference to end-of-pipe treatment. The final category refers to monitoring for compliance with the standards. The estimates consider process water only, and the study assumes that non-contact streams, such as cooling water, would not contribute to costs.

Each of these four measures warrants more detailed examination:

a. Controlling Mercury and Other Effluents.

About 80 per cent of the paper and pulp industry's costs arise from the assumed joint use of granulated activated carbon (GAC) and ion exchange (IE) processes applied to the effluent stream either at the mills themselves or at associated POTWs. For most directly discharging mills, the severe limits placed on mercury dictate the need for this end-of-pipe treatment. Background mercury levels typically exceed the GLI limits. However, the *furnish* (raw materials) used in the pulp and paper manufacturing process typically contributes some mercury to the effluent stream. Thus, even with intake credits, the study assumes that most mills would need to treat their effluent.

The assumed treatment technology reflects a study by EA Engineering, Science and Technology (EA) on removing low level mercury contamination. In this study, EA concluded that only the joint use of the GAC and IE processes currently holds much promise for reducing mercury to the GLI limits. Nonetheless, the NCASI report describes the assumed cleanup technologies as illustrating feasible, but not necessarily the best or cheapest, methods for each mill.

The cost estimates for GAC and IE derive from EPA cost curves approximated by the following formulas:

$$C_{GAC} = .27 \cdot Q^{.48}$$
$$C_{IE} = 1.0 \cdot Q^{.84}$$

in which C denotes annual cost in millions of dollars and Q the treated effluent flow in millions of gallons per day.

For direct dischargers, the cost numbers derive from applying the formulas above to effluent volume. For indirect dischargers, the estimates assume that POTWs will install the treatment facilities and charge the costs to customers based on effluent flow. NCASI estimates that pulp and paper indirect dischargers contribute about 20 per cent of the total flow to their POTWs and thus will be responsible for about 20 per cent of their POTWs' clean-up costs.

Closing Water Systems at Recycling Mills. The NCASI study assumes that most paper recycling mills will eliminate effluent discharges by recycling the process water rather than treating an effluent at the end of the discharge pipe. In particular, the study assumes that all direct- discharging de-inking mills and all other recycling mills, both direct and indirect dischargers, would invest in water system closure. The study assumes that indirect-discharging de-inking mills will find it cheaper to pay their share of POTW costs.

The treatment technology involves treating the internal process water with biological and physical-chemical methods to make it usable back in the paper manufacturing process. At the end of the water purification process, one obtains a small concentrated stream that is allowed to evaporate, leaving behind a solid that is disposed of by landfill. The study assumes that the costs of processing internal recycled water in de-inking mills would be four times that of other mills. This reflects the greater processing required to make water recyclable in de-inking mills.

b. Converting Processing at Bleached Chemical Pulp Mills.

NCASI assumes that bleached kraft mills will change their manufacturing processes to use chemical bleaches and other materials that will permit levels of BCCs to fall within the GLI limits. In particular, NCASI assumes that bleached kraft mills will incorporate oxygen delignification and complete substitution of chlorine dioxide for chlorine in the first bleach stage and that hypochlorite stages will be eliminated. The kraft mill estimates include costs for upgrading chemical recovery capacity. Sulfite mill modifications assume changes only in the bleaching area.

c. Monitoring Effluents.

These estimates reflect assumptions concerning the compounds that would have to be monitored, the analytical or biological methods that would be used in each case, and the laboratory costs for each method. The laboratory cost estimates come from a survey conducted by NCASI.

2. Chemical Industry

A study commissioned by the Chemical Manufacturers Association (CMA) estimates that the GLI would cost chemical manufacturers about $45 million annually (1992 dollars).[4] This estimate includes only plants that discharge wastewater within the Great Lakes basin; it does not include costs that would result from applying the GLI Guidance to plants outside the basin within a state. However, the estimate combines costs of direct and indirect dischargers, each computed on the basis of the same treatment and cost assumptions. The SAIC study suggests that about half of all chemical plants in the basin are indirect dischargers. Thus, as much as 50 per cent of the CMA figure might also be included in estimates for POTWs.

The estimates are derived from a survey conducted by Tischler/Kocurek. The survey collected information on compliance costs from a sample of six of the 95 CMA member

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4 *Compliance Cost Survey for the Great Lakes Water Quality Initiative*, report prepared by Tischler/Kocurek for the Chemical Manufacturers Association (CMA), September 1992.

plants that: (i) are located on one of the Great Lakes or a tributary, and (ii) discharge wastewater. The survey asks for compliance costs corresponding to five different cases. The initial three cases vary the compounds that are assumed to be subject to GLI limits. Case 1 includes only those chemicals for which the EPA has already established explicit limits. Case 2 adds more bioaccumulative compounds that current estimation procedures suggest would also qualify as BCCs subject to limitations. Case 3 adds some non-bioaccumulative chemicals. Cases 4 and 5 establish upper limits to costs by assuming, respectively, treatment of non-contact cooling water, if it violates GLI Guidance, and treatment of all discharges.

With the exception of Case 5, the costs don't differ much across the scenarios. Thus, the CMA applies the results of Case 3 in estimating relationships that are used to determine an expected value and an upper-bound (90 per cent confidence limit) for overall industry costs:

Expected Value Formulas

Unit Capital Costs $= 12.94\ e^{-.725 \cdot Q}$

Unit O&M Costs $= 1.41\ e^{-.543 \cdot Q}$

Upper Bound Formulas

Unit Capital Costs $= 33.4\ e^{-.725 \cdot Q}$

Unit O&M Costs $= 6.52\ e^{-.543 \cdot Q}$

In the above cost equations, effluent flow (Q) is in millions of gallons per day, and the unit costs are in dollars per gallons per day for capital and annual dollars per gallon per day for operations and maintenance (O&M). Using a 10 per cent fixed charge rate to annualize capital costs obtained by these formulas, the survey suggests that the chemical industry's annual cost of compliance would probably be about $45 million, with an upper limit of $133 million (see Exhibit IV-4).

3. Petroleum Industry

Compliance with the GLI would cost petroleum refiners in the Great Lakes basin between $44 and $112 million (1992 dollars) annually, according to the results of a survey sponsored by the Ohio Petroleum Council (OPC).[5] The low-end estimate assumes limitations only for the EPA's current list of BCCs with explicit standards and that the facility could increase the concentration by the amount of the limitation ("net limits" with intake credits). A variety of middle-range estimates assume, alternatively, net and end-of-pipe limits (no credits or mixing zones) and progressively larger numbers of compounds subject to limitations. The upper-bound estimate assumes treatment of all facility effluents, including non-contact cooling water.

The survey collected data from four of the eight plants accounting for 83 per cent of the refinery capacity in the Great Lakes basin. Thus, the upper cost estimate above grosses up the upper bound estimate for the four reporting refineries by 20 per cent, whereas the

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5 *Summary of the Ohio Petroleum Council Survey on the Impact of the Great Lakes Water Quality Initiative on the Petroleum Industry*, prepared for the Ohio Petroleum Council by ERM-Midwest, Inc., January 1993.

lower estimate assumes both the low estimate for the four reporting refineries and no costs for the non-respondents. While the survey asked that indirect discharges be treated as requiring the same cleanup (at POTWs) as direct discharges, none of the reporting refineries discharged to POTWs. Thus, the cost estimates here appear to involve no double counting with POTWs.

Exhibit IV-4

CMA Estimates of the Costs of Compliance with the GLI

State	Number of Plants Affected	Expected Annual Cost (Millions of 1992 Dollars)	Upper Bound Annual Cost (Millions of 1992 Dollars)
Illinois	0	0.0	0.0
Indiana	10	6.5	25.2
Michigan	30	9.7	36.6
Minnesota	1	9.7	3.2
New York	19	4.4	16.3
Ohio	24	10.6	39.5
Pennsylvania	1	0.9	3.5
Wisconsin	10	2.7	10.4
Total	95	44.6	133.1

4. Iron and Steel Industry

Compliance with the GLI would cost a new 400,000 ton per month integrated steel mill between zero and $26 million (1992 dollars) annually, according to a study sponsored by the American Iron and Steel Institute(AISI).[6] Expanding these estimates to all major dischargers in the steel industry, the AISI results suggest that the industry faces annual costs of $30 to $400 million dollars annually. The low estimate assumes intake credits and compliance with the limits established just for those 34 compounds with explicit Tier I criteria. The high estimate assumes no intake credits, not even for the blowdown from non-contact cooling water, and compliance with Tier II criteria for Benzo(a)pyrene (BaP).

6 American Iron and Steel Institute Great Lakes Water Quality Initiative Study, The Chester Engineers. September 1992.

These values derive from a range of estimates of compliance costs relative to the alternative of satisfying the more lenient EPA Best Available Technology (BAT) standards. Specifically, the study presents estimates for the costs of complying with:

- existing state standards for a site in Ohio and a site in Indiana,
- GLI standards with intake credits and only current Tier I limitation on top of the state standards for each of the two sites,
- GLI standards without intake credits on top of the state standards at the Indiana site,
- GLI standards including limits on BaP on top of the state standards at the Indiana site, and
- GLI standards without intake credits and including limits on BaP on top of the state standards at the Indiana site.

For Ohio, the study suggests that complying with the existing standards would cost about $10.6 million annually. Under the most optimistic scenario for GLI (current Tier I limits and intake credits), the cost expands to $13.1 million annually, which represents a $2.5 million increment. For Indiana, the study finds that complying with the existing standards would cost about $17.2 million annually. Under the most optimistic scenario for GLI, the costs do not change. However, under less optimistic assumptions, they rise substantially. In the most pessimistic case, costs reach $43 million annually, or an increment of $26 million over the costs of complying with existing state standards.

The estimates reflect conceptual plans for new integrated mills at particular sites in Ohio and Indiana. The cost estimates differ for those two locations, because of differences not only in state standards regulating effluents but also in background concentrations.

5. Electric Utilities

The cots for the utility industry in the Great Lakes basin to comply with the GLI would range from just under $500 million (1992 dollars) annually, assuming intake credits make it unnecessary to treat non-contact cooling water, to as much as $3.4 billion annually, in the almost inconceivable case that the non-contact cooling water would need to be treated. These two estimates are based, respectively upon a 1992 study by the Utilities Water Act Group and a 1993 study by ENSR Consulting and Engineering (ENSR). We have excluded this last case in the range of cost estimates that we've used in assessing the economic effects of the GLI.

The two major operations in which the GLI will affect electric utilities are treating process wastewater and treating cooling wastewater. We examine each of these in turn.

a. Treating Process Wastewater.

Bringing process water into compliance with the GLI would cost electric utilities almost $500 million dollars annually (see Exhibit IV-5), according to estimates prepared for the

Ad Hoc Utility Group by ENSR.[7] The estimates reflect an assessment of the compounds needing to be removed from the wastewater streams and the required cleanup technologies for generic coal, oil, and nuclear plants specified so as to be representative of the average generation facility of each type in the Great Lakes Basin. The wastewater treatment costs for each facility get extrapolated to state- and basin-wide totals using effluent volume as the scaling factor.

Exhibit IV-5

ENSR Estimates of the Costs of Compliance with the GLI

State	Affected Plants	Annual Cost (Millions of 1992 Dollars)		
		Total	Capital	O&M
Illinois	2	20	8	12
Indiana	4	30	10	20
Michigan	19	215	75	140
Minnesota	2	18	1	4
New York	11	265	22	43
Ohio	10	320	27	51
Pennsylvania	0	0	0	0
Wisconsin	10	334	28	51
Total	**58**	**493**	**172**	**321**

The ENSR analysis involves:

- identifying chemicals of potential concern (CPC);
- determining, for each outfall at each sample facility, those CPCs that would exceed the GLI limits;
- specifying the appropriate wastewater treatment system for each sample facility; and
- estimating the costs of wastewater treatment at each facility.

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7 *Regulatory Impact Analysis of the Draft Great Lakes Water Quality Initiative for the Electric Utility Industry*, study prepared for the Ad Hoc Utility Group by ENSR Engineering and Consulting, June 1993.

The cost estimates are derived from a variety of sources including published studies and judgments of professional consultants.

As a result of its study of each generic facility, ENSR identifies the following CPCs

- cadmium
- copper
- mercury
- chromium
- PCBs
- nickel
- lead
- selenium
- phenols
- zinc.

ENSR evaluates likely loadings against limits for each of these CPCs at each of the three facilities.

ENSR analysis of treatment options includes a preliminary screening of available technologies followed by a detailed assessment for each facility. In the end, ENSR finds that each of the facilities require similar technologies including:

- chemical oxidation/reduction,
- chemical precipitation,
- ion exchange,
- carbon absorption,
- filtration,
- evaporation, and
- solidification of sludge.

In some cases, ENSR finds that process and cooling waters are commingled in the effluent streams. ENSR assumes that the two streams can be separated, thereby avoiding the expense of treating cooling water. This separation could be expensive, according to industry engineers, but this cost has not been included in the ENSR estimates. The study, moreover, recommends that the GLI standards be implemented in such a way that this separation would be unnecessary. The study asserts that the dilution of toxins that occurs in the facility when process waters commingle with cooling waters allows for better environmental protection than when such dilution and mixing occurs in the aquatic environment outside the facility.

b. Treating Cooling Wastewater.

The requirement that utilities bring cooling water discharges into compliance with the GLI limits would raise the costs of electric generation between 30 and 70 per cent, according to a study sponsored by the Utility Water Act Group (UWAG).[8] We haven't included these costs in our compilation of trade association estimates; given the enormity of these

8 *Removal of Intake Pollutants by Electric Utilities: An Economic and Technical Feasibility Analysis*, submitted to the Utility Water Act Group by CHMHill, November 1992.

costs, full intake credits, which otherwise seem probable, become almost a certainty. Nonetheless, we have chosen to review the UWAG study to illustrate that rigid application of the GLI standards could prove exorbitantly costly.

The UWAG study assesses the economic and technological feasibility of removing pollutants originating in intake waters for a hypothetical 600 megawatt (MW) power plant under the worst case assumptions that:

- no mixing zones are allowed and
- EPA's water quality criteria apply to the whole effluent at the end of the discharge pipe.

The study also assumes that copper, the chemical chosen to illustrate the treatment methods and process options, appeared in the intake water in concentrations exceeding the GLI limitations.

The UWAG study evaluates options involving:

- treating the entire cooling water flow and discharging the flow to a body of water;
- installing cooling towers to reduce the discharge volume, blowing down water to control salt buildup in the cooling tower, treating and discharging the blowdown to a body of water, and disposing of solids at an industrial landfill; and
- installing cooling towers to reduce the discharge volume, blowing down water to control salt buildup in the cooling tower, treating and recycling the blowdown back to the cooling tower, and disposing of solids at an industrial landfill (a generally closed-cycle option).

The study assumes that iron co-precipitation would be used in treating once-through cooling water and cooling tower blowdown under the second option, whereas evaporation and crystallization would be used under the generally closed-cycle system.

D. Publicly Owned Treatment Works Would Bear the Brunt of GLI Costs

Compliance with the GLI would cost POTWs from $252 to $756 million (1992 dollars) annually, with an expected value of $376 million, according to estimates developed by Hinshon Environmental Consulting (HEC).[9] The estimates arise from a questionnaire completed by 170 POTWs representing more than 50 per cent of the municipal wastewater discharges throughout the Great Lakes basin. HEC also developed another, much higher cost estimate (not presented here) that assumed treatment of combined sewer overflows.

The HEC low-cost scenario assumes that POTWs:

- will not need to construct new treatment facilities beyond tertiary filtration;

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9 Economic Assessment of the Cost of Compliance for Publicly Owned Treatment works Under the Great Lakes Initiative, Hinshon Environmental Consulting, December 4, 1991.

- will focus on rigorously monitoring the discharges of industrial users to minimize pollution through source controls rather than new treatment facilities at the municipal plant; and
- will not need anti-degradation studies for incremental loading increases caused by new residential customers.

The high-cost scenario assumes that POTWs:

- will need to install advanced waste treatment to control trace pollutants, such as mercury, that aren't attributable to discrete point sources and
- will still rigorously oversee industrial sources and institutions, including hospitals, in controlling pollution at the major sources.

Compliance costs for new and expanding facilities could be higher or lower than for existing facilities. The standards themselves contribute to higher costs. New facilities and effluent sources must comply immediately with anti-degradation and the numerical limits for BCCs without mixing zones. Technological advances, however, will lower costs. New plants will benefit from older plants going through the costly experience of learning to remove pollutants economically. Also new plants will be built with cleanup processes included in a convenient and economical manner within the facility, whereas older plants must make do with retrofitting. Thus, one can make a case for either higher or lower costs for new plants. Our estimates of overall regional costs assume that new and expanding facilities will face the same costs as current ones.

E. Conversion of Compliance Costs into Economic Impact

The benefit of an environmental program is not measured by counting the amount of pollution removed, but by analyzing the impact of that program on human health, wildlife, and the enhanced value of the improved resource. By the same token, measuring the cost of compliance with environmental regulations does not provide a complete nor an accurate portrait of their impact on the workings of the economic system.

Compliance costs must be either absorbed in the form of lower profits, or passed on to other firms and consumers as price increases. Lower profits affect the regional economy by reducing the incentive to invest, while higher prices merely spread the costs so that the pattern is repeated in other industries and states. Ultimately, as reduced competitiveness causes layoffs, a cycle of income and expenditure reductions spreads the impact beyond the manufacturing sector. A minor offsetting stimulus to the local economy is provided during the period when new treatment facilities are under construction.

It matters to the economy as a whole which sectors incur the initial compliance costs. For example, cement producers can generally recoup their higher costs through price increases, without worrying that European and Asian competitors will grab a share of their market; the same is not true for the automotive industry.

DRI has used the compliance costs estimates in the four scenarios as inputs to the DRI Model of the Great Lakes Economy in order to capture the effects described above. Two sets of simulations were run: one using the four scenarios developed by DRI, another based directly on the EPA cost study.

Compliance cost estimates from trade associations were generally provided as totals for the entire Great Lakes Basin, with no state-by-state breakdown provided to protect the confidentiality of individual trade association members. Model inputs were therefore distributed across states using the implicit distribution in the EPA cost study methodology. That study reviewed permits for a sample of 50 of the 588 major NPDES dischargers, and 9 of the 3,200 minor dischargers. (See Exhibit IV-6.)

