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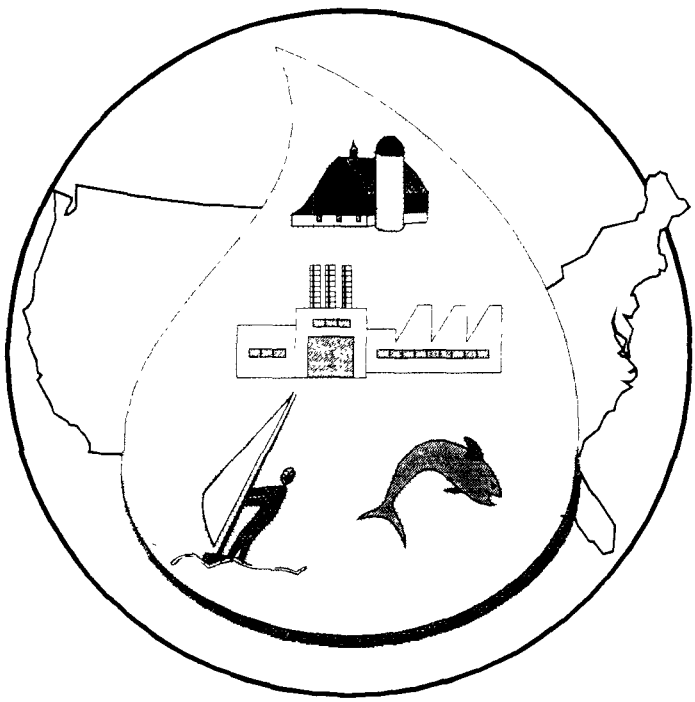

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Welcome Address

Integrating the Environment and the Economy: The Challenge For Clean Water Act Reauthorization

LaJuana S. Wilcher
Assistant Administrator
Office of Water
U.S. Environmental Protection Agency

I'm delighted to join you for this conference on integrating the environment and the economy. The U.S. Environmental Protection Agency is especially pleased to be a co-sponsor with Resources for the Future, one of the premier centers of resource economics expertise in the world. The Office of Water hopes that this conference will be the start of an on-going partnership with Resources for the Future in which we'll focus on enhancing the role of economic analysis in environmental water policy—something long overdue.

It's been said that: "Economics...is the one profession where you can gain great eminence without being right." Nevertheless, in environmental policy, economics is now playing a critical role. When I was under consideration for this job more than 3½ years ago, I thought I was fairly well prepared because of my background as a biologist and lawyer. But it quickly became apparent that economics was playing an increasing role in environmental policy. So, three years ago, I married an economist. Now, I can hardly discuss the electric bill at home without hearing the term "real dollars." Well, they're *all* real to me, and to most of the people I know. And, with the economic downswing we're facing, people are more and more concerned with the costs of environmental compliance. Yet they are not ready to sell the environment down the river, so to speak. Last month, Money Magazine published a survey of the qualities of life Americans want in a place to live. For the second year in a row, clean water ranked highest of 44 factors—higher than a low crime rate, clean air, and plentiful doctors. And in a recent Roper survey, 64% of people surveyed picked environmental protection *over* economic development when forced to choose between the two.

Yet, in spite of the importance of water, in spite of all the water quality improvements, and in spite of all the economic analyses done, we know little about the economics of clean water. We need to know more. EPA is seeking information about three things: First, the economic importance of the nation's water resources and the economic sectors dependent on those resources. Second, the economic effects of past and on-going clean water programs. Third, whether the Clean Water Act might better reflect economic concerns and issues and, if so, how.

Issues such as funding the water and waste water treatment infrastructure, controlling non-point pollution sources, regulating industrial sources of water pollution, and implementing market-based approaches to water quality problems represent the diversity and complexity of challenges facing water programs in the 1990s. We hope to use the information presented during this conference as part of the agency's discussion in the debate next year over the reauthorization of the Clean Water Act.

Few issues are more important to human or economic health than clean water. We live on the Water Planet. Viewed from space, it is abundantly clear that Earth is a special vessel, unique in the solar system because of the life-sustaining presence of water. Although water covers 70% of the earth, over 97% of it is salty. Less than 1% is readily available fresh water found in rivers, lakes, and groundwater. That means that less than 1% of the world's water was readily available to the 560 million people who

inhabited this planet in the 1700s. And it means that that same small fraction is readily available to the 5.3 *billion* people who live on earth today. Water is the anchor of civilization and the fount of human development.

1.0 WHY WORRY ABOUT ECONOMICS?

Shortly after becoming EPA's Administrator, Bill Reilly asked the Science Advisory Board, a public advisory group of distinguished scientists, to assess and compare different environmental risks in light of the most recent scientific data. In addition, Bill asked the Board to examine risk-reduction strategies and make recommendations for comparing risks and risk-reduction options.

In its September 1990 report, Reducing Risk: Setting Priorities and Strategies For Environmental Protection, the Board made ten recommendations. One of them provided a basis for this conference. The Board wrote:

"EPA Should Develop Improved Methods To Value Natural Resources And To Account For Long-Term Environmental Effects In Its Economic Analyses."

With that recommendation the Science Advisory Board was supporting EPA's use of economic analyses in helping to structure environmental regulations and programs. But the Board was also telling us to do a better job of assessing the value of the natural resources EPA is charged with protecting.

The Board's challenge was echoed at the International Conference on Water and the Environment in Dublin, Ireland last January. The participants wrote:

"Past failure to recognize the economic value of water has led to wasteful and environmental damaging uses of the resource. Managing water as an economic good is an important way of achieving efficient and equitable use, and of encouraging conservation and protection of water resources."

The growing international focus on the role of economics in environmental protection was also demonstrated at the 2nd Annual Meeting of the International Society For Ecological Economics in Stockholm last August. Bob Wayland, Director of EPA's Office of Wetlands, Oceans and Watersheds, represented EPA at that symposium, which focused on the growing global realization that the environment and economy are intertwined.