Cost estimates based on that permit review process were then extrapolated to the remaining facilities using effluent flow strata. While this procedure is methodologically unsatisfying, not least because the costs and effluent flows in the EPA sample show a very low correlation, in the face of limited information on the economic characteristics of the dischargers it represents an understandable compromise. The number of dischargers for each industry sector in each state is known through the Permit Compliance System,[10] providing a useful base for the calculation. However, this methodology ignores the variance in permitting stringency across states. Thus Michigan, which has water quality criteria generally comparable with GLI, will under this methodology appear to incur high initial compliance costs, while in reality Michigan permit writers may not need to adjust many permits as a result of GLI.

For the two scenarios that are derived directly from the EPA cost study, their implicit distribution of costs across states is maintained,[11] as depicted in Exhibits IV-6 and IV-7. In DRIs Policy Set B, which assumes a relatively lenient implementation of the GLI, adjustments factors were used to re-distribute costs, reducing the bias from ignoring variance in permitting standards across states. Policy Set A, which assumes that GLI goes far beyond the "reasonable potential" standards in most states, maintains the EPA distribution of compliance costs for direct dischargers.

Across the scenarios, indirect dischargers incur from 1/3 to 2/3 of all compliance costs (see Exhibit IV-2). These facilities, whose effluent flows through municipal sewer systems (POTWs), could be affected in two ways: POTWs could use their pre-treatment programs to pass on their stricter permit limits directly to their dischargers, or treat the effluent themselves and pass on the costs in the form of higher fees. For both cases, DRI treated the higher costs as falling entirely on the manufacturing sector (ignoring the possibility that higher fees could be shared with residential and commercial dischargers as well), and used the distribution of manufacturing output in each state a proxy for the incidence of compliance costs.

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10 an EPA-maintained data base of NPDES dischargers.

11 The EPA did not release any state distribution, stating with justification that the distributions are not statistically significant given the small sample size (though it should be noted that a larger sample size would not have corrected for the bias from omitting state-specific permitting procedures). However, using the Technical Background Document that contained the replicate their methodology and generate the implicit distribution across states.

Exhibit IV-6

Implicit Distribution of Compliance Costs by State and Industry in EPA Study

Industry	IL	IN	MI	MN	NY	OH	PA	WI	Total	Percent
Mining	-	-	-	-	-	-	-	-	$0.1	0.1%
Food	-	-	$0.1	-	$0.1	-	-	-	$0.3	0.3%
Paper/Pulp	-	-	$6.1	-	$4.0	$0.2	-	$6.7	$17.0	15.9%
Inorganic Chem	-	-	$0.2	-	$0.2	$1.4	-	-	$1.9	1.8%
Org. Chem	$2.3	$2.4	$9.6	-	$9.5	$9.4	-	-	$33.2	31.0%
Metal Finish	$0.1	$0.1	$1.5	-	$0.4	$0.8	-	$0.2	$3.2	3.0%
Metal Mfg	$0.1	$0.4	$0.5	-	$0.4	$0.4	-	-	$1.8	1.7%
Steam Elect	$0.1	$0.2	$0.8	-	$0.4	$0.4	-	$0.3	$2.3	2.1%
Misc	-	$0.9	$0.4	-	$3.8	$0.8	$0.4	-	$6.4	5.9%
POTW	-	$3.7	$11.6	$0.5	$10.2	$9.6	$0.4	$5.0	$41.0	38.2%
Total	$2.7	$7.6	$31.0	$0.5	$29.1	$23.0	$0.9	$12.3	$107.2	100.0%
Percentage	2.5%	7.1%	29.0%	0.5%	27.2%	21.5%	0.9%	11.4%	100.0%	

in Millions of dollars (- indicates entry < $100,000)
Source: Derived from SAIC (1993) (Scenario #2)

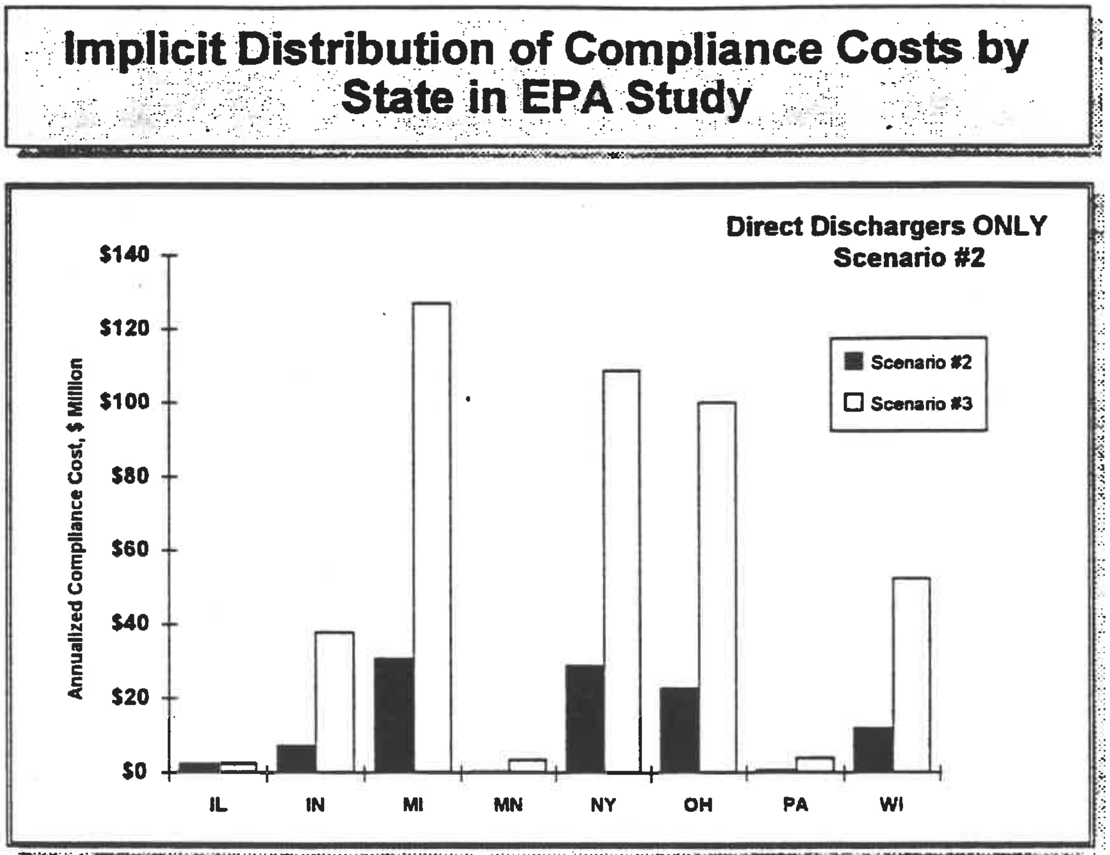
Direct Dischargers Only

1. Annualization of Capital Costs

The trade association studies generally develop estimates of the recurring annual O&M costs and the up front capital investment needed to comply with GLI. DRI has applied a 10 per cent factor to the (1992-dollar) one-time investment in obtaining an annual payment that covers financing costs (debt and equity) and depreciation, net of tax benefits. This 10 per cent factor assumes

- one-third debt, two-thirds equity financing
- annual capital costs of 9 per cent for debt and 10 per cent for equity
- an economic depreciation rate of 8 per cent annually (reflecting construction-intensive investment)
- present value of tax depreciation deductions worth 50 per cent of the initial investment
- expected long-run annual inflation rate of 4 per cent
- marginal tax rate of 40 per cent.

Exhibit IV-7



Using the formula for the fixed charge rate for a non-profit making investment, we obtain a value of about 10 per cent

$$\begin{aligned} FCR &= (r_d(1-\tau)w_d + r_e(1-w_d) + \delta - \pi)\cdot(1-\tau Z) \\ &= (.09(1-.4).33+.1(.67)+.08-.04)\cdot(1-.4(.5)) \quad (1) \\ &= .109 \end{aligned}$$

where r_d denotes the cost of debt, r_e the cost of equity, τ the marginal tax rate, w_d the debt share of total financing, δ the economic depreciation rate, π the expected inflation rate, and Z the present value of tax depreciation deductions.

This procedure differs from the technique used by the EPA cost study to annualize capital costs and results in estimates that are 20% lower on average.

2. DRI Economic Scenarios Reveal a Loss of Competitive Advantage for Great Lakes States

The added costs of achieving the water quality standards under the GLI will adversely affect the competitiveness of Great Lakes firms, resulting in a loss of market share for industries absorbing compliance costs, and for their suppliers within the region. Losses in production, employment, and incomes in affected industries will be transmitted throughout the economy, reducing employment in services, trade, finance, utilities, and government. With fewer job opportunities, out-migration of population will increase, reducing demand for new housing. Investments in pollution abatement structures and equipment will provide some modest offsetting stimulus, concentrated in the 1997-2003 phase-in period.

The sections below discusses the methodology behind these findings in greater detail.

a. Economic Impacts of Compliance Costs: Methodology

DRI developed estimates of the economic impacts of the costs of compliance with the GLI through simulations of the DRI/McGraw-Hill Model of the Great Lakes Economy. Developed specifically for this project, the model is a dynamic system of over 1,400 equations describing the economic structures and linkages of the eight Great Lakes states. This econometric model of regional competition and growth captures the interactions between industry costs, production, employment, incomes, population movements, and construction markets in each of the eight states. The modeling structure provides a comprehensive and consistent framework for evaluating the economic impacts of the policy choices of the Council of Great Lakes Governors.

The industrial structure of the Great Lakes model embodies several innovations in regional modeling, including explicit input cost measures and inter-industry purchasing relationships. For 20 manufacturing industries and eight states, the model determines real shipments, employment, wage rates, wage and salary income, and an input cost index that includes capital, labor, electricity, and material costs. The model's eight non-manufacturing sectors include employment, wage rates, and wage and salary income.

The Great Lakes Regional Model is linked to the DRI/McGraw-Hill Quarterly Model of the U.S. Economy. The influence of national economic forces is shaped by state-specific conditions of relative costs, industrial structures, demographics, and income and spending patterns. Therefore, each state's changing competitive strengths and weaknesses determine its success in capturing a share of the national market. In addition, assumptions regarding the impact of major economic policy initiatives, such as the North American Free Trade Agreement (NAFTA) are built in to the "base case" for the GLI simulations.

Capital costs are the primary channel through which compliance costs affect industrial competitiveness. Secondary price effects are captured through the materials price index. As Great Lakes region manufacturers pass along higher capital costs in the prices of their goods, the relative cost of materials in the region increases. While adjustments to capital costs are specific to each industry and state, a common adjustment was made to the materials price index.

The direct impact of compliance costs on industry shipments depends on the percentage increase in total input costs, as well as on the price sensitivity of industry sales. To accurately capture the competitive effects of higher input costs on industrial shipments, DRI has constructed a set of input cost indexes for each manufacturing industry by state. The cost indexes are weighted averages of four component indexes for wage rates, electricity costs, material prices, and a rental price of capital. Variable weights for each cost component are derived from DRI/McGraw-Hill's Factor Input Margin model, which uses input-output analysis to determine the contribution of different factors of production to total input costs by industry at the national level. Over time, the factor proportions of total input costs vary with shifts in technology and evolving inter-industry relationships. The price elasticity of industry shipments is determined in the estimation of the econometric model.

b. Inter-industry Purchasing Will Also Be Affected

Another channel through which environmental policies affect regional economic activity is inter-industry purchasing relationships. The Great Lakes states have clusters of interdependent firms in related industries. Examples of clusters include motor vehicles, forest products, industrial machinery, and chemicals. Some firms will sell their products outside the region, while supporting firms provide raw materials, components, and support services. For example, demand for steel will be affected by changes in sales of automobiles or machinery by firms in the region. The Great Lakes Regional Model incorporates a unique set of inter-industry generated demand variables that capture a supplying industry's potential sales to other industries within the state or region. Purchase coefficients, expressed as a fraction of the purchasing industry's output, are derived from DRI/McGraw-Hill's Inter-industry Model and vary over time as technologies and industry structures change.

In summary, regional industrial output is influenced by a variety of competitive and structural forces. In the Great Lakes Regional Model, a state's share of the national market in a given industry depends on input costs, inter-industry demand, final market demand, and business tax rates--all expressed relative to the national standard. An increase in the costs of compliance with water quality regulations adversely affects industry cost competitiveness, directly reducing its sales. When one industry in a given state loses sales, all of its suppliers throughout the region suffer. Thus, the model simulates how compliance costs imposed in Ohio will reduce economic activity in Wisconsin, Michigan, and the other Great Lakes states.

c. Introduction of Compliance Costs Raises Capital Costs

A wide range of environmental policy options with varying compliance costs was considered. For both the lenient and stringent policy sets developed by DRI, we ran alternative simulations using high and low cost estimates. In each scenario, DRI developed estimates of compliance costs by industry and state. Compliance costs include the costs of investing in new facilities and technologies, together with increases in operating and monitoring costs. Costs incurred by manufacturing firms were grouped according to their two-digit Standard Industrial Classification (SIC) codes.

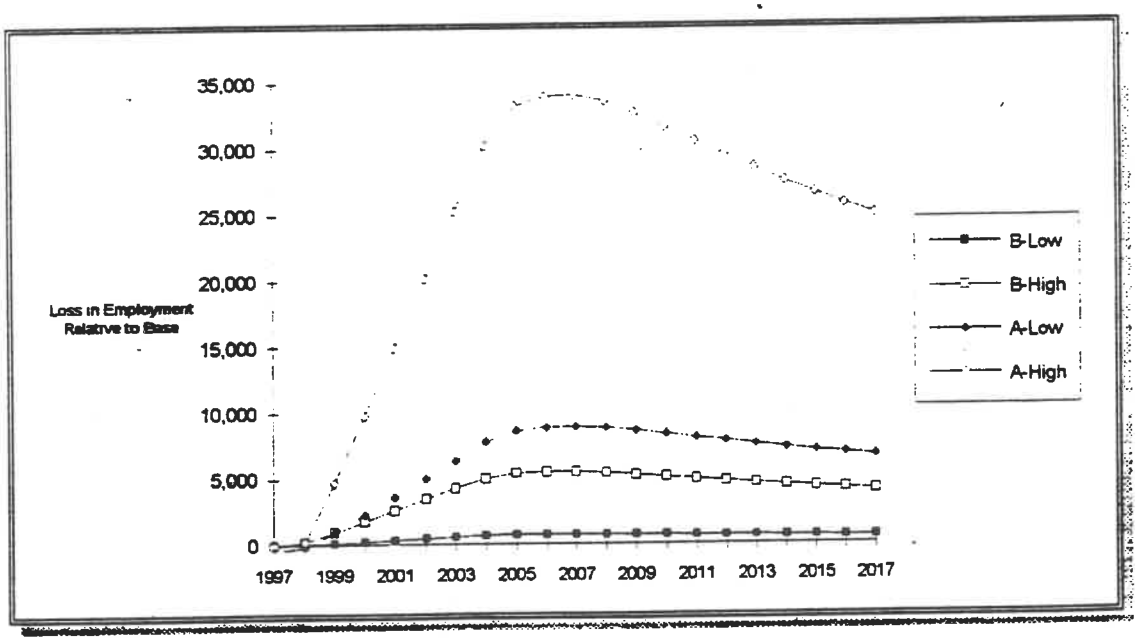
The following industries are affected in one or more states: food processing; tobacco; textiles; lumber and wood products; paper; printing and publishing; chemicals; petroleum refining; rubber and plastics; leather; stone, clay, and glass; primary metals; fabricated metals; non-electrical machinery; electrical equipment; transportation equipment; instruments; and miscellaneous manufacturing.

In each model simulation, compliance costs by state are introduced by raising an industry's capital cost index by a multiplicative factor to reflect the annual costs of financing and operating pollution abatement structures and equipment. Investments are assumed to be financed and depreciated over a 10-year period. Regulations are phased in over a seven-year period from 1997 through 2003. Thus, the proportionate increase in capital costs rises steadily through 2003 and then stabilizes.

Investments in new facilities will provide some offsetting stimulus to construction markets. The Great Lakes Regional Model includes real investment in nonresidential (and residential) structures by state. Real investment in structures, along with population changes and relative wage rates, determines construction employment. In each simulation, we assumed that investments in plant and equipment equal 50% of total compliance costs and would be divided equally between structures and equipment. For each state, the sum of capital expenditures on structures for all affected industries was added to real investment in nonresidential structures. The stimulus to construction activity is concentrated in the 1997-2003 period, as regulations are phased in. After 2003, the impact is diminished because only replacement investments are undertaken.

Exhibit IV-8

Potential Employment Loss as Result of GLI
(Number of Jobs)

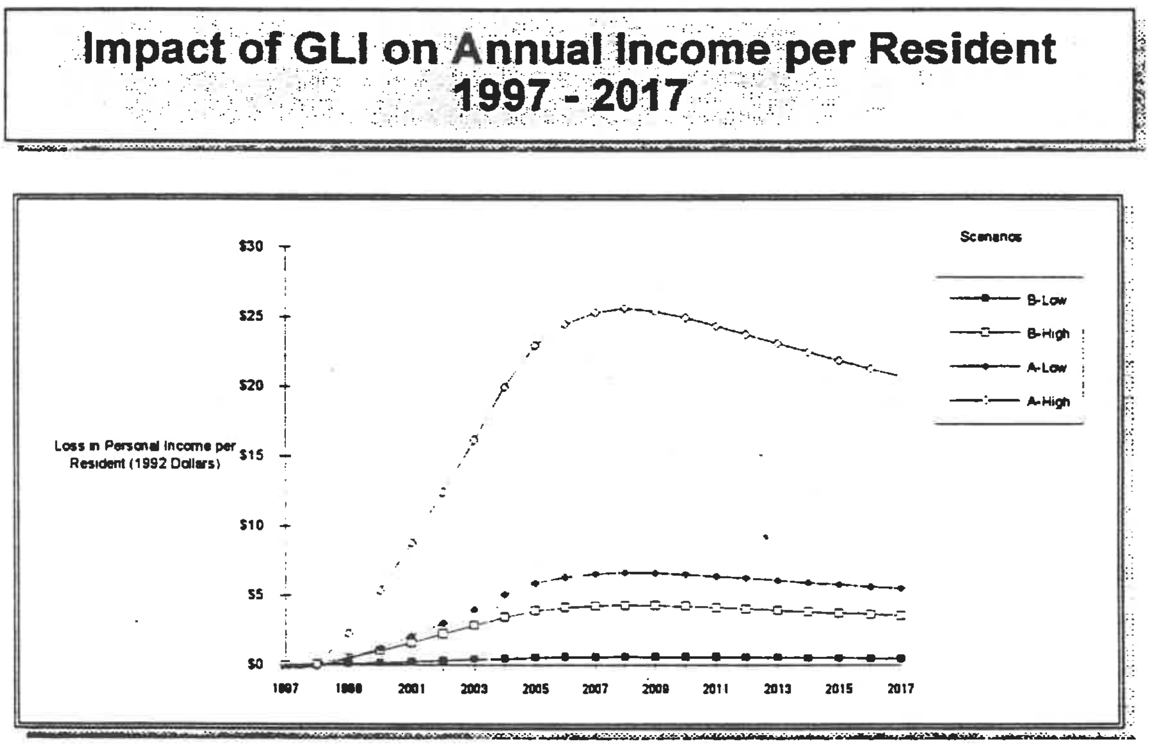


F. The Economic Impact to the Great Lakes States: Jobs and Competitiveness

1. Time Path of GLI Impacts

State officials have estimated that under the most optimistic timetable for the implementation of GLI, the first permits to be reviewed subject to the Guidance would be in 1997. Each year, roughly one-fifth of the outstanding permits are up for renewal, but due to variances and other delays, the bulk of the permits will probably not reflect the new procedures until seven years have passed. Therefore, in these simulations, the compliance costs were phased-in in equal increments between 1997 and 2003.