This week's conference is timely because of the current debate about how environmental policy fits into our nation's economic growth. While some continue the argument that environmental protection and economic growth are incompatible goals, we see that they are both necessary, and that they are complementary. We find support in this belief from many quarters. President Bush has said:

"In the long run, successful environmental protection is a prerequisite to solid, sustainable economic growth."

And Michael Porter, professor at the Harvard Business School, reported in his book The Competitive Advantage of Nations, that:

"Strict environmental regulations do not inevitably hinder competitive advantage against foreign rivals; indeed, they often enhance it... Nations with the most rigorous requirements often lead in exports of affected products."

Stephen Farber, formerly a professor of economics at Louisiana State University and now with the University of Pittsburgh, reports that the establishment of more than 500 environmental

management, clean up, and manufacturing process control firms in the Pittsburgh area has been a leading factor in that city's resurgence from the decline of previously important but highly-polluting industries.

2.0 ECONOMIC ANALYSIS AT EPA—THE AGENCY'S RESPONSE

That's good anecdotal information. Regrettably, that is much the type of information we have. Despite 20 years of work and experience, EPA has relatively little quantitative evidence to document the benefits of its activities. Our historical lack of focus on economic analysis may partly stem from the fear that accurate cost-benefit ratios might show low returns from some programs.

But we are starting to cast off that way of thinking and to routinely develop cost-benefit calculations, driven by our recognition of the principle of economic scarcity as applied to the environment.

In the Office of Water, minor regulations imposing little or no cost, or which actually reduce compliance costs, usually get a brief economic analysis and a passing look at benefits. But major rules, which impose $100 million or more in annual compliance costs or create other significant economic effects, are scrutinized very carefully to determine direct and indirect costs and benefits for human and environmental protection. Office of Water economic or regulatory impact analyses typically address:

- The projected direct costs of the rule on those regulated, looking for disproportionate effects on segments such as small businesses or small cities.
- Whether the regulations may close businesses, with accompanying job losses and community income tax losses.
- And, the larger economic effects of compliance costs, such as the effect on the U.S. balance of trade or the long-term stability of the country's manufacturing base.

We also test the value of human health and environmental benefits and we attempt to monetize them. For example, we consider,

- The type, number and severity of human disease cases which water pollution control may prevent. The Office of Water, like the rest of EPA, has great difficulty deciding the economic value of these "cases prevented." That issue, as well as the monetary value of a human life, has vexed the agency for 20 years, with little agreement or consensus among our economists and policy makers. The result is a great disparity among various regulations in the value placed upon an avoided death or disease case. In the most recent group of regulations issued under the Safe Drinking Water Act, for example, estimated costs per avoided death range from less than a few million to many *billions* of dollars.
- We also attempt to estimate the degree to which water quality improvement affects other direct beneficial uses of a water body such as enhanced fishing, boating and swimming, and sometimes commercial use. We attempt to calculate how water quality gains may increase the number of recreational user-days for a water body. In some cases, we can estimate the degree of commercial fishery improvement and can value the increased catch.

In order to make better-informed decisions about water quality programs and regulations, the Office of Water is establishing a discrete Benefits and Incentives Staff. Two senior economists, supplemented by natural resource economists from outside the agency on rotating assignment, will conduct across-the-board analyses of the benefits and costs of our programs. They will also consider market incentive

opportunities. We hope to receive from them rigorous analyses that will help us to prioritize scarce and thinly-spread Office of Water resources.

The new economic unit is right in line with the agency's brand-new strategic plan, which recommends that EPA,

> "Improve the economic analyses that promote efficiency and cost-effectiveness in our decisions..."

You may be aware of another step EPA has recently taken to improve economics within the agency. The Science Advisory Board now has the "Environmental Economics Advisory Committee", co-chaired by Dr. Kerry Smith of North Carolina State University and Dr. Allen Kneese of Resources for the Future. This new committee is charged with helping EPA program offices to improve their analytical capabilities. The Office of Water plans to take advantage of their expertise.

3.0 AN ENVIRONMENTAL TOWER OF BABEL

The principle of scarcity is certainly in evidence when assessing the economic resources of the United States for correcting environmental problems. No one argues that those resources should not be used first for problems of greatest concern. The question is, which problems are those? That debate rages, perhaps most significantly, in the U.S. Congress.

The process by which Congress re-authorizes environmental laws, and thus determines national environmental priorities, sometimes challenges both science and logic. The laws which require EPA to develop and enforce regulations cover a vast array of environmental media, pollution problems, and waste types. Whether, and how, each of these laws considers economic effects covers an equally wide range. The result is a statutory, regulatory, and economic Tower of Babel. A former EPA administrator once noted that, while most organizations set priorities one, two, three, four, and five, Congress and EPA have traditionally set priorities one, one, one, one, and one.

While politics will always be politics, a storehouse of solid factual data from comprehensive analyses will interject some thoughtfulness into the dialogue, and provide a common language in which to discuss serious questions of resource allocation. The form of major statutes affecting the health and livelihood of millions of Americans should not rest upon political posturing or the success of propaganda campaigns.

EPA and the nation need a sense of the scientific and economic effects of laws and regulations, and the benefits of alternatives. Since the agency often lacks fundamental baseline information on potential environmental harm or benefits, we sometimes develop regulations on the basis of our scientific ability to measure contaminants, rather than our ability to quantify their danger. Given the economic scarcity of resources for environmental remediation, that is foolhardy. As Dr. Margaret Whelan of the American Council on Science and Health has pointed out,

"Today, one can detect minute chemical residues measured in parts per million, even parts per billion. We are reaching the point where we can find almost anything in anything—where the concept of 'zero' for all practical purposes does not exist."

Comprehensive analyses would provide both scientific baselines and economic information. They would help EPA justify programs and actions to a broad constituency including Congress, states, non-governmental organizations, other federal agencies and other nations.

4.0 HOW YOU CAN HELP US

As I said a bit earlier, we are counting on you, the speakers and attendees of this conference, to help us further our commitment to good policy-making supported by sound economic information. Let me be a little more specific about what we're interested in getting at during the next three days.