Exhibit IV-9



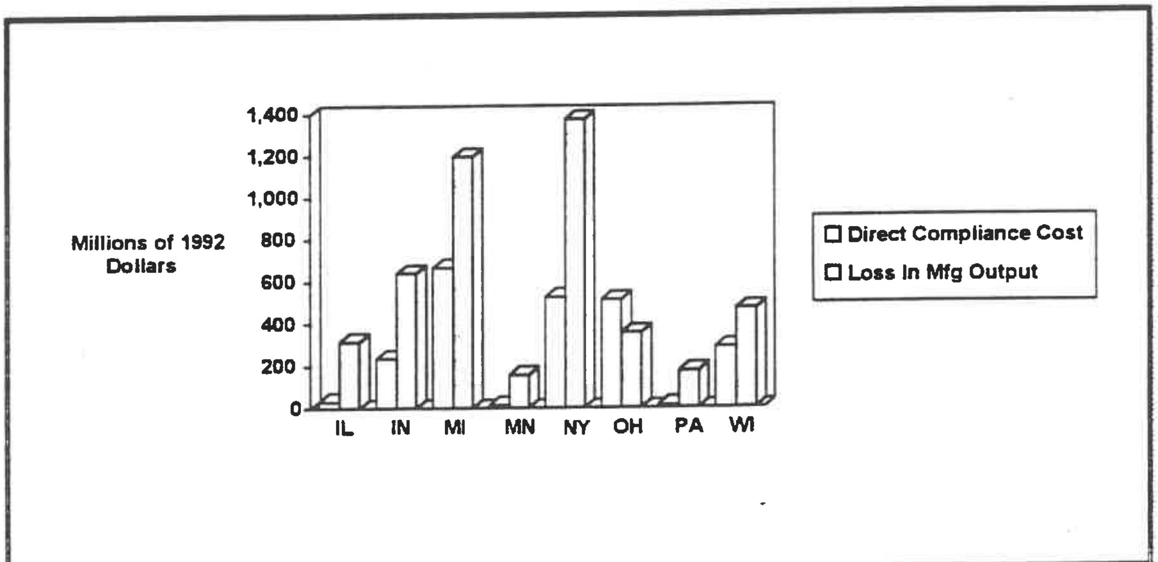
2. Impact on States

The economic impact of GLI on individual states does not closely follow the pattern of direct compliance costs. Just as the ill effects of pollution are easily transported across state boundaries, so are the costs of environmental clean-up easily transmitted between states.

Exhibit IV-10 shows how direct compliance costs translate into changes in manufacturing output on a state-by-state basis, for Scenario A-High in the year 2005. While Michigan, New York and Ohio experienced compliance costs on the order of $600 million each, their loss in manufacturing output varied widely, because of their role in the national economy. The economies of New York and Michigan each produce inputs to thousands of facilities that will be affected in each of these states, and consumer goods for many of the workers that will be laid off. On the other hand, a large proportion of Ohio's discharges are oil refineries, which do not have strong backward linkages, so the state is somewhat insulated from the costs of the clean-up program.

Exhibit IV-10

Comparison Between Compliance Costs and Loss in Manufacturing Output by State Scenario A-High, Year 2005



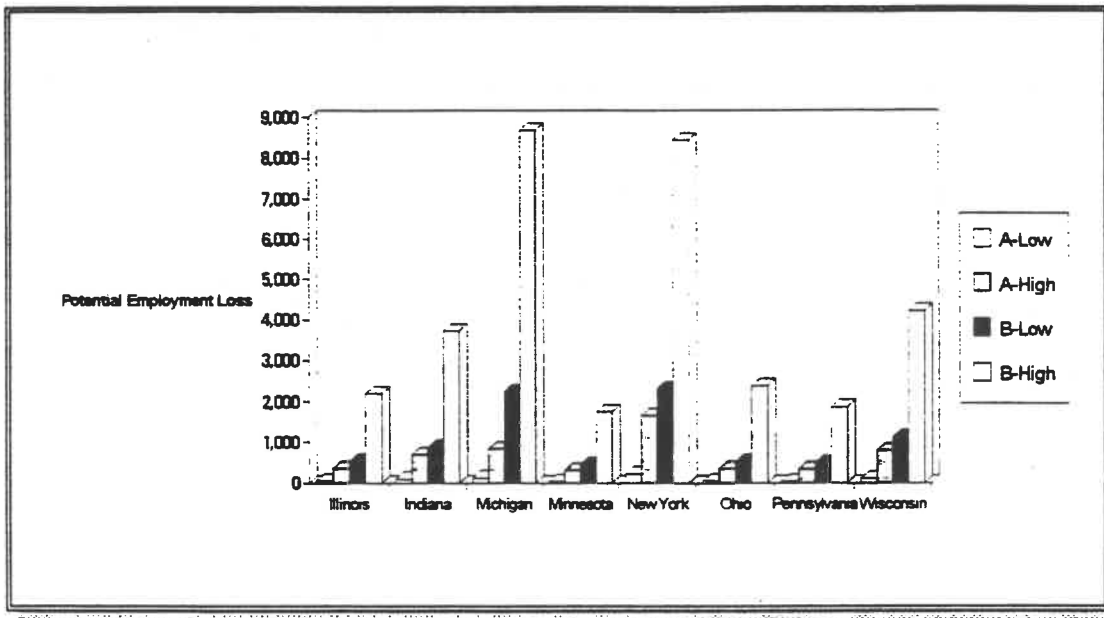
Conversely, states such as Illinois, Pennsylvania and Minnesota, precisely because of their low direct compliance costs, exhibit a high ratio of output loss to direct cost. This is not because the income multiplier is higher in those states, but simply because these states will continue to soak up larger indirect effects the larger the clean-up costs incurred by their neighbors. To further illustrate this point, consider New Jersey, which will have no compliance costs at all, but significant indirect effects.

The distribution of employment loss for all four scenarios is depicted in Exhibit IV-10, which again shows New York, Michigan, and Wisconsin bearing the brunt of the costs.

As more information regarding the impact of GLI becomes available, state officials and other interested parties will be motivated to re-cast the estimates using updated cost estimates. Tables in Appendix B shows how costs from individual states are propagated to the other states.

Exhibit IV-11

Distribution of Employment Loss by State, Year 2005



3. Impact on Industry and Competitiveness

The manufacturing sector will bear the brunt of the impact of GLI, and the DRI Regional Model indicates that industries will not prove very adept at passing off these costs on to the consumer. Because compliance costs are primarily fixed capital costs, that cannot be adjusted *ex post* according to the level of output, the effect of GLI behaves similar to a non-distorting, lump sum tax.

The "lump sum nature" of the compliance costs explains why the ratio of foregone output to compliance cost for GLI is fairly low — roughly 2:1. Furthermore, because the manufacturing sector is capital-intensive, the loss of jobs is relatively modest for an impact of this size. Thus the total loss in personal income in the region is actually smaller than the magnitude of the capital cost outlays. On balance sheets, profits will be affected far more than payroll expenditures.

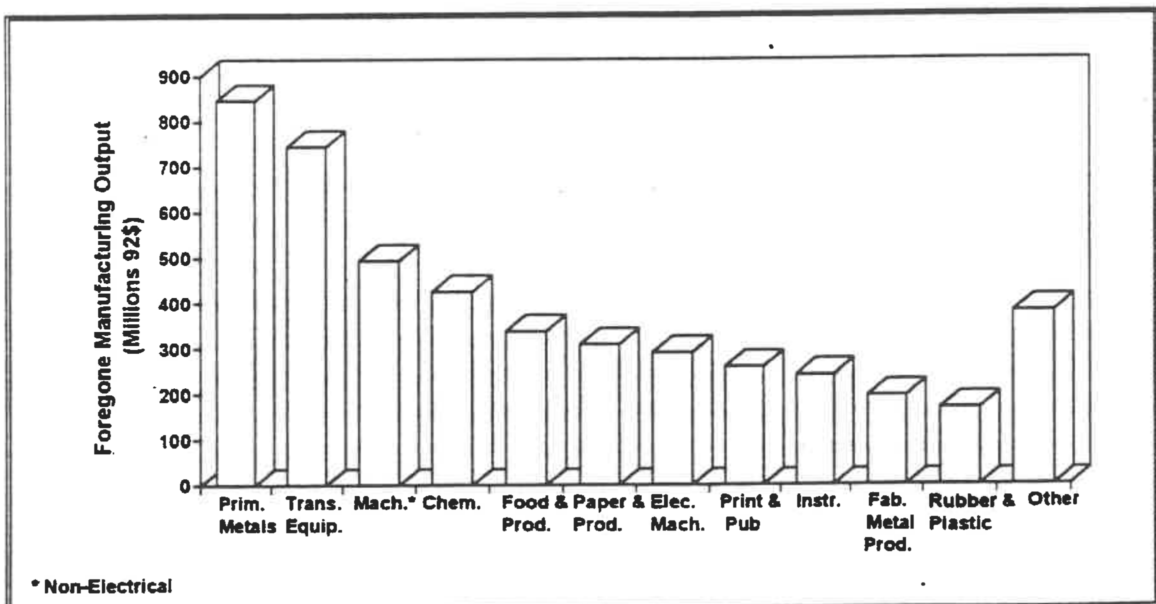
To the extent that profits will suffer, those few facilities that were on the verge of shutdown will be pushed over the threshold by this regulation. But on the whole, the economic system will spread the costs among industries relatively efficiently, and for the most part, owners of capital will be the primary losers. This does not show up in the DRI model's reporting of personal income losses, because profit losses can only affect this measure through lower dividends, and dividend payments tend to fluctuate less than corporate profits.

Also, the regional model does not depict individual firms, but industries at the state level, so shutdowns cannot be predicted directly. This is picked up indirectly by incorporating the historical relationship between increases in the local cost of doing business relative to the nation, and changes in the level of employment in each sector. In other words, competitive pressures determine the number of jobs in each industry, and when prices rise to the point where they are less competitive, a combination of layoffs and shutdowns adjusts the size of the industry.

Two figures are provided here to illustrate the sector-specific impacts of GLI (Exhibits IV-12 and IV-13). The two most extreme scenarios are portrayed, showing loss of output in the year 2005. For Scenario A-High, primary metals, transportation equipment, and non-electrical machinery are hit the hardest, absorbing $2 billion or 44% of the total loss in output. For Scenario B-Low, transportation equipment, non-electrical machinery, and chemicals are affected the most, although the magnitudes are far smaller at $43 million.

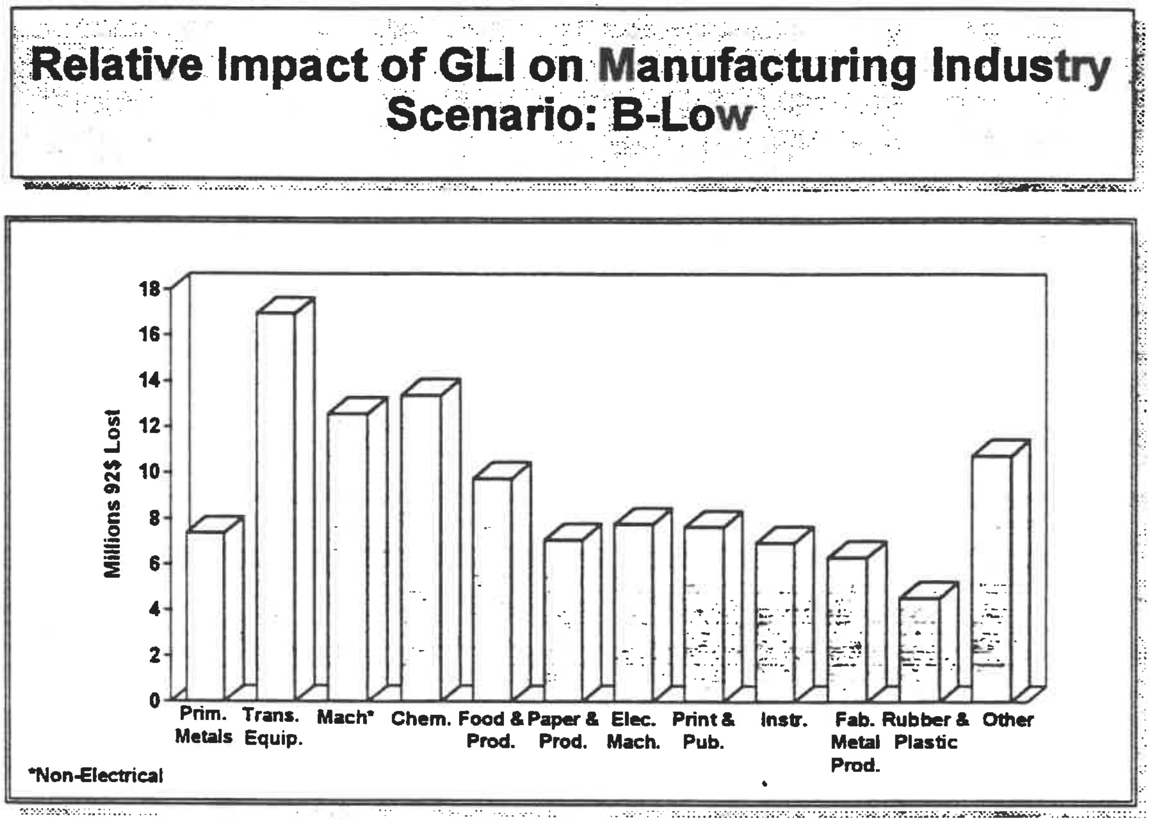
Exhibit IV-12

Relative Impact of GLI on Manufacturing Industry
Scenario: A-High



For the six industries with the highest impact in each scenario, the compliance costs are compared with the total loss in output in Exhibit IV-14 and IV-15. It should be kept in mind that the ratios between costs and output loss shown in this figure are not *multipliers*, since they do not isolate incremental cost increases from one industry, but represent the total impact of cost increases in all sectors taken together.

Exhibit IV-13



Looking at individual industry multipliers, as reported in Appendix B, we find that sectors such as transportation equipment and chemicals have multipliers almost three times the size of those for primary metals and the paper industry. The former industries have a high impact because they currently purchase a vast quantity of inputs from local producers, and when they reduce their output levels, the entire region suffers. The latter set purchase most of their inputs in raw form, and therefore reduced output in these sectors does not impact the region to the same degree. These industries will attempt to pass on their increased costs in the form of price hikes, but when their customers in the Great Lakes region find these products too expensive, they can generally find substitutes from suppliers outside the Basin.

The Following Is A Working Draft For Comment – The Findings Do Not Represent The Position of the Council or Any Individual Governor.

Exhibit IV-14

Compliance Costs vs. Loss in Manufacturing Output by Sector
Scenario A-High, Year 2005

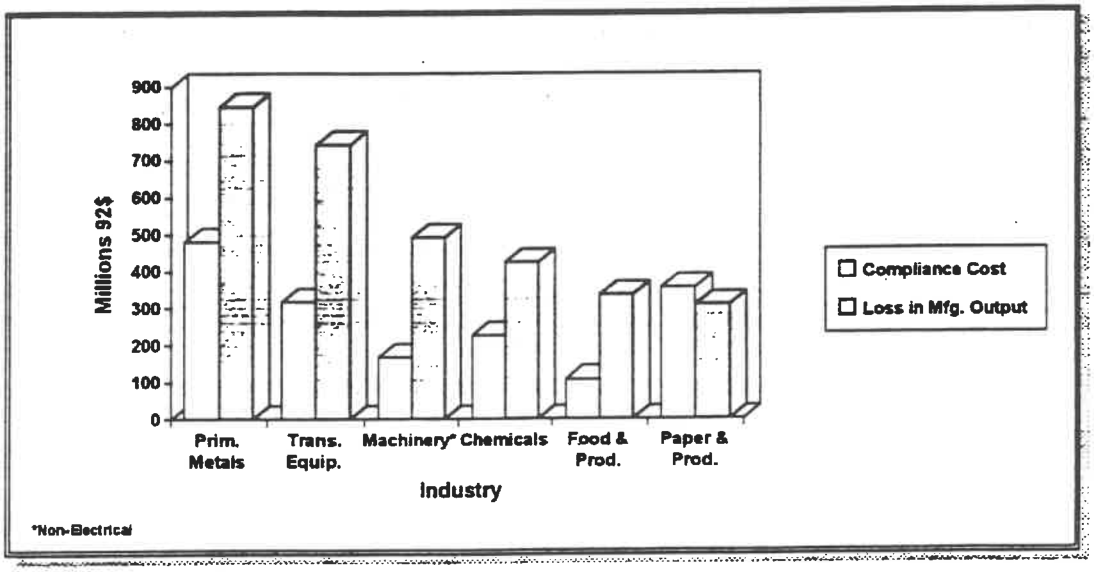
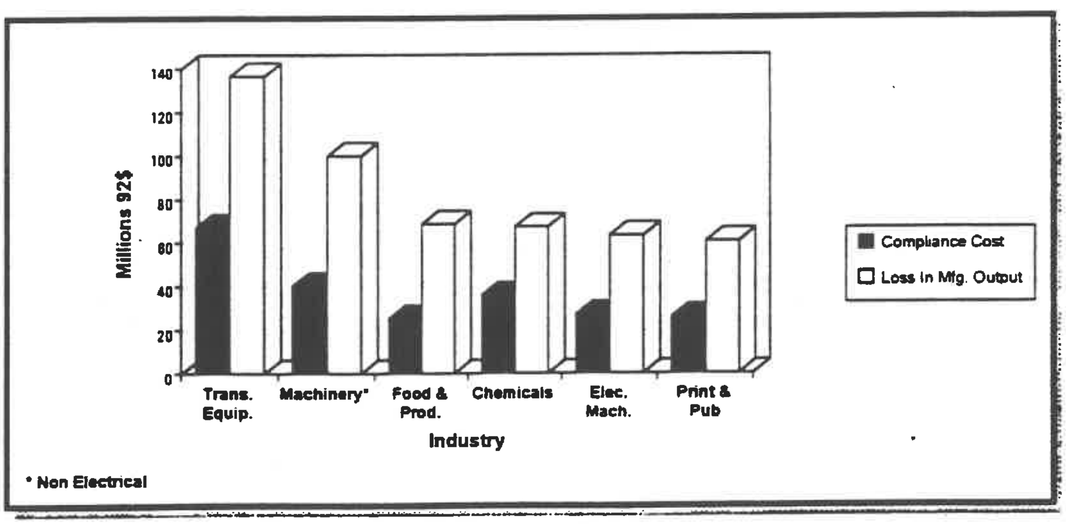


Exhibit IV-15

Compliance Costs vs. Costs in Manufacturing Output by Sector
Scenario: B-High, Year 2005



G. Putting the Economic Impact into Perspective

While many observers have become alarmed at the potential for GLI costs to exceed $2 billion, it should be emphasized that even an impact of this size would be imperceptible in a region this large. The eight states bordering the Lakes comprise nearly one-third of the total US population, and over one-third of the manufacturing output.