Today's first conference session, and our luncheon speaker, Anne Northup, will address the water and waste water infrastructure—one of the more contentious issues expected in Clean Water Act reauthorization. How much further should we push municipal waste water treatment system requirements, how do we approach combined sewer overflow discharges, what else should we require for treating storm water discharges and, above all, how do we fund the remaining infrastructure needs? Total capital needs for waste water and drinking water needs through the year 2008 will be about $120 *billion.* Given the magnitude of these needs and the competing demands for dollars, the question becomes how best to protect the nation's water resources without unduly burdening companies, municipalities, and taxpayers.

Another area of great interest to us is water pollution from agriculture. The question is, how best to accommodate agricultural interests to environmental protection? According to the states, pollution resulting from agriculture is the largest source of impairment in the nation's rivers and lakes. EPA's 1990 National Water Quality Inventory reports that 61% of water quality impaired stream miles and 57% of impaired lake acres are the result of agricultural runoff. How do we address these problems without damaging the productivity of the nation's farmers and ranchers?

What about economic sectors that are very dependent on clean water for their economic health, such as recreation, tourism, and the commercial fishing industry? It is astounding how much economic activity is associated with these water-based activities! Recreational fishers spend on the order of $32 *billion* each year on tackle, gear, lodging and transportation. Commercial fishing contributes about $16.5 *billion* to the U.S. economy. Boaters spend almost $14 *billion* annually on boats, gear, lodging and other items. The U.S. Department of the Interior estimates that about 80 million Americans swim in the nation's water bodies. All of these economic sectors largely depend on the fundamental health of water bodies, and clearly benefit from water quality improvements resulting from Clean Water Act mandates. I'm sure our speakers will have much to add to these "snapshot" statistics.

What about exports of goods manufactured in the United States? Like all Americans, we have a strong interest in the jobs and economic growth created by exports. And, as I mentioned earlier, we believe that a dynamic domestic water treatment industry bolstered by export sales will benefit our own environment. We just received a report from the National Advisory Council For Environmental Policy and Technology—otherwise known as NACEPT—dealing with environmental exports. NACEPT recommends, among other things, that EPA support U.S. exports of environmentally beneficial technologies to stimulate environmental improvement and economic competitiveness. NACEPT identified several specific steps that EPA could take in this area, such as supporting business development centers overseas for U.S. environmental firms and making information available on international environmental markets.

Tomorrow, a panel of experts from the water and waste water technology and services industry will describe the international market for these products and services. We'll be interested in your recommendations and theirs on whether and how a statutory role for EPA might provide assistance in this area. We have no preconceived notions in this regard, and we are sensitive to the view, expressed by some, that the federal government has no role in assisting the private sector in this fashion.

Some industries have seized the reins and are already making profits using pollution prevention. Tomorrow you will hear Don DeMeuse, Chairman of the Board and Chief Executive Officer of the Fort Howard Corporation describe how Fort Howard has grabbed those reins. Others will describe how their companies instituted pollution prevention practices in their facilities, and made money.

We expect to hear some lively debate on economic incentives and other market-based approaches to environmental management tomorrow and Wednesday. This is an area in which the Office of Water is already investing. Our Point/Non-point Trading Project encourages regulatory agencies and nutrient dischargers to reach voluntary agreements reducing nutrient loadings to water bodies through a least-cost strategy. The Office of Water allocated $800,000 this year alone to fund state watershed management projects including nutrient controls through point/non-point trading systems.

I suspect that Fred Krupp, our keynote speaker later this afternoon, might have something to say in this area as well.

I'd like to leave you with a few final thoughts about why we think this focus on economics is so important. As you can see from our agenda and speaker list, we have gone out of our way to gather a diverse group of experts with differing views about the role of economics in water pollution control. While we believe that economic considerations must and should be better incorporated into the Clean Water Act, we know that this opinion is not universally held. The specific applications of economic considerations and ideas need to be identified and debated before they are built into the Act or our regulations. The best way we know to accomplish this is early and frequent public discussion. The public is ready to participate—a Times Mirror Magazines survey taken last June finds that 92% of respondents believe that a good balance can be found between economic progress and the environment.

Let's use this conference as an opportunity to better establish the linkage so many of us see between the economy and the environment. Let's also begin an informed debate over how to consider economic factors in improving the quality of the nation's waters. The debate will help us to understand the close linkage between economics and the environment, and to begin incorporating that linkage into the way we go about protecting the environment. President Bush has made that point, saying,

"...our ecology and the economy are interdependent. Environmentalists and entrepreneurs must see how much their interests are held in common. It's time to harness the power of the marketplace in the service of the environment."

We must also work to overcome the beliefs among some people that using market forces to control pollution is somehow immoral. If the market is more efficient and multiplies the work of scarce resources, surely that is a highly moral policy.

It's been said that we are entering '...a new world... as strange and new as Columbus discovered. It is a world where infinite... demands have run straight into finite resources."

At the United States Environmental Protection Agency, we are prepared to address, with your help, the challenge of this new world for water resources.

Thank you.

Monday, October 19, 1992

Session 1: The Water Infrastructure and Economic Development

SESSION SUMMARY

MODERATOR: Michael B. Cook

PRESENTERS:

David Aschauer—*Water Infrastructure and Economic Growth*

Gerry E. Dorfman—*Clean Water Construction and the American Economy*

Douglas B. MacDonald—*Water Infrastructure and Economic Development*

Heather Ruth—Paper Unavailable

William Stelle—Paper Unavailable

Water Infrastructure and Economic Growth

David Alan Aschauer
Elmer W. Campbell Professor of Economics
Bates College

ABSTRACT

This paper focuses on the role played by the water and wastewater infrastructure in the post-World War II productivity performance of the United States. The first substantive section of the paper reviews empirical evidence on the impact of changes in infrastructure capital and, more specifically, water and wastewater capital, on productivity, profitability, and costs of production. The next section of the paper considers trends in infrastructure spending and goes through standard *growth accounting* exercises to obtain an estimate of the contribution of water and wastewater infrastructure to productivity growth. Attention is focused not just on the *direct* contribution of infrastructure or productivity but also on the *indirect* contribution arising from a spur to private investment and capital accumulation. It is shown that an important portion of productivity growth in the United States has been the direct and indirect consequence of capital investment in water and wastewater infrastructure. At the same time, it is not the case that any significant portion of the *slowdown* in productivity growth can be explained by trends in water and wastewater investment. The final section of the paper proposes an explanation for the sizeable estimated contribution of water and wastewater infrastructure to productivity growth by focusing on the way such infrastructure sets the stage for *agglomeration economies* as well as external effects such as *knowledge-spillovers*.