As shown in Exhibit IV-15, the worst-case scenario would reduce personal income by less than one-tenth of one percent, and manufacturing output by 0.33%. These magnitudes are nearly imperceptible; the region can clearly afford the GLI.

Exhibit IV-16

Costs are Spread from State to State

	Share of Compliance Cost	Share of Loss in Personal Income	Share of Loss in Manufacturing Output
Illinois	1%	6%	7%
Indiana	10%	10%	14%
Michigan	29%	23%	26%
Minnesota	1%	6%	3%
New York	23%	35%	29%
Ohio	22%	5%	8%
Pennsylvania	1%	6%	4%
Wisconsin	13%	10%	10%
TOTAL	100%	100%	100%

Based on DRI Scenario A-High

Of course, a reduction in manufacturing output of 0.33% should not be taken lightly, and every effort should be made to make GLI more cost-effective, so that those resources can be directed toward their best possible use: it may be, for example, that non-point source reductions will have a high price tag,[12] and the bulk of the regions capacity to absorb

12 Non-point source reductions of toxic pollutants are expected to impact coal-fired electricity generation, for example, and the multiplier effects from these compliance costs are likely to be significantly higher, since they impact all sectors of the economy, including residential, in the first round. On balance, however, DRI would expect the overall economic impact per cost per pound of, say, mercury removed to be far lower for non-point sources than for point sources.

costly legislation should be reserved for the projects that will have the greatest impact on beneficial uses of the Lakes.

Exhibit IV-17

Putting the Economic Impact into Perspective

Costs of GLI Relative to Great Lakes Economy For the Year 2005

	Scenarios			
	B-Low	B-High	A-Low	A-High
Percentage Loss in Manufacturing Output (Relative to Base)	0.008%	0.057%	0.088%	0.337%
Percentage Loss in Personal Income (Relative to Base)	0.002%	0.016%	0.024%	0.094%
Loss in Personal Income per Resident (1992 dollars)	$0.55	$3.90	$5.91	$22.95

The Following Is A Working Draft For Comment -- The Findings Do Not Represent The Position of the Council or Any Individual Governor.

V. Benefits of Complying with the Great Lakes Water Quality Initiative

The benefits of the Great Lakes Water Quality Initiative (GLI) must ultimately be measured in terms of their effect on the fitness of Great Lakes water for its designated uses. These uses include drinking, swimming, protecting aquatic life, and fish consumption. Our best overall indicator of the condition of the Lakes is represented by the number of shoreline miles meeting the standards for a designated use.

A water body's fitness for its designated use is affected by the level of existing and incremental contamination. The main intent of the GLI is to reduce the incremental contamination, known as "loadings," taking place each year. However, the degree to which the GLI would achieve reductions in either existing levels or loadings is difficult to measure.

In this chapter, we present information showing that virtually all shoreline miles of the Great Lakes meet the standards that ensure their fitness for drinking and swimming. The problems associated with toxins in the Great Lakes center upon aquatic wildlife. Fish consumption advisories exist throughout the Great Lakes. Currently PCBs are responsible for the fish consumption advisories and these advisories are not going to be lifted for some decades -- with or without the GLI.

Once the PCB levels have been reduced through a natural process of volatilization, fish advisories in the Niagara River and Lake Ontario may be lifted due to GLI, because GLI is projected to eliminate some 95% of current dioxin loadings from all sources. This is the single most tangible benefit of GLI.

In addition we explore the matter of measuring the impact of the GLI on the contaminants themselves. While this study could not review the permits of over 500 major dischargers, several existing studies have been evaluated to estimate the current and future loadings throughout the region.

In sum, the changes in beneficial uses following the implementation of GLI will be modest, and largely contingent on future actions regarding non-point sources.

A. Baseline Status of the Great Lakes

1. Water Quality

Water quality is typically described in terms of how well the body of water meets its intended or designated use. These uses include drinking, swimming, protecting aquatic life, and producing fish for consumption. The degree to which the Great Lakes meet their water quality goals can be measured by the number of shoreline miles meeting the standards for a designated use.

The federal Clean Water Act requires states to report biennially on the quality of water within their borders. The data given in Exhibits V-1 - V-4 were taken from the 1992 editions of the state reports, commonly referred to as "305b reports." While states differ in the methods they use to designate uses and to determine whether their waters meet these uses, the 305b reports provide a useful overall picture of the states' view of their water quality.

In the following subsections, we report on the degree to which the states' Great Lakes waters meet these designated uses.

a. Designated Use: Drinking

Exhibit V-1 shows the number of Great Lakes shoreline miles for each of the eight Great Lakes and the number of miles of shoreline meeting the designated use for drinking water. For those states that report on drinking water, 98% of the shoreline miles fulfill the state's criteria for drinking water supply. The relatively large number of shoreline miles in Michigan not meeting their designated use for drinking water is due largely to taste and odor problems caused by algae blooms in Saginaw Bay.

Exhibit V-1

Great Lakes Shorelines Meeting Designated Use for Drinking Water Supply

		Miles Meeting Designated Use		
State	Shoreline Miles	Full	Partial	Not
Minnesota*	272			
Wisconsin	840	820	20	
Illinois	63	63		
Indiana	43	43		
Michigan**	3288	3208		80
Ohio*	236			
Pennsylvania*	45†			
New York	577	576	1	

*Not reported in 305b report.
**Michigan does not use partial designations.
†Estimated.
Source: State 1992 305b reports.

These data are consistent with the results of our review of reports of noncompliance with federal drinking water Maximum Contaminant Levels (MCLs). At the request of DRI/McGraw-Hill, the U.S. EPA searched its Federal Reporting Data System for all notices of exceedances of MCLs for surface water supply systems anywhere in the eight Great Lakes states during federal fiscal year 1991. (This search did not examine exceedances of MCLs for parameters like turbidity and bacteriological contaminants, which are not addressed by the GLWQG).

Only 11 relatively small water supply systems indicated exceedances of MCLs at some time during the year. Nine of these 11 exceeded the MCL for total trihalomethanes, which are more likely to be formed during the disinfection of water with chlorine than to be present in the water supply itself. Only two small systems, serving a total of 2,300 people, had exceedances of MCLs for contaminants other than trihalomethanes, and these systems do not take their water from the Great Lakes.

Exhibit V-2

Great Lakes Shorelines Meeting Designated Use for Swimming

		Miles Meeting Designated Use			
State	**Shoreline Miles**	**Full**	**Partial**	**Not**	**Not Assessed**
Minnesota	272	23.2	.		248.8
Wisconsin	840	780	40	20	
Illinois	63	62.3	0.7*		
Indiana	43	43			
Michigan**	3288	3287		<1	
Ohio	236	231	5		
Pennsylvania†	45††				
New York	577	483	94		

*Partial support with minor impairment
**Michigan does not use partial designations.
†Not reported
†† Estimated
Source: State 1992 305b reports.

The results of this database search and the data in Exhibit V-1 do not necessarily mean that chemical contaminants are not present or not detected in the waters of the Great

Lakes. Rather, they indicate that, with minor exceptions, contaminants in waters of the Great Lakes are not present at concentrations high enough to cause concern, given state and federal standards for drinking water.

b. Designated Use: Swimming

One goal of the Federal Clean Water Act is that, wherever attainable, waters be of sufficient quality for swimming. To measure progress toward this goal, states are required to report in their 305b reports the degree to which their water bodies achieve their designated use for swimming. These data are presented in Exhibit V-2.

Almost all (97%) of the assessed waters of the Great Lakes meet their designated use for swimming. Where waters are determined not to be meeting their designated uses for swimming, the cause is usually bacteriological contamination. High turbidity levels are also responsible for beach closings along the New York shoreline of Lake Ontario.

Exhibit V-3

Great Lakes Shorelines Meeting Designated Use for Protecting Aquatic Life

		Miles Meeting Designated Use			
State	**Shoreline Miles**	**Full**	**Partial**	**Not**	**Not Assessed**
Minnesota	272			23.2	248.8
Wisconsin	840	720*	120		
Illinois	63	63*			
Indiana	43		43		
Michigan**	3288			3288	
Ohio	236		236		
Pennsylvania†	45††				
New York	577	577			

*Threatened
**Michigan does not use partial designations.
†Not reported
†† Estimated
Source: State 1992 305b reports.

c. Designated Use: Protecting Aquatic Life

The amount of shoreline meeting its designated use for protecting aquatic life varies tremendously among the Great Lakes states, as shown in Exhibit V-3. These variations are more indicative of differences in the way the states determine whether the designated use is met than of actual differences in water quality. Nevertheless, the degree of use attainment is substantially less for protecting aquatic life than for drinking or swimming. This reflects the fact that water quality standards for many chemicals are more stringent for the purpose of protecting aquatic life than for the purpose of drinking or swimming.

d. Designated Use: Producing Fish for Consumption

Fish consumption advisories exist throughout the Great Lakes. This fact is illustrated in Exhibit V-4, which shows that nearly all of the Great Lakes shoreline miles fail to fully meet their designated use for fish consumption. These advisories are based upon the presence of chemicals in the Great Lakes ecosystem that are long-lived and tend to accumulate in body fat (except mercury, which accumulates in muscle).

Exhibit V-4

Great Lakes Shorelines Meeting Designated Use for Producing Fish for Consumption

		Miles Meeting Designated Use		
State	Shoreline Miles	Full	Partial	Not
Minnesota	272			272
Wisconsin	840		840	
Illinois	63			63
Indiana	43		43	
Michigan	3288*			3288
Ohio	236		236	
Pennsylvania	45**		45†	
New York	577	85	492	

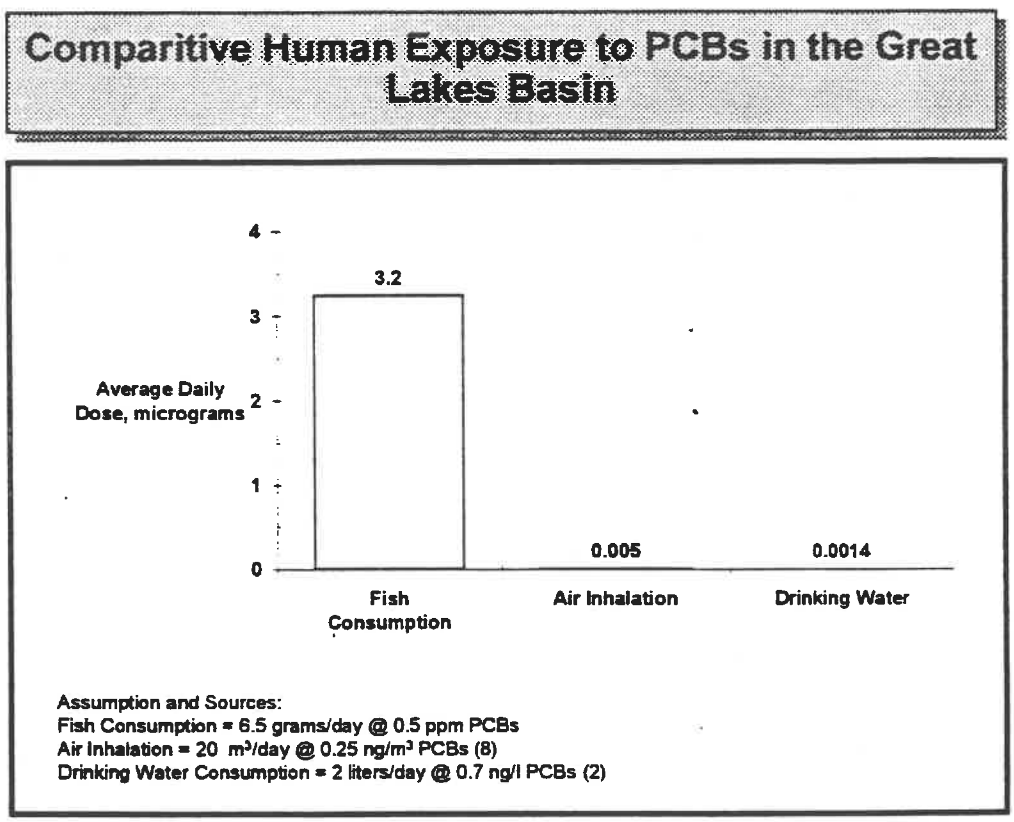
*Michigan does not use partial designations.
**Estimated
†Assumed based on fish consumption advisories.
Source: State 1992 305b reports.

These chemicals, which the GLI refer to as bioaccumulative chemicals of concern (BCCs), accumulate to increasing concentrations along the food chain. Therefore, their concentrations in fish are orders of magnitude higher than those in the water in which the fish live. In general, the older and larger the fish, the higher it is in the food chain, and the greater its fat content, the higher the concentrations of BCCs it will contain.

The issue of contamination of fish consumed by humans is important because it represents the primary means by which humans are exposed to toxins in the Great Lakes. this is illustrated for the case of PCBs in Exhibit V-5, which shows that human exposure to these substances by means of fish consumption is tremendous multiple of that occurring by means of air inhalation or drinking water.

It should be noted that the fish consumption rate used in Exhibit V-5 is that used by the EPA as the national rate of freshwater fish consumption, which has been criticized as being too low.[1,2] Higher fish consumption rates, whether they be for average consumers or subsistence or sport fishermen, would further emphasize the point that fish consumption is a far larger source of human exposure to PCBs than air or drinking water.

Exhibit V-5



1 COLBORN, THEODORA E.; DAVIDSON, ALEX; GREEN, SHARON N., R.A.; DODGE, (TONY); JACKSON, C. IAN; LIROFF, RICHARD A.; 1990, *Great Lakes Great Legacy?* The Conservation Foundation Washington, DC/ The Institute for Research on Public Policy, Ottawa, Ontario.

2 GREAT LAKES SPORT FISH ADVISORY TASK FORCE, JUNE 1993, *Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory.*

The contaminants responsible for fish consumption advisories and commercial fishing bans for the Great Lakes and connecting channels are listed in Exhibit V-6. With the exception of mercury and dioxins (which are produced as unwanted byproducts) the uses of all seven of these contaminants has been banned or severely restricted in the United States and Canada. However, despite these restrictions, large quantities of PCBs are still in use in the United States in closed systems, primarily electrical transformers, and may continue to enter the environment from leaks or spills from this equipment. Similarly, atmospheric deposition of DDT has been estimated to be 10 per cent to 20 per cent of its peak flux in the 1960s due to its continued use in Mexico and Central America.[3]

Actually, relatively few of the dozens of pollutants present in the Great Lakes are responsible for fish consumption advisories for those waters. This is the case even though states periodically survey fish for far more pollutants than those listed in Exhibit V-6.

Exhibit V-6

The Use of PCBs and Most of the Other Contaminates that Cause Fish Consumption Advisories Is Banned or Severely Restricted.

Contaminants Responsible for Fish Consumption Advisories in the Great Lakes

	Contaminant						
Water Body	Chlordane	DDT	Dieldrin	Dioxins*	Mercury	Mirex	PCBs
L. Superior	X				X		X
L. Michigan	X	X	X		X		X
L. Huron							X
St. Clair R.					X		X
L. St. Clair					X		X
Detroit R.					X		X
L. Erie	X						X
Niagara R.				X		X	X
L. Ontario				X		X	X

* Dioxins and/or dibenzofurans

Note: Wisconsin has issued advisories due to "pesticides" (chlordane, DDT, dieldrin, or toxaphene) for Lakes Michigan and Superior.

States differ in their procedures for issuing fish consumption advisories; however, work is underway to create a uniform protocol for advisories.[4] One likely outcome of this effort

3 Rapaport, R.A.; Urban, N.R.; Capel, P.D.; Baker, J.E.; Looney, B.B.; Eisenreich S.J.; Gorham, E., 1985, *"New" DDT inputs to North America: atmospheric deposition.* Chemosphere 14:1167-1173.

4 Great Lakes Sport Fish Advisory Task Force, June 1993, *Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory.*

would be more stringent standards for contaminant concentrations in fish than those issued by the Food and Drug Administration, which some states use in issuing advisories. It is unclear how these more stringent standards would change the data presented in Exhibits V-5 and V-6. Since fish consumption advisories for PCBs are already ubiquitous throughout the Great Lakes states, for example, this column of Exhibit V-6 would not be affected at all.

Monitoring and reporting on the effect of fish consumption by land-bound wildlife in the Great Lakes basin is not carried out as it is for human consumption. States are not required to report on the effects of water quality on wildlife as part of their 305b reports. Nevertheless, numerous studies show a range of effects on fish-eating species in the Great Lakes region. These effects are presented in Exhibit V-7.