1.0 INTRODUCTION

In the United States, there is increasing interest in policies pointed toward the goal of increasing the pace of productivity growth—annual expansions in output per laborer (or labor input). This interest is primarily due to two sets of factors. Looking backward in time, the long-term rates of growth of output and of productivity have fallen below that of the "golden age" of the 1950s and 1960s. Further, the United States productivity growth rate has been substantially below that of some of its major economic trading partners for much of the post-World War II period, leading to the fear—rational or not—that these other countries pose a threat to the economic leadership position of the United States. Looking forward in time, the labor force growth rate of the United States is expected to slip below the population growth rate soon after the turn of the century. In the decades ahead, the number of workers available to support the population will decline, and the maintenance of the historical pace of improvements in living standards will require the typical worker to become steadily more productive.

While there are many potential mechanisms to raise productivity growth, most turn on boosting the rate of capital accumulation—either tangible capital such as plant and equipment, or intangible capital such as that generated by research and development expenditures. Traditionally, the role of fiscal policy in this process has been to encourage private savings and private investment through tax incentives or to raise national savings through reductions in the government budget deficit.

But the results of recent empirical research offers the possibility of a direct channel by which fiscal policy can affect national investment and national productivity growth. It has been recognized that the public infrastructure—streets and highways, mass transit, water and sewer systems, and the like—should be considered as a factor of production, along with labor and private capital, in the private sector production process. It has also been recognized that public infrastructure spending, as a share of total output, reached a peak in the latter half of the 1960s. The results of some of the empirical studies[1,2] indicate that this reduction in the pace of public capital accumulation is capable of explaining a very substantial

portion of the slowdown in productivity growth in the United States over the past two decades. And other studies (e.g., Aschauer[3] (1989c)) suggest that cross country differences in productivity growth might also be partly explained by differences in levels of infrastructure spending.

This paper focuses on the role played by the water and wastewater infrastructure in the post-World War II productivity performance of the United States. The next section of the paper reviews empirical evidence on the impact of changes in infrastructure capital and, more specifically, water and wastewater capital, on productivity, profitability, and production. The next section of the paper considers trends in infrastructure spending and goes through standard *growth accounting* exercises to obtain an estimate of the contribution of water and wastewater infrastructure to productivity growth. Attention is focused not just on the *direct* contribution of infrastructure to productivity but also on the *indirect* contribution arising from a spur to private investment and capital accumulation. The final section of the paper proposes an explanation for the sizeable estimated contribution of water and wastewater infrastructure to productivity growth by focusing on the way such infrastructure sets the stage for *agglomeration economies* as well as external effects such as *knowledge spillovers*.

2.0 WATER AND WASTEWATER INFRASTRUCTURE, PRODUCTIVITY, PROFITS, AND COSTS OF PRODUCTION

Over the past few years, economists have conducted a significant amount of empirical research to answer the question: to what extent does the adequacy of the public capital stock—or infrastructure—affect the performance of the private sector economy. At least three separate, but complementary, approaches to this question have been pursued. First, economists have estimated production functions as technical relationships between economic output and private factors of production—labor and private capital structures and equipment—and public capital. Second, economists have also attempted to measure the impact of infrastructure capital on the profitability of firms. And third, there has been an investigation of the relationship between public capital and firm costs of production. All three approaches conceive of public capital as a necessary factor of production, which, in turn, generates the following set of hypotheses:

- That public capital should raise private sector output (given private factors of production);
- That public capital should raise the profitability of private firms; and
- That public capital should lower firm costs of production.

Table 1 lists the results of studies using the production function approach. While most of the work has focused on the total public capital stock or the core infrastructure, certain researchers have separated public capital into highways, water and sewer, and other public capital categories. The point estimates for the impact of public capital on private output and productivity vary greatly, from a high of nearly 0.40 in some of my own work to a low of around less than 0.05 in the work of Randy Eberts[4] and Charles Hulten and Robert Schwab.[5] As the estimates are elasticities, they indicate the percentage change in private sector productivity which will arise from a given percentage change in public capital. Yet there is a degree of conformity to the results. For one thing, the estimated elasticities tend to rise with the geographic level of analysis: the elasticities are largest for national data sets, are smaller for state level work, and smallest for municipalities. This would be expected on the basis of the argument that infrastructure capital may have significant spillover effects across geographic boundaries, leading to benefits which are only fully picked up at higher levels of aggregation. For another thing, the more aggregative the definition of public capital—running from total public capital to core infrastructure capital, on down to highways, water and sewer systems—the larger the estimated impact of public capital on productivity. Indeed, in many cases, the estimated elasticity for total public capital equals the sum of the elasticities for highways, water and sewers, and other public capital, which is a direct implication of the underlying theory. And finally, the effects of

public capital are larger the larger the industrial scope of analysis; for instance, the relatively small impact of public capital on productivity in the Eberts study is partly explained by the constrained geographical scope—municipalities—but also by the constrained industrial scope—he is picking up effects on manufacturing industries and not on construction, services, and other industries.