Exhibit V-7

Wildlife and Fish Species Known To Be Affected by Contaminents in the Great Lakes

Species	Population Decrease	Effects on Reproduction	Eggshell Thinning	Congenital Malformations	Behavioral Changes	Biochemical Changes	Mortality
Mink	●	●	NA	NE	NE	NE	●
Otter	●		NA	NE	NE	NE	?
Double-crested Cormorant	●	●	●	●		●	?
Black-crowned Night Heron	●	●	●	●		●	?
Bald Eagle	●	●	●	NE		NE	NE
Herring Gull		●	●	●	●	●	●
Ring-billed Gull				●		NE	●
Caspian Tern		●		●	NE	NE	
Common Tern		●	●	●		●	
Forster's Tern		●		●	●	●	
Snapping Turtle	NE	●	NA	●	NE	NE	NE
Lake Trout		●	NA			●	
Brown Bullhead			NA			●	
White Sucker			NA	●		●	

Source: Adapted from Environment Canada, 1991

I = documented effect
NA = not applicable
NE =not examined
s = unpublished records
? = suspected, since population declined

2. Pollutant Loadings

Environmental benefits achieved through the GLI will depend on their changing the amounts of pollutants in the Great Lakes system. One key factor affecting the amounts of contaminants in a system is the rate at which pollutants enter the system. These incremental pollutants, referred to as "loadings," are generally measured in pounds or kilograms per year. One source of loadings to the Great Lakes system, and the one that the GLI implementation procedures primarily address are point source discharges, that is, discharges from distinct outfall pipes, as opposed to diffuse (non-point) sources such as agricultural runoff or infiltration of contaminated ground water.

DRI/McGraw-Hill requested data from the U.S. EPA on the 1991 point source loadings to the Great Lakes basin for two dozen pollutants. Our purpose was to determine the baseline point source loadings for the pollutants seen as most responsible for impairing the uses of water and to determine how total loadings of these pollutants might change upon implementation of the GLI.

The loadings data were supplied by the Region V office of the EPA, by means of the agency's Permit Compliance System database. This database compiles the monthly discharge monitoring reports for all permitted facilities in the Great Lakes basin. The agency used the same procedures used to calculate loads for our request as they have to answer Congressional inquiries about loading rates and to write the Lake Michigan Lakewide Area Management Plan.

The results of the EPA's calculation of pollutant loads are presented in Exhibit V-8. These data are given for each lake basin, and include discharges directly to the lake and discharges to tributaries feeding the lake. The sums of the discharges to each Lake Basin are also listed.

Exhibit V-8

Point Source Pollutant Loadings to the Great Lakes in 1991, kg

	Lake Basin					
Pollutant	**Superior**	**Huron**	**Michigan**	**Erie**	**Ontario**	**Total**
Chlordane, technical mixture			31			31
'4,4'-DDT						--
'4,4'-DDD					17	17
'4,4'-DDE				-	0 3	0 3
Dieldrin			8		0 3	8
Heptachlor			4	0 0	2	6
Heptachlor Epoxide						--
Hexachlorobenzene	106	0.3	162	• 10	29	306
Mirex					1	1
PCBs	6	20	36	88	17	167
'2 3,7,8-TCDD	0		2.7			3
Toxaphene			32			32
Pentachlorophenol	157	4		19	137	318
Phenol, single		11		342	4.433	4.786
Cyanide, free*		279	4.398	22.546	2.712	29.935
Cyanide, free**			57	1 5		59
Cyanide, total			74,378	53.846	9,964	138,187
Cadmium, total	67	28	3,195	6,641	1,673	11,604
Chromium, VI	6	6	2,840	638	115	3.604
Copper, total	1796	5,222	40,253	31,811	20,464	99,545
Lead			3,163	345	300	3.808
Lead, total	555	106	9,662	19,941	8,609	38,873
Mercury			64	0		64
Mercury, total	11	1	135	414	120	681
Nickel, total	838	112	22,852	72,266	14,141	110,208
Selenium, total	62		12	121	1,818	2,012
Silver, total	92	29	319	564	4,135	5.138
Zinc, total	5433	7,997	108,525	158,157	80,738	360,849

*amenable to chlorination
**water plus wastewaters

Source. U.S. Environmental Protection Agency Permit Compliance System

Several aspects of the calculations used to arrive at the data in Exhibit V-8 warrant explanation. As noted above, these data are based on the results of each facility's discharge monitoring report. When monitoring data have been reported as non-detectable, the EPA calculation of loads takes these values to be zero. For some pollutants, like cyanide and mercury, several different methods may be used for measuring concentrations. Therefore, multiple loading rates are given, depending on the method of analysis used.

Also, the data in Exhibit V-8 must be compared with other sources of the same pollutants into the lakes. Only then can one gain some sense of the potential benefits to be achieved by reducing the loading from the permitted sources. Unfortunately, quantitative data on the loading of pollutants to the Great Lakes from non-point sources are extremely rare, although estimates have been made of the rate of atmospheric deposition for a number of compounds. (Atmospheric deposition refers to toxic pollutants that pass from the air into the water.)

We present a comparison between point-source loadings and atmospheric deposition in Exhibit V-9. This table compares recent estimates of atmospheric deposition of 12 toxic chemicals to the Great Lakes with the loadings from Exhibit V-8. This comparison is limited in that only a subset (of 12) of the pollutants in Exhibit V-8 are listed, and more importantly, in that other sources of pollutants are not listed at all. These other sources include releases from contaminated sediments, surface runoff, and contaminated ground water infiltration. For the naturally occurring substances (metals), data on natural fluxes from the atmosphere, in tributaries, and from ground water must also be considered.

Exhibit V-9

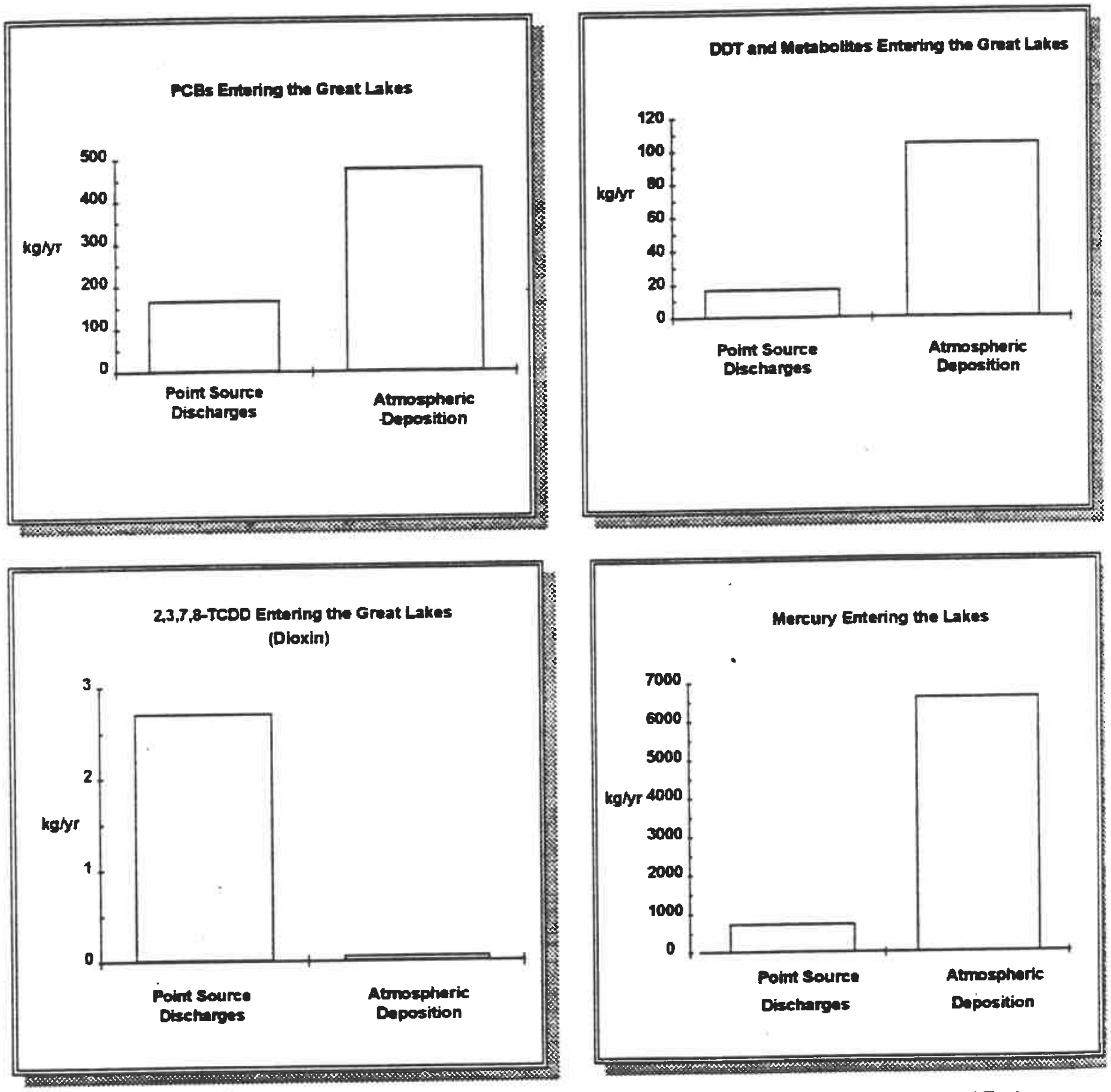
Comparison of Point Source Discharges and Atmospheric Deposition to the Great Lakes, kg/yr

Chlordane	31.1	40.2	44%	-
t-DDT	16.9	104.7	14%	-
Dieldrin	7.8	16.0	33%	-
Heptachlor	5.8	4.1	58%	-
Heptachlor Epoxide	0.0	20.1	0%	-
Mirex*	0.9	3.1	21%	-
t-PCBs	167.3	480.0	26%	4%
*2,3,7,8-TCDD	2.7	0.1	98%	-
Toxaphene	32.1	52.9	38%	-
Cadmium	11604.0	37187.0	24%	-
Lead	42681.0	259401.0	14%	-
Mercury, total	744.5	6624.0	10%	-

Sources: EPA Permit Compliance System and Eisenreich and Strachan, 1992 (8), except as noted.
*Atmospheric deposition data from Strachan and Eisenreich, 1988 (9)
**For Lake Michigan only (See Exhibit V-15) For other pollutants, data for sediments and leaking waste sites is not sufficient

Exhibit V-10

Point Source Contributions Are Dwarfed for Most BCCs by Atmospheric Deposition



Sources: Eisenreich, Steven J.; Strachan, William N.J., April 1992, *Estimated Atmospheric Deposition of Toxic Substances to the Great Lakes, An Update*, A Workshop Held at the Canada Centre for Inland Waters, Burlington, Ontario, January 31 - February 2, 1992, EPA Permit Compliance System.

Exhibit V-10 illustrates the comparative roles of point-source discharges and atmospheric deposition for four contaminants. For PCBs, DDT, and mercury, atmospheric deposition represents a multiple of point-source loadings into the Great Lakes. Dioxin is an exception in that its point-source loadings exceed atmospheric deposition of the contaminant. The exhibit underscores the fact that in addressing only point-source contributions, the GLI is addressing less than half of the pollution problem in the Great Lakes.

B. Potential Environmental Benefits of the GLI

1. Loading Reductions

Any environmental benefits that result from the GLI will derive from the reduction in pollutant loadings to the Great Lakes. Accurately projecting the change in loading would involve comparing the discharge from each facility with and without the GLI. This in turn would involve the recalculation of permit limits for hundreds of facilities and thousands of pollutants. We have employed two approaches to reduce this burden. In its study of the compliance costs for the GLI,[5] the U.S. EPA selected a sample of 50 facilities to represent the major dischargers to the lakes. We extrapolated the effects on these facilities to the universe of facilities in the Great Lakes regions based on the flow of the dischargers.

We have also examined the effects the GLI would have on hypothetical facilities. The National Wildlife Federation[6] studied the effects on a single facility in each of the Great Lakes states. In an exercise requested by Senator Carl Levin, the U.S. EPA has prepared comparisons of permit limits calculated using existing state procedures for three hypothetical facilities with the EPA's interpretation of what the limits would be under the Guidance.[7]

2. EPA Cost Study of 50 Sample Facilities

Each of these approaches has its shortcomings. In examining sample facilities as part of its cost study, the EPA based its changes in loadings on the difference between existing permit limits and those of the GLI. (Where the permit required monitoring, but did not impose a limit, loadings were based on the highest reported effluent concentration.)

This approach tends to overstate the loading reductions for three reasons:

- First, many facilities discharge at less than their permit limits. Since the EPA effectively assumed that all facilities discharge at their permit limits, the actual reductions in loading after GLI implementation would be lower than indicated.
- Second, in situations in which monitoring data were used to calculate loads, the practice of using the highest reported concentration rather than an average overstates the actual loadings. Again, these would overstate the reduction to be brought about by the GLI.

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5 Science Applications International Corporation, April 16, 1993, *Assessment of Compliance Csots Resulting from Implementation of the Proposed Great Lakes Water Quality Guidance.*

6 *Cutting the Poisons: Estimated Reductions in Point Source Loadings of Great Lakes Toxic Pollution from the Great Lakes Water Quality Initiative*, May 11, 1993, National Wildlife Federation/Great Lakes Natural Resource Center.

7 *Letter to Senator Carl Levin from Tudor T. Davies, Acting Deputy Assistant Adminsitrator, U.S. Environmental Protection Agency*, June 17, 1993.

- Third, in some cases where discharges are not significantly different from permit limits, the permit limits do not reflect current regulatory requirements such as the National Toxics Rule. Therefore, at least some of the loading reductions attributed to the GLI would actually be due to another regulatory

Exhibit V-11

Comparison of Baseline Loading and Reductions Estimated in EPA Study with Loading Calculated by EPA's Permit Compliance System

Table 9. Comparison of Baseline Loading and Reductions Estimated in EPA Cost Study with Loading Calculated by EPA's Pemit Compliance System

	Pollutant Loadings		Loading Reductions EPA Cost Study	
	EPA Cost Study	EPA PCS Data	WQBEL #1	WQBEL #2
	lbs/day			
Arsenic	53.56	NR	1.10	1.09
Benzene	0.00	NR	0.00	0.00
Cadmium	5760.89	70.10	5367.95	5622.53
Chlordane	1.17	0.19	0.43	0.80
Chlorobenzene	0.00	NR	0.00	0.00
Chromium III	3.38	NR	0.00	0.00
Chromium VI	15.33	21.77	9.44	10.58
Copper	78598.67	601.36	75664.12	76292.93
Cyanide, free	77.31	18.09	32.84	34.93
Cyanide, total	0.09	834.80	0.00	0.00
4,4-DDT*	0.32	0.10	0.00	0.00
Dieldrin	0.15	0.05	0.10	0.10
2,4-Dimethylphenol	0.00	NR	0.00	0.00
2,4-Dinitrophenol	0.00	NR	0.00	0.00
Endrin	0.00	NR	0.00	0.00
Heptachlor	0.37	0.04	0.11	0.21
Hexachlorobenzene	1.50	1.85	0.17	0.17
Hexachloroethane	0.00	NR	0.00	0.00
Lindane	0.00	NR	0.00	0.00
Mercury	56.58	4.52	38.79	45.89
Methylene Chloride	0.00	NR	0.00	0.00
Nickel	8659.86	665.78	80.27	92.78
Parathion	0.00	NR	0.00	0.00
PCBs	3.16	1.01	0.23	0.41
Pentachlorophenol	6.84	1.92	1.09	2.02
Phenol	0.00	28.92	0.00	0.00
Selenium, total	911.50	12.15	903.51	903.77
2,3,7,8,-TCDD (Dioxin)	.00059	0.02	.00056	.00056
Toluene	0.67	NR	0.00	0.00
Toxaphene	6.40	0.19	0.05	0.05
Trichloroethylene	27.17	NR	26.11	26.11
Zinc	9225.14	2179.92	1017.05	1048.61

*and metabolites
NR = PCS loadings data not requested by DRI

Sources: Assessment of Compliance Costs Resulting from the Proposed Great Lakes Water Quality Guidance (10); U.S. EPA Permit Compliance System program. (The EPA cost study made an adjustment for bringing facilities up to current standards when estimating costs but not when calculating loading reductions.)

Due to these shortcomings, DRI recommends using the EPA Permit Compliance System data as a more accurate representation of baseline loadings..

Exhibit V-11 compares pollutant loadings and loadings reductions estimated in the EPA study for major point source dischargers based on the difference in permit limits for a sample of 50 facilities with the 1991 discharges calculated by the agency's Permit Compliance System (PCS).

In almost all cases, the loadings estimates from these two data sources differ substantially. With the exceptions of hexavalent chromium, cyanide, hexachlorobenzene, phenol, and dioxin, for which the PCS calculations range from slightly to significantly greater than the cost study estimates, the cost study estimates of loading tend to be much higher than the loads calculated by the PCS. These differences are extremely large for some of the metals, such as cadmium, copper, nickel and zinc, which account for a large majority of the total pollutant load.

The most likely reasons for the greater discharge estimates in the EPA cost study are the use of permit limits to estimate loads and the potential lack of representativeness of the 50 sample facilities.

Exhibit V-11 also shows the reduction in pollutant loadings estimated in the EPA cost study for two water quality based effluent limitations (WQBEL). For WQBEL #1, the permit limits were set equal to the background concentration in the receiving water when negative wasteload allocations were calculated. For WQBEL #2, the limit was set to the most stringent water quality criteria when negative wasteload allocations resulted; thus, this limit is considered to be more stringent.

Because many of the loading reductions estimated in the cost study are larger than the baseline loadings calculated by the Permit Compliance System, their accuracy must be viewed with great suspicion. This is especially true for the metals like cadmium, copper, mercury, and selenium, which the cost study estimates to have some of the largest baseline discharges and greatest reductions in discharges due to the GLI.

3. National Wildlife Federation Study

The National Wildlife Federation (NWF)[8] calculated reductions in loadings for a hypothetical facility in each of the eight Great Lake states. The overall percentage reduction in loadings calculated in this study is comparable to the 81% estimated in the EPA cost study.

This study suffers from the same problem as the EPA cost study: reductions in discharges are based on permit limits rather than actual discharges. Perhaps more importantly, the

[8] *Cutting the Poisons: Estimated Reductions in Point Source Loadings of Great Lakes Toxic Pollution from the Great Lakes Water Quality Initiative*, May 11, 1993, National Wildlife Federation/Great Lakes Natural Resource Center.

NWF study examines only one facility and makes the highly unrealistic assumption that all of the wastewater from the hypothetical facility comes from ground water. In addition, very few facilities other than power plants and some sewage treatment plants discharge at rates exceeding 100 cubic feet per second (65 million gallons per day), which is assumed in this study. We are aware of none discharging at this rate whose sole supply of water is ground water or that even have wells capable of producing at this rate.

The assumption about ground water is important because the GLI does not allow the use of intake credits when ground water is the source of the waste water. Therefore, the permit limits calculated in this example are lower than they would be if the intake and receiving water body were the same. For the same reason, the reductions in loadings are greater than they would otherwise be. (The NWF study has also been criticized by the state of Ohio for failing to properly calculate permitted discharges under existing state rules, thereby producing too high a baseline of discharges, which also leads to the overstating of the potential reduction in discharges[9]).