Focusing on the estimates of the impact of water and sewer infrastructure on productivity, we have estimates from work by Alicia Munnell and by Robert Eisner.[7] Both Munnell and Eisner find that water and sewer capital is an important factor in explaining private sector productive performance, with a rise in water and sewer capital of 1% (about $2.9 billion as of 1990) associated with a rise in output per worker of between 0.12% (about $60 per worker per year) and 0.08% (about $40 per worker per year). These impacts on productivity are robust to different estimation strategies. Eisner obtains comparable results when he emphasizes the time series variation in his state-level data set as when he emphasizes the cross-sectional variation in the data. Furthermore, these results explain away the low estimates found by Hulten and Schwab. Specifically, Hulten and Schwab emphasize the time series variation in the data, arguing that any association in the data in the levels of variables is mere evidence of a spurious correlation since it can be expected that output, or productivity, and public capital both grow over time. Yet Eisner obtains results similar to Hulten and Schwab's only when he fails to decompose public capital into the different categories of highways, water and sewers, and other public capital. So if Hulten and Schwab had taken pains to similarly decompose total public capital by functional category, it is likely that their results would have been closer to the Eisner results indicated in Table 1.

Table 2 shows the results of a different research strategy of linking public capital with the profitability of private firms. The profit function assumes that firms have chosen an optimal level of output based on the prices of private factors of production--labor and capital—and on the availability of public capital. Deno estimates a profit function of this form and then derives an output supply function from which he can calculate the response of output to public capital. Deno[8] finds that the impact of public capital on profits of manufacturing firms, and, thereby, on the optimal level of production is significant, with output elasticities for highways equal to 0.31, for sewers equal to 0.30, and for water capital equal to 0.07. Lynde and Richmond[9] also look at the importance of public capital to profits, although they only consider total public capital and not the separate categories of highways, water, and sewers. In general, they find a somewhat smaller quantitative importance for public capital but one which is highly statistically significant nonetheless. So the evidence from the profit-based empirical work is that increases in public capital raise private sector profits given product prices, wages, and rental prices of capital.

A third approach to capturing the impact of public capital accumulation on private economic activity is to estimate a cost function. The cost function approach has certain advantages over the production function and profit function approaches. In the present context, the primary advantage is that it effectively deals with a key criticism of the estimates obtained from production function studies. Specifically, a number of economists have argued, in principle correctly, that it is likely that the correlation between public capital and output or productivity is capturing not only the productive effect of public capital but also the effect of higher output on the demand by federal, state, and local governments for infrastructure capital. In short, the correlation is likely to be reflective of two-way causation—not only from public capital to productivity but also from productivity to public capital. And, to a lesser extent, the same argument can be made against the profit function studies since profits, productivity and output tend to be positively correlated. Therefore, there are valid grounds on which to take the stance that the elasticity estimates in Tables 1 and 2 offer no substantive evidence in favor of the hypothesis that public capital raises productivity and profits. Indeed, it would be possible for public capital to detract from productivity and also for a positive correlation between the two variables to exist; all that would be required would be that the social, or non-economic, benefits from infrastructure capital be significant enough to generate a sufficient level of demand by federal, state, and local governments and that the benefits be in the class of normal goods, where more is demanded the higher is the level of income.

Table 1

Productivity and Infrastructure

Researcher	Elasticity	Geographic Scope	Infrastructure Variable
Aschauer (1989a)	0.39 0.24	National	Total Core
Munnell (1990a)	0.33	National	Total
Hulten & Schwab (1991)	0.03	National	Total
Moomaw & Williams (1991)	0.25	State	Highway
Munnell (1990b)	0.15 0.06 0.12	State	Total Highway Water and Sewer
Eisner (1991)	0.06 0.08 0.12 0.08	State	Highway Water and Sewer
Garcia-Mila & McGuire (1992)	0.04	State	Highway
Duffy-Deno & Eberts (1989)	0.08	Metro Area	Total
Eberts (1986)	0.03	Metro Area	Core

Table 2

Profits and Infrastructure

Researcher	Scope	Comment
Lynde & Richmond (1991)	National	Elasticity estimate of 0.20 for total public capital
Costa, Ellson & Martin (1987)	State	Elasticity estimate of 0.20 for total public capital
Deno (1988)	Metro Area	Elasticity estimates: total = 0.69 highway = 0.31 sewer = 0.30 water = 0.07

The cost function approach finesses this problem of reverse causation by estimating the relationship between firm costs of production and public capital while controlling for the level of output. We have the cost function

$$C = C(Y, w, r, KG)$$

where C = cost of production, Y = level of output, w = wage rate, r = rental rate of capital, and KG = public capital. The key hypothesis, of course, is that increased public capital lowers costs of production. In this setting, if the positive association between output and productivity from the production function studies was merely reflective of a tendency for higher output to induce a heightened demand for public capital, there would be no reason to expect a separate association between public capital and costs. On the other hand, if the true reason for the production function correlation was public capital raising productive efficiency, here it would be expected that increased public capital would lower costs of production.

Table 3 summarizes the evidence from the cost studies. Using national data for twelve manufacturing industries in the United States, Nadiri and Mamuneas[10] find a significant impact of core public capital—in this case, streets and highways and water and sewer systems—on firm costs of production. Other studies at the national level have been undertaken by Conrad and Seitz[11] for Germany and by Berndt and Hansson[12] for Sweden. Conrad and Seitz find that enhancements to public capital lowers costs of production in three separate industries in Germany: manufacturing, construction, and transportation. Berndt and Hansson[12] also find that the core public capital stock influences firm costs; still, in the Swedish case, they also estimate that there has been overinvestment in the public capital stock. Finally, in a study utilizing state level data for the United States, Morrison and Schwartz[13] find that while on average across states the public capital stock is associated with reductions in production costs, the shadow value of public capital is higher in the Sunbelt regions than in the Rustbelt.

Table 3

Costs of Production and Infrastructure

Researcher	Scope	Comment
Nadiri & Mamuneas (1991)	National	Core public capital and R&D capital lower costs
Conrad & Seitz (1992)	National (Germany)	Core public capital lowers costs in manufacturing, construction, and transportation
Berndt & Hansson (1991)	National (Sweden)	Core public capital lowers costs; overinvestment in Swedish public capital
Morrison & Schwartz (1991)	State	Shadow value of public capital higher in West and South than in East and North

An objective, balanced reading of this entire body of work would seem to unavoidably lead to the conclusion that public capital, in general, and water and wastewater capital, in particular, is of key importance to the performance to the private economy. This observation raises the question: how much has investment in the water and wastewater infrastructure contributed to economic growth over the past four decades? A related question follows: have we been investing adequately in the water and wastewater infrastructure? The next section attempts tentative answers to these questions.

3.0 WATER AND WASTEWATER INFRASTRUCTURE AND ECONOMIC GROWTH

Given estimates of the impact of water and wastewater capital stocks on productivity, it is possible to use the methodology of *growth accounting* to determine its impact on economic growth. Two sorts of contributions of water and sewer capital to economic growth can be computed. First, a direct contribution to growth arises when water and wastewater infrastructure investment keeps pace with growth in the labor force and in private capital stocks. A failure of water and wastewater capital to keep pace with growth in private factors of production will detract from economic growth and development. Firms which are unable to fully utilize their capital in the face of limited water supplies, in the presence of water main breaks, and when sewers back up will be subjected to lower profit margins and to higher costs of production. Second, an indirect contribution of water and sewer capital arises in the form of a spur to private investment and economic development. An improved water infrastructure lowers costs and raises profits for existing firms making use of their current level of productive capacity. But a higher profit rate on private capital generates an increase in private investment which, in turn, boosts private sector productivity and economic growth.

Table 4 shows estimates of the direct contribution of water infrastructure investment to economic growth in the United States over the period from 1950 to 1988. Evident in these figures is the significant slowdown in productivity growth during the last two decades, with productivity growth down by 1.5% per year in the 1970s and over 1% per year in the 1980s (relative to the 1950-70 period). On the basis of decade averages, the growth rate of the stock of water and wastewater capital has been relatively steady during this period of time, hovering between 3.2% per year during the 1980s to nearly 3.8% per year during the 1960s. The direct contribution of water infrastructure investment to economic growth is obtained by multiplying the growth rate of the water capital stock and the output elasticity of water and wastewater capital. In these calculations, the smallest elasticity estimate has been used and so the results may be regarded as somewhat conservative.

Table 4

Contribution of Water and Wastewater Infrastructure to Productivity

Years	Productivity Growth (% per year)	Water Capital Growth (% per year)	Contribution of Water Capital (% per year)
1950-60	2.68	3.66	0.29
1960-70	2.68	3.78	0.30
1970-80	1.16	3.42	0.27
1980-88	1.61	3.17	0.28

As Table 4 indicates, the direct contribution of the water infrastructure has been in the range of one-quarter to one-third of a percent per year and, because of the relative constancy of the growth in water capital, has varied to only a minor extent. At first blush, one-quarter to one-third of a percentage point difference may not seem to be significant. However, small percentage differences in growth rates can cause quite large compounded changes in productivity levels over relatively short periods of time. For example, these numbers would imply that if the average growth rate of the stock of water capital had been 2% per year rather than the actual 3 to 3.5% per year of the 1970s and 1980s—and nothing else had changed—the level of output in the economy would be some 5.6%, or $280 billion lower.

Table 5 provides detail on the indirect contribution of water infrastructure to productivity and economic growth. These contributions are generated from a model in which:

1. The growth rate of the private capital stock depends:

   -- Positively on the rate of return to private capital and on the capacity utilization rate in manufacturing (as in Feldstein (1982)); and

   -- Holding fixed the return to private capital, negatively on the public investment rate.

2. The rate of return to private capital—which feeds into the investment equation—depends:

   -- Positively on time (proxying for technical progress);

   -- Negatively on the private capital-labor ratio (a diminishing marginal product of private capital);

   -- Positively on the public capital stock; and

   -- Positively on capacity utilization (capturing cyclical effects).

Consistent with the previous set of calculations, the most conservative of the estimates of water infrastructure's importance to firm production technology has been chosen. The model also assumes that given the rate of return to private capital, a 1 dollar increase in public investment induces a 1 dollar reduction in private investment. Only over time, as the rate of return to private capital rises with increases in the public capital stock, can a higher rate of public capital investment bring forth an increase in national—public plus private—investment.

Table 5

Direct and Indirect Contributions of Water and Wastewater Infrastructure to Productivity

Years	Direct Contribution (% per year)	Indirect Contribution (% per year)	Total Contribution (% per year)
1950-60	0.29	0.09	0.38
1960-70	0.30	0.10	0.40
1970-80	0.27	0.09	0.36
1980-88	0.28	0.08	0.36

As is indicated in Table 5, the indirect contribution of water infrastructure is significantly smaller than the direct contribution, varying between 0.08 and 0.10% per year over the past four decades. Nevertheless, the contribution is significant and raises the total contribution of water and wastewater capital to between one-third and two-fifths of a percent per year. The message is clear; without adequate investment in water and wastewater infrastructure, our long-term economic growth performance would have

been decidedly poorer. This leaves aside the adverse impacts that lower investment in our water infrastructure would have had on the environment and the overall quality of life.

Still, unlike total infrastructure investment, trends in water infrastructure investment cannot be held accountable for any significant portion of the slowdown in productivity growth experienced in the United States over the past two decades. As the accompanying figures indicate, infrastructure spending by federal, state and local governments has fallen since the early or mid-1960s. Total infrastructure spending—on current and capital account—has fallen from 3.5% of gross national product in 1962 to under 3% of output by 1989. Yet spending on water and wastewater infrastructure has remained relatively constant as a fraction of output at around two-thirds of a percent of gross national output.

A similar pattern shows up in the figures for capital spending on infrastructure. While the slide in overall infrastructure capital accumulation has been quite striking—from nearly 2% of output as late as 1965 to around 1.2% of output by 1989—water and wastewater capital investment has remained stable as a share of national resources. It should be noted, however, that these are measures of gross investment, with no accounting for depreciation of the existing stock of infrastructure capital; consequently, to the extent that the water and wastewater infrastructure is depreciating at a more rapid rate in recent years than in the 1950s and 1960s, a smaller share of the total investment dollars would show up in net additions to the water and wastewater infrastructure capacity.