4. Senator Levin's Request to the EPA

The comparison requested by Senator Carl Levin (D, Michigan) in which state permit limits were compared with GLI limits for three hypothetical facilities may provide the most useful illustration of the potential effects of the GLI on permit limits and pollutant loadings. The state permit limits were calculated by personnel in the respective state environmental agencies, who presumably best understand current state regulations and policies. The hypothetical facilities were conceived of by the U.S. EPA , and thus possess a useful degree of realism.

The results of the Levin request to the EPA are repeated for your convenience in Exhibit V-12 for monthly average WQBELs, which give a better indication of the differences in loadings than daily maximums do. Note that the results in Exhibit V-12 are taken from the June 17, 1993 response to Senator Levin, and not a later version (June 28). The earlier version is believed to be a more reasonable comparison because in the later version many state procedures that would result in stricter permit limits were not employed; in addition, permit limits were presented even when analyses revealing reasonable potential to exceed water quality criteria indicated that no permit limits would be necessary.

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9 *Cutting the Poisons: Estimated Reductions in Point Source Loadings of Great Lakes Toxic Pollution from the Great Lakes Water Quality Initiative*, May 11, 1993, National Wildlife Federation/Great Lakes Natural Resource Center.

Exhibit V-12

Summary of Comparison of GLWQG Limits with State Limits

Pollutant	Monthly Average WQBELs: GLWQG	Range of State Limits: min	Range of State Limits: max	Number of States with No Limit
	micrograms/liter			
Pulp and Paper Mill:				
Cadmium	NL	1	3.4	6
Copper	NL	20	30	6
Mercury	1.8E-4*	0.0013	1.5	2
Nickel	NL	-	-	8
PCBs	3E-6*	1.46E-05	0.134	1
Phenol	NL	300	300	7
Selenium	NL	-	-	8
Zinc	NL	180	1387	5
Metal Finisher:				
Cadmium	2	5.2	11	2
Chromium VI	16	12	19	4
Copper	NL	47	54	5
Cyanide (F)	8	7.4	23	3
Methylene Chloride	NL	30	32	6
Nickel	195	160	227**	4
PCBs	NL	1.46E-05	0.02	3
Phenol	NL	26	28	6
Toluene	NL	107	180	6
Trichloroethylene	NL	25	25	7
Zinc	318	160**	300	4
Publicly Owned Treatment Works:				
Cadmium	27	10	17	5
Chromium VI	NL	14	16	6
Copper	NL	39	43	6
Cyanide (F)	NL	-	-	8
Nickel	1038	371	371	7
Zinc	NL	52	110	5

*Compliance evaluation levels for these pollutants would be 3 orders of magnitude or more greater
**weekly average limit

Source: Letter to Senator Carl Levin from Tudor Davies (12)

The results summarized in Exhibit V-12 do not show a clear trend in stricter permit limits with the GLI for the three hypothetical facilities. In many cases, GLI procedures would result in no permit limits, while at least some of the state procedures would require limits.

Where the GLI does result in permit limits, the range of state limits generally surrounds the value calculated using the GLI. However, in each case in which the GLI determined that a limit was necessary, the procedures for at least one of the states resulted in no limit being necessary.

When the GLI resulted in permit limits for mercury and PCBs, pollutants for which the GLI establishes wildlife criteria, the limits are much lower than those calculated by the states. The GLI limits for these pollutants, like most of the state limits, are far below current analytical quantification levels; therefore, concentrations used to assess compliance (the compliance evaluation level) would be orders of magnitude greater. In practical terms, until analytical methods improve significantly, the GLI limits would differ little from most of the state limits

The results of the Senator Levin exercise are consistent with other analyses conducted by the states, which have questioned the additional treatment requirements determined in the EPA cost study. An analysis conducted by the state of Michigan "eliminates essentially all of the compliance costs" estimated by the EPA report to be necessary for facilities in the state to comply with the GLI, because the GLI and Michigan approaches to calculating WQBELs "at existing facilities are quite comparable."[10] If correct, this means that facilities in Michigan would not have to install additional treatment for their wastewaters, but neither would they be reducing pollutant loadings. Because roughly half of the major discharges to the Great Lakes basin are located in Michigan, and a large fraction of pollutant discharges in the basin come from the state, the conclusion reached by the state limit the total reduction in point source discharges achievable by the GLI.

Despite the range of estimates of reductions in loadings to be achieved by the GLI, we can make some judgments about its potential for improving designated uses. We do this by examining how the total loadings of pollutants to the lakes might change as a result of the guidance. Clearly, if no change in loadings results for a particular pollutant, the impairment of beneficial uses by that pollutant will not change. If a reduction in loadings does occur, the question of how beneficial uses might change needs to be answered.

A mass balance model of the behavior of pollutants within the lakes would be useful in making this assessment. Because the application of such a model is beyond the scope of this report, however, we rely instead on an assessment of relative loadings rates, and mass balances performed by others on individual lakes (or parts of lakes) as the basis of our judgments regarding the potential for improvements in beneficial uses.

The actual degree of reduction in loadings will depend on the final form the guidance takes and the interpretation of it. Even if the initial loadings calculated by the EPA cost study are too high, they are equal for of both the scenarios evaluated. The difference in the degree of loading reductions is due to the difference in calculated permit limits. Thus, implementation procedures such as the strict interpretation of intake credits and the elimination of mixing zones will reduce the level of discharges from the affected facilities,

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10 *Letter to G. Tracy Meehan, Director, Office of the Great Lakes from James Grant, Chief, Great Lakes and Environmental Assessment Section, Michigan Department of Natural Resources*, June 11, 1993.

even if in the larger context of discharges to the lakes, as discussed below, the effects are small.

5. Effect of the GLI on Drinking Water Would Be Insignificant

As noted above, virtually all of the reported Great Lakes shoreline miles already meet their designated uses for drinking water, and drinking water from the lakes is a minor source of exposure to residents in the basin.[11] The use of activated carbon treatment by municipal drinking water systems that fail to meet regulations for turbidity and coliform bacteria further limits exposure to organic contaminants.[12]

Thus the GLI can make little improvement in the amount of shoreline meeting its designated use for drinking water because there is so little room for improvement. Any reduction in pollutant concentrations in drinking water will be of little significance because pollutant concentrations are found only at very low levels in drinking water, levels below Guidance, which have been established on the assumption of lifetime exposures and wide margins of safety.[13]

6. Effect of the GLI on Swimming Would Be Nonexistent

Little improvement in the degree of shoreline miles meeting designated uses for swimming is possible for the Great Lakes, again because almost all of the shorelines already meet their standards for this designated use. Because the parameters that result in the failure to achieve designated uses for swimming, such as bacteriological contamination and high turbidity levels, are not addressed by the guidance, it will have no direct benefit in increasing the number of shoreline miles available for swimming.

7. Effect of the GLI on Aquatic Life and Fish Consumption Would Be Negligible

Improvements in aquatic life and reductions in fish consumption advisories will result from decreases in the exposure of aquatic flora and fauna to pollutants. Absent complete mass balance modeling results on how exposures to organisms in each lake might change due to implementation of the GLI, we describe the relative loadings of several key pollutants to illustrate how reduced point-source loads might affect concentrations in the lakes.

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[11] Environment Canada; Department of Fisheries and Oceans; Health and Welfare Canada; March 1991, *Toxic Chemicals in the Great Lakes and Associated Effects, Synopsis.*
Coburn, Theodora E.; Davidson, Alex; Green, Sharon N.; Hodge, R.A. (Tony); Jackson, C. Ian; Liroff, Richard A.; 1990, *Great Lakes, Great Legacy?* Conservation Foundation, Washington, D.C., The Institute for Research on Public Policy, Ottowa, Ontario.

[12] Coburn, Theodora E.; Davidson, Alex; Green, Sharon N.; Hodge, R.A. (Tony); Jackson,.C. Ian; Liroff, Richard A.; 1990, *Great Lakes, Great Legacy?* Conservation Foundation, Washington, D.C., The Institute for Research on Public Policy, Ottowa, Ontario.

[13] Environment Canada; Department of Fisheries and Oceans; Health and Welfare Canada; March 1991, *Toxic Chemicals in the Great Lakes and Associated Effects, Synopsis.*

Estimates of PCB loads to Lake Michigan are listed in Exhibit V-13. Three types of sources are listed in this table: point source discharges, atmospheric deposition, and loads associated with the flow of tributaries into the lake.

Exhibit V-13

PCB Flows into Lake Michigan

	kg/yr
Point Source Discharges	36
Waukegan Harbor	20.4
Grand Calumet River	199
Lower Fox River	283
Other Tributaries	298
Atmospheric Deposition	113.8
Total	**950.2**

*Includes discharges to tributaries.
Sources: EPA Permit Compliance System, Lake Michigan Lakewide Management Plan; Peck et al., 1993; Eisenreich and Strachan, 1992.

Exhibit V-13 clearly indicates that tributary loads are the largest contributor to loadings in Lake Michigan, accounting for almost 85% of the total, while point source discharges make up less than 4%. Although some double-counting occurs in this table because the tributary loads include point source loadings, that amount cannot be significant. The data for point source loadings includes point source loadings to tributaries. Even if all of the point source loadings were subtracted from the tributary loadings, the total tributary loadings would change little. The principal source of PCBs in the tributary loads is not municipal or industrial point sources, but the transport of sediments contaminated in the past.[14,15]

If the change in PCB concentrations in the Lake Michigan is taken to be proportional to the change in loadings, then the potential decrease in concentrations to be achieved by the GLI in its current form is negligible. This is illustrated in Exhibit V-14, which scales a

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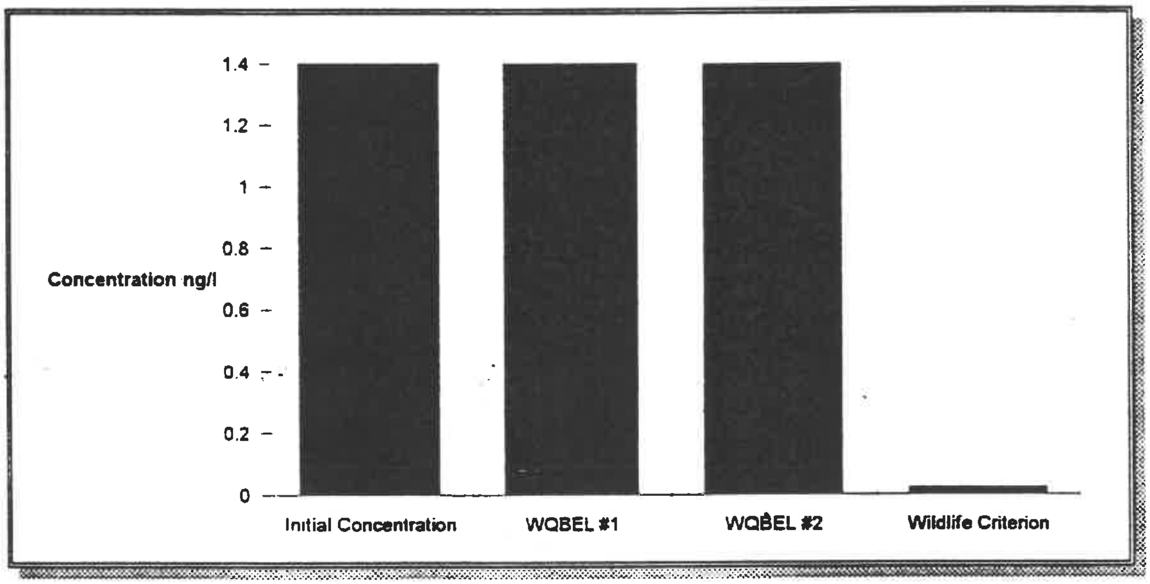
14 Hulsey, Brett; Peck, John; Savagian, Andrew; *Clean Lakes, Clean Jobs: A Case for Cleaning UP Contaminated Sediments to Make the Great Lakes Safe for Industry and Fishing*, Sierra Club Great Lakes Program.

15 Environmental Science and Technology, Vol. 27, No. 7, p. 1246, *Science*, 1993.

typical concentration of PCBs in the water by the change in loadings predicted to occur in the EPA cost study of 50 sample companies.[16] Because of the small contribution of point sources to the lake, and the modest reductions predicted to occur under either of the scenarios evaluated (7.3% and 13% for WQBEL 1 and 2, respectively), the overall change in concentrations is not discernible.

Exhibit V-14

Potential Change in Lake Michigan PCB Concentrations Under 2 GLWQG Permit Conditions



Furthermore, even these reductions are most likely overestimates, for as the EPA study notes, the assumption that facilities currently discharge at their permit limits was "primarily the reason that reductions were estimated for pollutants for which production has been banned (e.g. PCB, 4,4-DDT, etc.)."[17]

Similar results would be obtained if the same calculations were made for Lake Superior. Industrial and municipal point sources have been estimated to account for 5%, 6%, and 7% of the PCBs, mercury, and lead loadings, respectively, to the lake.[18] Therefore, any

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16 Science Applications International Corporation, April 16, 1993, *Assessment of Compliance Csots Resulting from Implementation of the Proposed Great Lakes Water Quality Guidance*

17 Science Applications International Corporation, April 16, 1993, *Assessment of Compliance Csots Resulting from Implementation of the Proposed Great Lakes Water Quality Guidance*

18 DIAMOND, M.; MACKAY, D.; SANG, S.; VLAHOS, P.; VOLDNER, E.; DOLAN, D.; 1992, *Mass Balancing and Virtual Eliminaton*, A Peer Review Workshop at University of Toronto December 7-8, 1992..

loadings reductions projected to occur with the proposed GLI will not be sufficient to bring about major improvements in water quality.

8. Overall Impact on Designated Uses will be Modest

In general, we expect the GLI to be responsible for only very modest improvements in designated uses for aquatic life and fish consumption. In the case of pollutants responsible for fish consumption advisories (as well as effects on wildlife) the compounds believed to be responsible for impairing uses are primarily ones whose production has already been banned.

Mercury and dioxin (an unwanted byproduct) are exceptions to this generalization, but because of the relatively large atmospheric contribution to mercury loadings (see Exhibit V-10), the potential mercury reductions are also minor. For dioxin, which has a minor atmospheric component, reductions in total loadings could be significant if the data from the EPA's permit compliance system are accurate and non-point sources are small. However, even if dioxin loadings are significantly reduced by the GLI, the small reductions in loadings of the other pollutants means that few fish consumption advisories might be removed and only one pollutant affecting fish and wildlife would be addressed.

Clearly, all of the sources of pollutants affecting the lakes must be considered. One way of setting priorities for reducing pollutant loads is to use of mass balance models to predict where the largest benefit of reducing loads can be achieved. Such models could also answer the question of whether minor reductions in point source discharges would even be necessary if the larger non-point sources were controlled.

The oft-stated argument is that all discharges of persistent toxins must be eliminated because the long hydraulic retention time of the Great Lakes basin means they will remain there for decades. However, the time contaminants remain in the lakes actually bears little relationship to the flushing time of the lakes.[19,20] On a practical level, uncritical acceptance of this belief diverts energy and resources from activities that would yield greater improvement in the waters of the Great Lakes.

D. EPA Benefit Valuations Reflect Optimistic Assumptions on GLI Contributions

The US EPA Regulatory Impact Analysis[21] (RIA) reports that, in 3 case studies of particular locations within the Great Lakes Basin, the value of benefits provided by the GLI appears to be about the same order of magnitude as the costs. This result, however, arises from arbitrary and quite optimistic assumptions on the proportional contribution

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19 Environment Canada/Department of Fisheries and Oceans/Health and Welfare Canada, March, 1991, *Toxic Chemicals in the Great Lakes and Associated Effects, Synopsis.*

20 Environment Canada; Department of Fisheries and Oceans; Health and Welfare Canada; March 1991, *Toxic Chemicals in the Great Lakes and Associated Effects, Synopsis.*

21 The "Regulatory Impact Analysis of the Proposed Great Lakes Water Quality Guidance" was conducted for the US EPA by RCG/Hagler, Bailly, Inc., April 15, 1993.

GLI would make to an increased *consumer and producer surplus* value of a water body. Specifically, EPA values the environmental benefits of the GLI by either

- obtaining a value for a possible change in water quality, such as from current conditions to a "contaminant free" state, and assigning a portion of that increment to the GLI or
- assessing the value of a water system in its current state and assuming a percentage increase that would result from the GLI.

EPA commonly assumes that GLI might account for as much as 50 per cent of the potential incremental use value of a water body or as much as 20 per cent of the current use value. However, data on loadings, as noted above, suggest that GLI would have effects at least an order of magnitude less.

Most of the benefits identified in the EPA study arise from increased water body use for recreational fishing, commercial fishing, or wildlife observation, and from higher non-use (or ecological) value. The study computes the GLI contribution to non-use value as 50 per cent of its contribution to use value. Thus, the full valuation of benefits hinge on the assumptions determining the contribution to the use value of a water body.

Not all the benefits estimated by the procedures just described can realistically be expected to occur instantaneously. Thus, EPA alternatively assuming a phasing in to full benefits over 10 and 20 years.

Lower Fox River Case Study. The EPA study estimates that, in the Lower Fox River watershed, the GLI would add benefits valued at 3 to 12 million (1992) dollars annually, with .9 to 5.7 million coming from increased recreational fishing, .2 to .3 million from commercial fishing, 1.3 to 1.8 million from wildlife observation, and .5 to 3.7 million from nonuse valuation. These values assume that the GLI would account for

- 50 per cent of potential incremental value from increased trout and salmon sports fishing,
- 20 to 100 per cent of potential incremental value from greater yellow perch sports fishing, and
- 5 per cent greater value from wildlife observation.

Saginaw River and Bay Case Study For Saginaw River and Bay, the EPA study estimates that the GLI would contribute benefits totaling 1.9 to 16.7 million (1992) dollars annually. The overall benefits reflect a 0.9 to 8.1 million value for enhanced recreational fishing, 0.2 to 0.7 million from increased commercial fishing, .1 million from better waterfowl hunting, and .2 to .7 million from wildlife observation. These values assume that the GLI would contribute

- 50 per cent of the potential value increase from recreational fishing,
- 10 per cent greater value from commercial fishing,
- 10 per cent greater value from waterfowl hunting, and
- 5 to 10 per cent greater value from wildlife observation.

Black River Case Study The EPA study estimates that, by enhancing the fishing and swimming in the Black River, the GLI would add benefits totaling from .1 to 1.2 million (1992) dollars annually. The values in this case build upon an earlier study of the benefits of transforming the Black River from its current state in 1982 to "fishable" water quality.[22] The EPA study assumes that, as compared with the total benefits of moving from 1982 water quality to fishable water quality, the GLI contributions would account for

- 1 to 5 per cent as much value from better recreational angling and
- 1 to 5 per cent as much value from recreational boating.