The point, however, is that recent assertions that there is an infrastructure deficit which has damaged the national economy's productive capacity and its competitiveness must be tempered when we look at the water and wastewater infrastructure. The fact that the United States has consistently invested an equal percentage of its output in the water infrastructure does not indicate whether this amount of investment is "too high" or "too low" to generate and sustain the appropriate level of water capital. But this fact does indicate that our slumping productivity cannot be explained (without further considerations) by a lack of attention to this portion of our infrastructure.

4.0 CONCLUDING THOUGHTS

Alicia Munnell argues that the estimate of the importance of public capital arising from the state level data is "sensible in that it implies a reasonable marginal productivity for public capital and equality between the productivity of public and private capital."[14] Yet this result pertains to total state and local public capital, and when the capital stock is separated into various functional categories, one finds that the marginal productivity of water infrastructure capital exceeds that of private capital to a substantial degree. One could react to this finding by asserting that these separate elasticity estimates are implausible. Or one could react by attempting to rationalize why water infrastructure might carry such importance to the economy.

One such rationalization would involve synthesizing the literature on public capital with that of *agglomeration economies* and *knowledge spillovers* to focus on various external effects fostered by infrastructure capital. From this perspective, infrastructure has two key characteristics. First, infrastructure helps tie together different geographic locales. This characteristic of the infrastructure, of course, is particularly evident in the case of interstate transportation and communications infrastructure. Second, infrastructure allows for significant concentrations of economic activity. This characteristic is evident in the case of water, wastewater, and other aspects of the urban infrastructure. What these two characteristics have in common, however, is that they lower the costs which individuals must bear in order to interact with one another.

This is where the *new growth theory* associated with Robert E. Lucas (1988), Boyan Jovanovic and Raphael Rob[15] and others becomes pertinent. The new growth theory emphasizes how the sharing of knowledge and skills between individuals can result in increasing returns to scale in productive activities. That is, a doubling of all inputs to production—labor, capital, and the like—leads to more than a

doubling of output. A particular example of how these externalities work is reported by Rauch.[16] He writes of a Silicon valley engineer who explained to him how firms locating in the San Jose metropolitan area were able to benefit greatly from the "cross-pollinization of ideas" because of the contact engineers and others. Geographic concentration was seen to facilitate these interactions due to a reduction in transportation and other costs of interaction.[7]

So, by allowing for geographic concentration, water and wastewater infrastructure may also allow for a greater "diffusion and growth of knowledge" and a significant boost to productivity and long-run economic growth. By this argument, an improvement in the national, regional, or urban infrastructure encourages not only the free flow of goods and services but also of skills and information. In such a situation, the measured effects of infrastructure capital on productive efficiency, on firm profitability, and on costs of production may be quite significant indeed.

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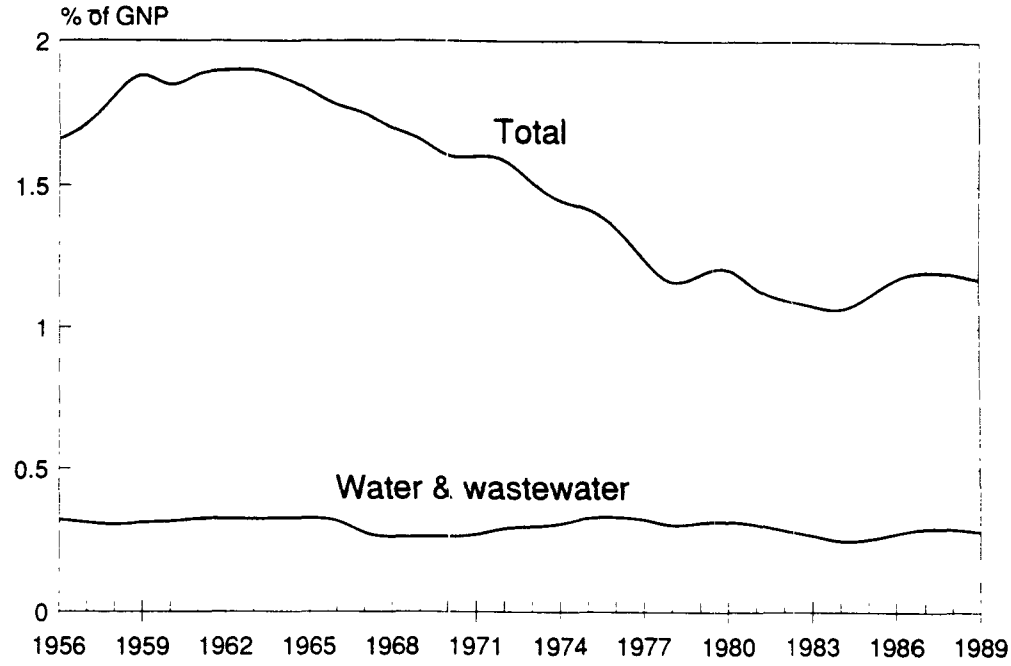
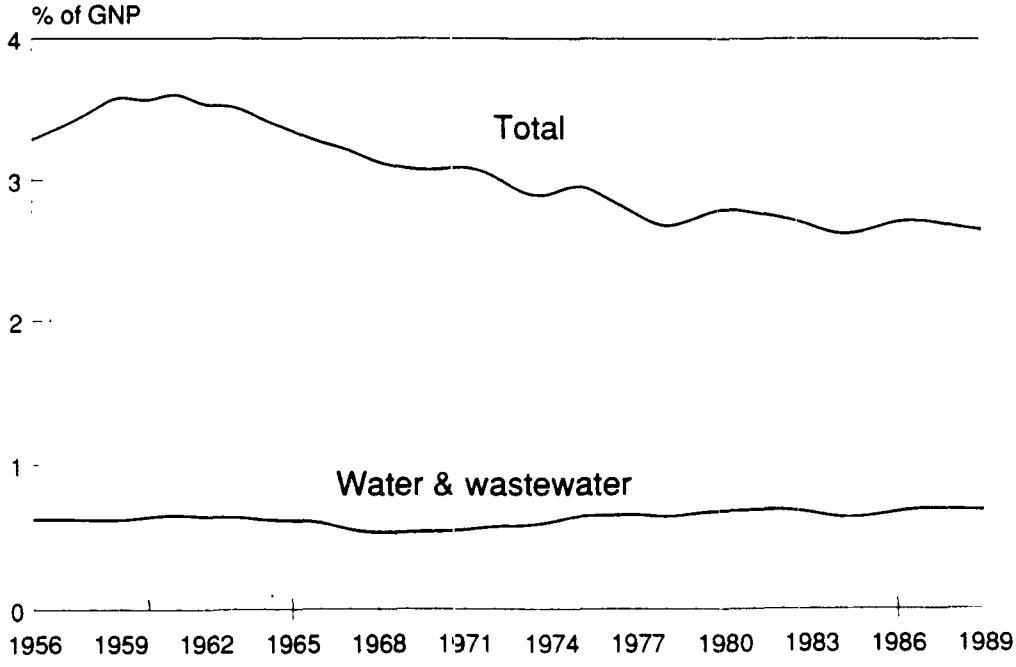
Infrastructure capital spending 1956-89