As shown in Exhibit V-15, the EPA cost estimates for the three case studies lie within the range of benefits for two of the cast study sites. and exceeds the maximum estimated benefits by a factor of ten for the Black River site. Because the site-specific approach may overlook benefits accruing to residents elsewhere on the lakes, and because the monetization of environmental benefits is an art more than a science, these results, if taken on their own, would not indicate an alarming imbalance between costs and benefits.

However, the costs used here are based on the EPA Cost Scenario #2, which is one-tenth as large as DRI's worst-case cost scenario (A-High). When compared to those larger estimates, the EPA benefit estimates confirm the main conclusion of this report, that if the GLI provisions causing potential "cost spikes" are not modified, there is a danger that the costs of the GLI will far exceed reasonable ranges of benefit measures.

E. An Ecosystem Approach to Regulation?

The EPA describes the Great Lakes Water Quality Guidance as taking an ecosystem approach to the regulation of toxins. The reason for this description seems to be that for the first time, federal guidance on water quality contains criteria for the protection of animal species that do not live in the water but are nevertheless exposed to toxins in the water through their diet. While such an approach is certainly needed, it is debatable whether it can be considered novel, or to what degree it really represents and ecosystem approach. Traditionally, one of the criteria established for water quality has been the protection of human health from adverse effects of eating fish in contaminated waters, which like wildlife, accumulate certain toxins in their fat or flesh. What is new about the guidance is that it considers effects on fish consumers others than humans, namely several species of birds and mammals.

Unfortunately, the approach taken by the guidance looks at only one part of the ecosystem, the accumulation of contaminants through the food chain. A true ecosystem approach would fully consider all sources and fates of contaminants in the Great Lakes basins, as well as its biological and physical characteristics. This is much closer to the approach taken in Lakewide Area Management Plans (LAMPs). Because the LAMPs focus on only one lake each, they might be considered less comprehensive than an ecosystem analysis of the entire basin. However, the large differences in physical and

22 *An Economic Assessment of the Benefits of the Final Effluent Limitations Guidelines for Iron and Steel Manufacturers*, US EPA/OPA, 1982

biological characteristics among the lakes may make them a more reasonable unit for ecosystem analysis.

Exhibit V-15

Case Study Benefit Cost Results for Great Lakes Water Quality Guidance[a] (Millions of 1992 [first quarter] dollars per year)

Benefit Category	Case Study Site		
	Fox River/ Green Bay	Saginaw Bay	Black River
Recreational Fishing	0.9 - 6.1	0.9 - 8.1	0.1 - 0.6
Recreational Boating and Swimming	+	+	0.0 - 0.1
Subsistence Fishing	+	+	+
Commercial Fisheries	0.2 - 0.3	0.2 - 0.7	
Waterfowl and Other Hunting	+	0.1 - 0.1	+
Nonconsumptive Use	1.3 - 1.8	0.2 - 0.7	+
Human Health Benefits	+	+	+
Nonuse/Ecologic Values	0.5 - 3.7	0.5 - 7.1	0.0 - 0.6
Total Benefits	2.9 - 11.9	1.9 - 16.7	0.1 - 1.2
Annualized Costs[b]	5.1	6.0	12.0

+	Positive benefits anticipated, but not estimated in monetary terms.
a	See body of report for explanation of assumptions employed to attribute benefits to the Guidance, and their application to specific benefit estimates.
b	Source: SAIC 1993, Cost Scenario 2.
Note:	Numbers may not add to total due to rounding.

Reproduced from EPA Regulatory Impact Analysis (RCG/Hagler, Bailly, Inc.), 1993

The failure of the guidance to take a true ecosystem approach may best be illustrated in the establishment of a the wildlife criterion for mercury. As a naturally occurring element, mercury would be expected to be present in all water bodies. This raises the question of its concentration would be in an unpolluted environment and what the proper water quality criterion should be. The guidance back-calculates an acceptable concentration using a dose that does not cause adverse effects on wildlife and a bioaccumulation factor to relate the concentration in water to the concentration in the food of the wildlife.

There are several problems with the criterion calculated in this way. While methyl mercury is the form of primary concern, the water quality criterion is based on all forms of mercury regardless of their relative toxicity. A large degree of uncertainty surrounds the magnitude of the bioaccumulation factor which is used to calculate the water quality criterion, to such a degree that the proposed criterion is lower than what the concentration would be in a pristine environment.

For a relatively pristine lake, expected mercury concentrations have been cited by one source to range from 0.4 to 0.8 ng/l (17), compared to the GLI wildlife criterion of 0.18 ng/l. Mercury concentrations in Lakes Superior and Huron, the cleanest of the Great Lakes, measured at <6.2 and 4.9 ng/l, respectively (2). Atmospheric deposition of mercury to the lakes is a far larger source than municipal and industrial discharges, yet preindustrial deposition rates have been estimated to be 30% of their current levels. When natural inflows from tributaries and ground water are added to the natural rates of atmospheric deposition, it seems unlikely that the concentrations in the lakes ever was or ever will be as low as the wildlife criterion proposed in the GLI, even in the absence of anthropogenic inputs.

The use of an ecosystem approach that includes the mass balance modeling of contaminants in the lakes could serve would serve two important purposes. For naturally-occurring compounds, mainly the metals, it would provide needed information on how natural flows compare with those due to man's activities. For all of the pollutants, it would indicate the relative significance of pollutant sources and the effectiveness of control strategies to enhance the ecosystems of the lakes. Combined with information on the costs of the various control strategies, it would point toward the most cost-effective solutions to the problems of toxic pollutants in the Great Lakes.

The Following Is A Working Draft For Comment -- The Findings Do Not Represent The Position of the Council or Any Individual Governor.

Appendix A. DRI/McGraw-Hill Model of the Great Lakes Economy

Overview

The DRI/McGraw-Hill model of the Great Lakes regional economy represents a new generation of regional models. The model is a dynamic system of over 1,400 equations describing the economic structures and linkages of the eight Great Lakes states. It is multidimensional, integrating the structural detail of interindustry relationships across eight states into an econometric model of regional competition and growth. This dynamic approach captures the interactions between production, employment, incomes, wages, industry costs, demographic forces, housing markets, and government finance in each of the eight states. The modeling structure is flexible, providing policy makers with a comprehensive and consistent framework for assessing the economic impacts of their policy choices.

The Great Lakes Regional Model is linked to the DRI/McGraw-Hill Quarterly Model of the U.S. Economy, incorporating national variables as basic drivers of economic activity within the eight states. The influence of national forces is shaped by state-specific conditions of demographics, industry mix, income and expenditure patterns, and relative cost structures. Each state's changing competitive strengths and weaknesses determine its success in capturing a share of the national market. Like the U.S. Model, the Great Lakes Regional Model operates at a quarterly frequency.

Theoretical Foundations and Innovations

According to the economic base (export base) theory of regional development, a region's economic growth is enhanced by the sale of its goods and services to markets outside the state. By exporting, industries generate new income and wealth which, in turn, promotes the expansion of sectors of the economy that serve primarily local markets. As described in the accelerator/multiplier theory, business investment increases as the capital stock adjusts to changes in output and employment. New job opportunities also attract an in-migration of population, increasing the demand for new housing.

The ability of the economy to sustain higher growth is, however, constrained by competitive forces captured in the model. The entry of new workers into the labor force lags behind the gains in employment, causing labor markets to tighten. The resulting upward pressure on wage rates contributes to a general acceleration in each state's consumer price level. Higher operating costs for businesses and higher living costs for residents move the economy back toward a trend rate of growth, although altered by the new industry structure.

This dynamic process represents a departure from the simple export base theory. The multiplier response to an initial stimulus is not constant, but rises initially with higher consumption and investment and then falls as resource constraints and cost pressures impair each state's competitive position. Moreover, the response to an economic stimulus will vary across industries and states, depending on their technologies, cost structures, and interindustry purchasing relationships. Part of the income created by export sales will be spent on goods and services provided by firms outside the state; this leakage diminishes the export multiplier.

The industrial structure of the Great Lakes Regional Model embodies several innovations in regional modeling, including the incorporation of explicit cost measures and interindustry demands. For 20 manufacturing industries and eight states, the model determines constant-dollar (real) shipments, employment, wage rates, wage and salary income, and an input cost index. The eight nonmanufacturing sectors include all variables except real shipments.

In constructing the model, DRI/McGraw-Hill utilized its proprietary quarterly database of real industry shipments by state. DRI has developed this database from five-year and annual Census Bureau surveys. With limited degrees of freedom, the equation structures are simple yet powerful. For each industry, a state's share of national production is driven by its input costs, interindustry generated demand (within the state and/or the Great Lakes region), and tax rates--all expressed relative to the nation's. In some industries, relative income, population, or final demand measures are also included.

The set of interindustry generated demand variables is unique and captures a supplying industry's potential sales to other industries within the state or region. Purchase coefficients, expressed as a percentage of purchasing industries' output, are derived from DRI/McGraw-Hill's Interindustry Model and vary over time as technologies and industry structures change.

The Great Lakes states, like other regions, have clusters of interdependent firms in related industries. Some firms will sell their products outside the region, while supporting firms will provide raw materials, components, and support services. For example, the lumber industry will benefit from an increase in shipments of paper or furniture, while the demand for steel will increase with sales of machinery or transportation equipment by firms within the region. The interindustry generated demand variables within the Great Lakes Regional Model capture these cluster relationships.

Another important feature of the model is the explicit representation of industry costs. Each industry cost index has four components--wages, the rental price of capital, electricity costs, and material costs. DRI/McGraw-Hill's Factor Input Margin model was used to determine the contribution of different factors of production to total input costs by industry at the national level. The weights applied to the four factor inputs vary over time with shifts in technology and production processes. The cost indexes capture regional variations in industry wage rates and electricity prices. Although the model was estimated using national measures of capital and material costs, regional variations can be introduced in impact simulations. For example, the financing costs of investments to meet water quality standards can be introduced through each industry's capital cost index. The model can then be solved to determine impacts of the change in capital costs on industry shipments and employment, incomes, consumer prices, population, and construction activity.

Model Structure

Industrial Production

The Great Lakes model projects the real value of shipments in 20 manufacturing industries, defined at the two-digit Standard Industrial Classification (SIC) level. The primary source for historical data on nominal shipments by industry is the Bureau of the Census, U.S. Department of Commerce. These nominal shipments are then deflated by the U.S. producer price indexes (rebased to 1987=1) for the corresponding two-digit SIC industries to obtain real shipments in constant 1987 dollars. Monthly producer price data are available from the Bureau of Labor Statistics for the nation as a whole, but not for individual states. For each industry, annual real shipments are then distributed to a quarterly frequency using the profile of each state's employment multiplied by the national ratio of real shipments to employment.

The Great Lakes regional model combines the industry shipments database with DRI's Interindustry Model to construct a powerful set of equations linking potential supplier production to changes in purchaser activity. These equations link one industrial sector to another by insuring that suppliers share in the growth of their principal end-markets.

More deterministic input/output structures apply fixed regional purchase coefficients in deriving a local area input/output matrix. In contrast, DRI/McGraw-Hill's Great Lakes model uses generated interindustry demand variables, while maintaining the desirable competitive features of a behavioral model. Rather than assigning weights mechanically, we use these interindustry demand variables as explanatory factors in the estimation of industrial shipments equations. These econometric equations yield a coefficient on the interindustry demand variable which indicates for each industry the degree to which local suppliers satisfy local end-market demand.

A sample interindustry demand equation for Great Lakes' industry **j**, which principally sells to industries **x**, **y**, and **z**, is as follows:

$$GQ_{jGL} = B_{jx} * Q_{xGL} + B_{jy} * Q_{yGL} + B_{jz} * Q_{zGL}$$

GQ represents interindustry demand for industry **j**, and **Q** represents output of industries **x**, **y**, or **z** in the eight Great Lake states (**GL**). The coefficients $\mathbf{B_{jx}}$, $\mathbf{B_{jy}}$, and $\mathbf{B_{jz}}$ measure purchases from industry **j** as a percentage of total output in industries **x**, **y**, and **z**. These shares are determined exogenously using DRI's Interindustry modeling system. The shares change over time, according to the evolving input-output relationships projected by DRI's Interindustry Service. The model includes interindustry generated demand variables for each state and the Great Lakes region. The relative importance of state versus regional end-markets is determined in the estimation of econometric equations. Michigan's rubber and plastic industry shipments, for example, are driven by generated demands of Michigan industries, reflecting the dominant role of the state's automotive industry. On the other hand, Indiana's rubber and plastic industry depends interindustry generated demand from end-markets throughout the Great Lakes region.

Total output in each manufacturing industry is modeled as a function of several explanatory variables. Each concept is expressed as its state value relative to its national value, measuring the competitiveness of each state economy. A state's share of the national market in a given industry thus depends on relative interindustry demand, relative "final demand," relative production costs, and relative business tax rates. "Final demand" is represented by state's or region's share of national income or population. Production costs include the industry's wage rate, the rental price of capital, electricity prices, and the wholesale price of intermediate materials. The basic functional form for the shipments equations for state **R** is:

$$Q_{iR} / Q_{iUS} = f(GQ_{iGL} / GQ_{iUS}, FD_{iR} / FD_{iUS}, COST_{iR} / COST_{iUS}, TB_R - TB_{US})$$

where
Q_{iR} *represents state shipments in industry i;*
Q_{iUS} *is national shipments in industry i;*
GQ_{iGL} *and* GQ_{iUS} *are the interindustry generated demand measures for industry i in the Great Lakes and the U.S.;*
$COST_{iR}$ *and* $COST_{iUS}$ *are production cost indexes for industry i;*
and TB_R *and* TB_{US} *represent business taxes as a share of personal income.*

In many cases, the state-specific interindustry demand variable (**GQ_R**) replaces the Great Lakes variable. Final demand terms (which represent consumer spending, government purchases, investment, and exports) do not enter the shipments equation for every industry because some industries produce goods almost entirely as inputs to other industries.

Industry-specific shipments are then used to determine employment by state in 20 manufacturing industries. Total manufacturing shipments affect employment in mining; wholesale and retail trade; and transportation, communications, and public utilities.

Employment

The Great Lakes model projects state-level employment in 20 manufacturing industries and eight nonmanufacturing industries. Manufacturing employment is modeled at the two-digit SIC code level of detail, while nonmanufacturing employment roughly follows a one-digit classification. The U.S. Department of Labor's Bureau of Labor Statistics (BLS) is the primary source of employment data. Monthly series are seasonally adjusted and converted to a quarterly frequency.

The Great Lakes model uses industry shipments, national labor productivity, and relative wage rates to estimate manufacturing employment by state for 20 industries. Equations are estimated in log-linear form. Employment is primarily a function of each state's real shipments and national labor productivity, but is also affected by cost considerations. The ratio of a state's manufacturing wage rate to the nation's captures regional variations in labor productivity. High-wage states, for example, are likely to be characterized by high capital-to-labor ratios and high labor productivity. The ratio of industrial wage rates relative to the industry's total cost index (including capital, energy, and material costs) captures substitutions between labor and other factors of production, such as capital and energy. The general form of the manufacturing employment equations is as follows:

$$E_{iR} / Q_{iR} = f(Q_{iUS} / E_{iUS}, RW_{iR} / RW_{iUS}, RW_{iR} / Cost_{iR})$$

where
E_{iR} *is employment in industry i in Great Lakes state R,*
Q_{iR} *is output in industry i in Great Lakes state R,*
Q_{iUS} / E_{iUS} *is output per worker nationally in industry i,*
RW_{iR} / RW_{iUS} *is the state's wage rate relative to the nation's in industry i, and*
$RW_{iR} / COST_{iR}$ *is the state's wage rate relative to total costs in industry i.*

The model determines nonmanufacturing employment in eight sectors, listed in order of size: services; wholesale and retail trade; state and local government; finance, insurance, and real estate; transportation, communications, and utilities; construction; federal government; and mining. While these sectors sell primarily to local markets, they also serve markets outside the state. Thus, nonmanufacturing employment is subject to the forces of regional competition.

Each nonmanufacturing employment equation has a unique specification to reflect the different drivers of each sector. The dependent variable is the ratio of state employment to national employment in a given sector. Key explanatory variables are expressed as state-to-nation ratios. Equations are estimated in log-linear functional form.

The key determinant in most nonmanufacturing employment equations is real discretionary income, which represents consumers' purchasing power. Discretionary income is total personal income less tax payments, utility consumption, and saving. Tax payments subtracted from personal income include not only personal taxes but individual payments of sales and property taxes. Each state's nominal discretionary income is then deflated by a state-specific consumer price index (CPI). Thus, an increase in a state's CPI will reduce real income, leading to weaker demand for goods and services and lower employment in nonmanufacturing industries.

In the state and local government sector, real income reflects both demand for public services and revenue-raising capacity. In some equations, state and local tax revenues directly influence government employment. Population, rather than income, is the dominant explanatory variable in equations for federal government employment.

Employment in most nonmanufacturing industries is also affected by each state's wage rate relative to the nation's. The difference between a state's effective state and local business tax rate and the nation's influences employment in services, trade, and finance. The business tax rate is defined as the sum of business payments for corporate, sales, and property taxes divided by total personal income.

Employment in construction is driven by real investment in structures, population, and relative wage rates. Real investment in structures has two components -- residential (determined by housing starts and real discretionary income) and nonresidential (determined by non-construction employment). Housing starts, in turn, are modeled as a share of the nation's and are driven by relative changes in population and levels of real discretionary income. Measures of construction activity also affect employment in finance, insurance, and real estate.

Finally, mining employment is driven by total manufacturing shipments, investment in structures, and the mining industry's relative costs.

Incomes

The Great Lakes model projects total personal income and its components for all eight states. Historical data is provided by the U.S. Department of Commerce, Bureau of Economic Analysis' Survey of Current Business and other unpublished materials. Personal income is the sum of three sets of concepts:

$$\begin{aligned}&\textit{Total Personal Income} =\\&\textit{Wage and Salary Disbursements} +\\&\textit{Nonwage Taxable Income} +\\&\textit{Nontaxable Income}\end{aligned}$$

In each industry, wage and salary disbursements are the product of average annual wage rates and employment. Total wage and salary income is summed over the 20 manufacturing and eight nonmanufacturing industries in each Great Lakes state.

Nonwage taxable income breaks down further:

$$\begin{aligned}&\textit{Nonwage Taxable Income} =\\&\textit{Dividends, Interest, and Rent} +\\&\textit{Proprietors' Income} +\\&\textit{Residence Adjustment} -\\&\textit{Personal Contributions for Social Insurance}\end{aligned}$$

For each Great Lakes state, dividends, interest, and rent are estimated as a share of the nation's. The explanatory variable is the ratio of each state's total personal income to the nation's in previous periods.

Nonfarm proprietors' income represents the earnings of self-employed individuals. The state/national ratio of nonfarm proprietors' income is modeled as a function of lagged moving averages of the states' share of U.S. personal income or wage and salary disbursements.

Farm proprietors' income is the net profits of unincorporated farms, reflecting cash receipts for crops and livestock minus expenses. In the model, each state's farm income is driven by national farm income and state's consumer price index relative to the nation's.

Personal contributions for social insurance include individual payments toward social security and government pensions and are estimated as a share of Great Lakes' wage and salary disbursements. Determinants are the U.S. ratio of social insurance contributions to wage and salary income, as well as each state's average wage rate relative to the nation's.

The residential adjustment is a measure of commuter income, defined as the difference between labor income earned by residents employed out-of-state and income earned by nonresidents working in the state. It is determined by wage and salary disbursements, other labor income, and personal contributions for social insurance in the Great Lakes region (positively) and in the specific state (negatively).

Nonwage nontaxable income breaks down into two components:

Nonwage Nontaxable Income =
Transfer Payments +
Other Labor Income

Transfer payments include payments to individuals for social security, welfare benefits, Medicaid, Medicare, unemployment insurance, and pensions of retired government workers. For each Great Lakes state, transfer payments are determined by the state's population and U.S. per capita transfer payments from federal, state, and local governments.

Other labor income is defined as nonwage labor income, including fringe benefits such as health insurance and private contributions to retirement plans. Other labor income is estimated as a share of each state's total wage and salary disbursements. Explanatory variables include the U.S. ratio of other labor income to wage and salary disbursements, along with each state's average wage rate relative to the nation's.

In the Great Lakes model, personal income is key factor driving housing activity, tax payments, and employment in several nonmanufacturing sectors. As a measure of "final demand," personal income also is a determinant of production in several manufacturing industries. The concept used production and employment equations is "real discretionary income", defined as total personal income excluding taxes and saving, and adjusted for inflation using each state's consumer price index.

Prices and Costs

To capture the Great Lakes states' competitiveness relative to the rest of the nation, the model includes several indicators, including consumer price indexes, wage rates, electricity prices, material costs, and capital costs.

Wage Rates

The model projects average wage rates by state in all 20 manufacturing and eight nonmanufacturing industries. Wage rates are defined as annual wage and salary payments per worker, expressed in thousands of dollars. The primary source for wage rate information is the U.S. Department of Commerce, Bureau of Economic Analysis' Regional Economic Measurement Division. Wage rates are computed by simply diving wage and salary disbursements by employment.

In many industries, a state's wage rate relative to the nation's is determined by an average of past relative consumer prices, reflecting the price expectations that underlie wage claims. Thus, price expectations adapt gradually to the recent history of inflation. In order to retain and attract employees for a given level of output, employers must maintain real, or inflation-adjusted, wage levels. To capture the effects of labor market tightness on wage rates, several equations include the difference between the state and national unemployment rate.

The interaction between rising wages and prices in the model generates a mild wage-price spiral that is dampened as higher wage rates adversely affect each state's competitive position (reducing labor demand) and draw more workers into the labor force (increasing labor supply). A slackening labor market then puts offsetting downward pressure on wages.

Wage rates determine total wage and salary disbursements in the state, which comprise over half of total personal income. In addition, wage rates are an important component of industry cost indexes, which determine an industry's cost competitiveness and demand for its products. An industry's relative wage rate directly affects its employment, as high relative wages are associated with high labor productivity.

Input Costs

In order to more accurately capture the competitive effects of increased input costs on industrial production, DRI has constructed a set of input cost indexes that fully integrate national and regional industry cost information. Wage rates alone do not fully describe the comparative advantage (or disadvantage) of firms in a particular industry. Energy, material, and capital costs, as well as their factor contributions to total input costs, also play important roles.

DRI's Factor Input Margin (FIM) model uses input-output analysis to determine the contribution of different factors of production (labor, capital, materials) to total input costs by industry at the national level. The FIM model is a component of DRI's regularly maintained interindustry data base. Over time, the factor proportions of total input costs change with shifts in technology and evolving interindustry relationships. DRI forecasts these factors' contributions for 82 industries, which then may be aggregated for analysis at the two-digit SIC code level.

Using the national proportions of industry input costs, state industrial cost indexes are constructed by using state-specific factor prices. In order to construct an industry's cost index, factor prices are simply indexed to their 1987 values and then weighted by their shares of input costs. Electricity prices reflect energy input costs, wage rates reflect labor costs, the rental price of capital reflects capital costs, and changes in a broad index of producer prices reflect material costs.

The state-specific information in wages and electricity prices provides a foundation for analyzing how input costs are rising (or falling) relative to the nation and provides richer detail for describing the competitive position of a state's industry. In the historical database and the baseline projections, the capital and material costs terms do not vary across states. However, variations are introduced in the forecast simulations to capture the direct capital costs of investments to reduce water pollution and the resulting indirect increases in region's material costs (paper, steel, etc.).

Industry input costs are directly employed in the specification of manufacturing shipments. In this manner, changes in relative input costs help determine regional shifts in industrial production.

Consumer Prices

DRI constructs consumer price indexes for the states utilizing CPIs reported by the Bureau of Labor Statistics for 27 metro areas and four Census regions. This is necessary because the BLS does not report CPIs at the state level. Since not all metro area price indexes are reported each month, DRI has interpolated between data points. The complete monthly data are then seasonally adjusted and converted to a quarterly frequency. The Pennsylvania index, for example, is a weighted average of the Philadelphia, Pittsburgh, and Northeast regional CPIs. Weights for the two metro areas are based on their respective shares of Pennsylvania's population; prices for the remainder of the state follow the regional CPI.

Each state's consumer price index is forecast as a function of the national consumer price index, and weighted relative changes in electricity costs and wage rates. While all components of the consumer price index cannot be modeled directly, relative movements in wage levels provide a good proxy for changes in omitted consumer prices.

Each state's consumer price index plays an important role in the model's dynamics. Discretionary income measures are deflated by the consumer prices to gauge changes in "real" income. Real income changes drive employment growth in most nonmanufacturing sectors and several manufacturing industries. Consumer prices also play a role in determining nominal wage rates.

Demographics

The model includes projections of the total population in each of the eight Great Lakes states. The U.S. Department of Commerce, Bureau of the Census is the primary source of demographic data. The total population series is distributed from an annual to a quarterly basis and constrained across all states to the national population series developed by DRI's U.S. Economic Service.

The principal determinant of regional population growth is employment growth. People tend to follow jobs, explaining migration to rapidly expanding regions. Other factors contributing to migration across state boundaries include wage rates and per capita incomes. Time trends and the share of U.S. population aged 65 and over capture the trend towards retirement in the sun belt.

Population is used as a measure of demand in several of the model's employment equations, real shipments of the printing and publishing industry, government transfer payments to individuals, and home-building activity.

Labor Market

The Great Lakes model projects each state's labor force, employment, and unemployment rate, as measured in the Bureau of Labor Statistics' household survey of employment by state. This household survey differs from the establishment survey that is used in the model's payroll employment equations. The household survey corresponds to place of residence and captures the proprietors and self-employed who are not included in the establishment count. Moreover, the household survey counts the number of workers, while the establishment survey counts the number of jobs in the state. Thus, persons holding more than one job are treated differently in the two surveys. The series are seasonally adjusted and converted to a quarterly frequency.

Each state's labor force is a function of the national labor force; payroll employment relative to the nation's, which captures the availability of jobs for new entrants; and real per capita discretionary income growth, which captures changing consumer confidence and households' needs to find new sources of income. Each state's share of national employment by place of residence is determined by the state's payroll employment relative to the nation's. Unemployment rates are determined from the labor force and employment as a simple identity.

The unemployment rate is a critical barometer of consumer confidence and an important determinant of housing activity and home prices. As a measure of labor market tightness, the unemployment rate also helps to determine wage rate growth in several industries.

The Following Is A Working Draft For Comment – The Findings Do Not Represent The Position of the Council or Any Individual Governor.

Appendix B. Selected Tables

Compliance Costs and Regional Economic Impact

Exhibit B-1

Distribution of Major Dischargers in the Great Lakes System by Industrial Category

Industrial Category	Total Number of Facilities
Mining	14
Food and Food Products	12
Pulp and Paper	54
Inorganic Chemicals	19
Organic Chemicals/Petroleum Refining	28
Metal Manufacturing	37
Metal Finishing	31
Steam Electric	50
Miscellaneous	27
Publicly Owned Treatment Works	316
Total	**588**

Source: Data contained in the EPA Permit Compliance System (PCS) for the year 1990

Exhibit B-2B

Summary of Annualized Compliance Costs
($ Millions; 1st Quarter 1992 Dollars)

Discharge Categories	Cost Scenario 1	Cost Scenario 2	Cost Scenario 3	Cost Scenario 4
Direct Dischargers - Major Industrial	$37.4	$61.1	$61.5	$88.5
Direct Dischargers - Major Municipal	$5.1	$41.2	$348.9	$353.5
Direct Dischargers - Minor	$10.5	$10.5	$10.5	$10.5
Indirect Dischargers	$26.5	$79.5	$53.0	$53.0
Total Costs	**$79.5**	**$192.3**	**$473.9**	**$505.5**

(Source: SCIENCE APPLICATIONS INTERNATIONAL CORPORATION, *Assessment of Compliance Costs Resulting from Implementation of the Proposed Great Lakes Water Quality Guidance*, April 16, 1993

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Exhibit B-3

GLI Compliance Cost Estimates for Direct Dischargers - Scenario 2

Category	Total Plants/Group	Annualized Costs by Category ($)						Group Cost as % of Total Cost	Average Animal Cost per Plant ($)
		Capital	Annual Monitor	Annual O&M	Special Monitor	Minim. Studies	Total		
Mining	14	28,041	34,020	19,299	34,171	0	115,531	0.1%	8,252
Food	12	0	51,240	0	23,757	227,579	302,576	0.3%	25,215
Pulp & Paper	54	449,459	183,699	577,611	130,916	15,111,454	16,453,139	14.6%	304,688
Inorganic Chemicals	19	206,202	53,388	1,371,040	22,638	289,636	1,942,904	1.7%	102,258
OCPSF/Refining	28	6,786,545	143,456	15,230,267	161,812	8,004,652	30,326,732	26.9%	1,083,098
Metals Mfrs.	37	81,955	125,040	210,067	18,509	1,204,276	1,639,847	1.5%	44,320
Metal Finishing	31	107,407	108,388	1,608,982	45,988	1,066,407	2,937,173	2.6%	94,748
Steam Electirc	50	14,832	213,606	105,000	74,748	1,320,793	1,728,979	1.5%	34,580
Miscellaneous	27	292,087	80,973	4,476,000	79,233	780,402	5,708,695	5.1%	211,433
Municipal	316	0	1,592,912	6,333,333	657,737	32,635,010	41,218,992,	36.5%	130,440
Subtotal	588	7,966,529	2,586,722	29,931,599	1,249,509	60,640,209	102,374,567	90.7%	174,106
Minors									
Municipal	927	0	2,252,610	0	1,880,771	0	4,133,381	3.7%	4,459
Non-Municipal	2280	0	5,540,400	0	779,090	0	6,319,490	5.6%	2,772
Subtotal	3,207	0	7,793,010	0	2,659,861	0	10,452,871	9.3%	3,259
Total	3,795	7,966,529	10,379,73 2	29,931,599	3,909,370	60,640,209	112,827,438	100.0%	29,731

Note: Costs are in first quarter 1992 dollars.

(Source: SCIENCE APPLICATIONS INTERNATIONAL CORPORATION, *Assessment of Compliance Costs Resulting from Implementation of the Proposed Great Lakes Water Quality Guidance*, April 16, 1993

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Loss in Manufacturing Output for Great Lakes Region DRI Scenarios for 1997-2017

(Millions of 1992 Dollars)

Year	A-High	A-Low	B-High	B-Low
	Scenarios			
1997	116	30	20	3
1998	697	181	118	16
1999	1,427	372	242	34
2000	2,138	557	362	51
2001	2,836	738	480	67
2002	3,508	913	594	83
2003	4,155	1,082	703	98
2004	4,580	1,192	775	108
2005	4,694	1,222	795	111
2006	4,723	1,230	800	112
2007	4,757	1,239	805	113
2008	4,758	1,239	805	113
2009	4,747	1,236	804	112
2010	4,737	1,233	802	112
2011	4,737	1,233	802	112
2012	4,737	1,233	802	112
2013	4,727	1,231	800	112
2014	4,711	1,226	798	111
2015	4,695	1,222	795	111
2016	4,688	1,221	794	111
2017	4,685	1,220	793	111

DRI Forecast of Base Manufacturing Output and Changes Due to GLI for All Scenarios Year 2005

(Million of 1992 Dollars)

	Base Level of Mfg Output	Change in Output due toGLI			
		Scenarios			
		BLOW	BHIGH	ALOW	AHIGH
Food & Prod.	150,557	-10	-69	-88	-337
Tobacco Products	124	0	0	0	0
Textile Mill Products	5,816	-1	-4	-6	-19
Apparel	22,151	-1	-7	-10	-37
Lumber and Wood	22,696	-2	-14	-30	-76
Furniture & Fixt.	22,215	-1	-6	-9	-35
Paper & Prod.	53,937	-7	-37	-217	-309
Print & Pub	97,684	-8	-61	-65	-259
Chemicals	105,499	-13	-67	-100	-425
Petroleum and Coal	32,660	-3	-14	-26	-86
Rubber & Plas.	71,655	-5	-35	-47	-169
Leather & Products	1,564	0	-1	-2	-6
Stone, Clay & Glass	30,060	-2	-14	-17	-67
Prim. Metals	68,872	-7	-53	-84	-846
Fab. Metal Prod.	97,464	-6	-43	-51	-196
N.E. Mach.	183,260	-13	-100	-123	-493
Elec. Mach.	105,846	-8	-63	-76	-291
Trans	244,569	-17	-136	-194	-744
Instrmnts	57,962	-7	-57	-62	-242
Misc.	16,932	-2	-13	-14	-56
TOTAL	1,391,522	-111	-795	-1,222	-4,694

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Loss in Manufacturing & Outputs by State and Mfg. Sector: Scenario A-High

(Millions in 1992 Dollars)

Sector \ State	IL	IN	MI	MN	NY	OH	PA	WI	Total
Food and Products	64	10	9	10	117	5	38	85	337
Tobacco Products	0	0	0	0	0	0	0	0	0
Textile Mill Products	2	0	1	0	4	3	7	3	19
Apparel	2	2	6	0	26	0	2	0	37
Lumber and Wood	4	16	7	2	16	1	9	20	76
Furniture & Fixt.	7	3	12	0	4	5	1	4	35
Paper & Products	6	12	144	15	71	29	1	30	309
Printing & Publishing	11	18	23	21	152	14	3	18	259
Chemicals	11	56	156	2	152	28	1	19	425
Petroleum and Coal	26	13	8	7	4	25	0	3	86
Rubber & Plastics	12	22	23	6	46	14	20	26	169
Leather & Products	1	0	0	0	2	0	0	2	6
Stone, Clay & Glass	5	8	23	3	11	11	2	4	67
Primary Metals	45	188	275	2	211	99	17	10	846
Fabricated Metal Products	23	27	41	11	39	14	14	26	196
Non-electrical Machinery	26	71	66	49	138	16	1	126	493
Electrical Machinery	9	61	27	12	113	23	5	42	291
Transportation	60	119	358	4	78	55	38	32	744
Instruments	3	12	13	13	159	8	17	17	242
Misc	1	4	6	0	34	5	1	5	56
Total	316	643	1,198	158	1,375	357	176	471	4,694

Note: Sectors are by 2-digit SIC codes

Loss in Real Income by State in 2005

(Millions of 1992 Dollars)

	SCENARIOS			
State	A-Low	A-High	B-Low	B-High
Illinois	2	18	27	109
Indiana	5	32	41	179
Michigan	6	41	109	424
Minnesota	2	19	28	107
New York	19	137	176	656
Ohio	2	14	21	97
Pennsylvania	3	21	30	111
Wisconsin	4	37	52	197
TOTAL	43	319	484	1,880

Loss in Potential Employment by State in 2005

(Millions of 1992 Dollars)

State	SCENARIOS A-Low	A-High	B-Low	B-High
Illinois	52	371	551	2,187
Indiana	93	698	882	3,719
Michigan	131	843	2,252	8,681
Minnesota	42	312	459	1,750
New York	227	1,660	2,316	8,427
Ohio	50	371	536	2,378
Pennsylvania	48	348	512	1,868
Wisconsin	102	799	1,141	4,220
TOTAL	745	5,402	8,649	33,230

Level of Personal Income in 2005 and Changes Due to GLI Using EPA Cost Study Scenarios

(Millions of 1992 Dollars)

State	Base Case	Scenario #2	#3
Illinois	254,882	-7	-17
Indiana	106,925	-9	-28
Michigan	175,663	-23	-56
Minnesota	98,007	-4	-15
New York	419,357	-43	-105
Ohio	212,024	-4	-13
Pennsylvania	244,713	-8	-36
Wisconsin	100,115	-13	-22
TOTAL	1,611,686	-111	-292

Level of Employment of 2005 and Changes Due to GLI Using EPA Cost Study Scenarios

State	Base Case	Scenario #2	Scenario #3
Illinois	6,159,121	-173	-411
Indiana	3,019,545	-253	-763
Michigan	4,448,995	-550	-1,374
Minnesota	2,682,545	-89	-294
New York	9,021,678	-597	-1,542
Ohio	5,687,897	-126	-408
Pennsylvania	5,966,943	-166	-766
Wisconsin	2,817,819	-336	-549
TOTAL	39,804,545	-2,288	-6,105

Appendix C. Individuals Contacted: Selected List

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MINNESOTA POLLUTION CONTROL AGENCY, Marvin Hora

MINNESOTA POLLUTION CONTROL AGENCY, Gary Kimball

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WISCONSIN ELECTRIC POWER COMPANY, David Lee

WISCONSIN NATURAL RESOURCES DEPARTMENT, Bruce Baker

WISCONSIN NATURAL RESOURCES DEPARTMENT, Duane Scheuttpelz

WISCONSIN NATURAL RESOURCES DEPARTMENT, David Webb

WISCONSIN NATURAL RESOURCES DEPARTMENT , Lyman F. Wible, Administrator, Division for Environmental Quality

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