Source: Congressional Budget Office

Infrastructure spending 1956-89



Source: Congressional Budget Office

Clean Water Construction and the American Economy

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ABSTRACT

Daily, utility contractors across the country unearth decaying and failed sewer lines and domestic water systems. Out of sight and out of mind in the absence of crisis, our wastewater and drinking water infrastructure crumbles while the documented need for new facilities and increased maintenance skyrockets.

Meanwhile, the construction companies that build clean water facilities operate with skeleton crews or simply close their doors, not because they are obsolete or inefficient, but because society is unwilling to increase its investment in necessary and expensive projects that pay dividends in the long run, as well as the immediate future. The problem is exacerbated by an ailing private-sector economy.

The first part of this paper is comprised of short narratives that describe the state of our nation's clean water infrastructure through the eyes of contractors in the field. These eyes can see that our clean water infrastructure is in terrible condition.

The second part of the paper includes real-world stories that illustrate the relationship between clean water capital investment and economic health. These stories demonstrate that investment in clean water infrastructure creates employment and strengthens the economy by increasing private-sector profitability, labor productivity, and private investment in plant and equipment.

1.0 INTRODUCTION

Every day, utility contractors across the country expose decaying sewer lines and deteriorating domestic water systems. Out of sight and out of mind in the absence of crisis, our wastewater and drinking water infrastructure crumbles while the documented need for new facilities and increased maintenance skyrockets. Fortunately, we have the expertise of the utility construction industry—contractors and supplies together—and the Clean Water and Safe Drinking Water Acts to arrest and eliminate the problem.

In this paper, I am going to share the roots of this dire need, as well as my personal experience as a utility contractor and the experience of many of the other 2,000 contractors and suppliers of the National Utility Contractors Association (NUCA). I am going to describe an appalling problem. It is appalling because we have had and still have the capacity to solve it. That is why I am going to be able to tell you about the solution.

Because of where I work, I will be giving you examples mostly from the West. These problems are not exclusive to the West; on the contrary, my conversations with contractors across the country indicate that the problems are national in scope. According to estimates by NUCA, which utilized needs assessments by the Environmental Protection Agency and other organizations, the states may have to finance as much as $167 billion of capital spending for water supply and wastewater facilities over the period 1993-2000.[1] Keep in mind that this is only a baseline, and the needs are expected to increase.

2.0 THE PROBLEM: DETERIORATING CLEAN WATER INFRASTRUCTURE

The problem includes deteriorating and failing sewer systems, leaking water systems, combined overflows, and consequently, a disappearing fresh water supply.

2.1 Deteriorating and Failing Sewer Systems

Our sewer systems are dangerously old, deteriorating, undersized, leaking, and inadequately maintained. In fact, they cannot be adequately maintained. How do you clean a sewer that is collapsing and filled with the rubble of its own bricks? How does the cleaning machine get through tree roots that collected debris and form dams? They don't. There are hundreds of miles of sewer pipeline that are barely functioning. You cannot see the millions of gallons of sewage that escape daily and contaminate our underground aquifers. Unlike the pothole on a highway that jars you into demanding action, the failing sewer system is insidious in its silent destruction of our water supply, our lifeline.

This problem exists in the cities and in the outlying communities. For example, a job we had in a rural community of 20,000 people in northern California replaced a septic tank system under the Farmers Home Administration water and waste disposal grant program. As I prospected the job before preparing a bid, I was dumbfounded. When walking through easement lines in families' backyards to determine the location of the new system, I was walking on saturated ground. Saturated not with water, but with wastewater—raw sewage that had overflowed from failed leaching systems. What is the damage to our family structure when children home from school or on a weekend cannot play in their backyard? Do people deserve to be trapped like that, deprived of the use of their own homes? What do you suppose is the impact on those families' productivity? On family life? It is immeasurable.

The problem is not only rural, but urban as well. On a project for a major city in southern California, we recently replaced a sewer pipeline that had failed earlier than expected due to unstable ground conditions. But for whatever reason, when we uncovered the existing pipe, we found gaping holes where raw sewage had been escaping into the surrounding ground for an unknown period of time. The devastating part of the story is that this sewer system was less than 100 yards from a fresh waterway. Therefore, the problem was compounded almost beyond reason by tidal action. Twice in a 24-hour period, the water level rose over the top of the sewer line, so wherever the pipeline had failed, it was accepting fresh water to be carried to a treatment plant. Conversely, when the tide was out, so went the sewage. What we had uncovered was a daily exchange of raw sewage and fresh water.

2.2 Leaking Water Systems

There are more than 76,000 community and ancillary water systems in the U.S.[2] An astounding number of these systems, because they were installed so long ago, are in a state of disrepair. Let me tell you I know that. My son is in charge of a 10,000-foot replacement water line for a small community in southern California. He has been continually plagued with suspension of work because the adjacent line, which his work will replace, has been leaking. Work is stopped while the leaking pipeline is repaired. This kind of situation has enormous costs, as you can imagine, but that is not my point. The important point is that there are countless holes in the water system.

My son only has to contend with what comes out of the pipes. He does not have to contend with the loss of water to the community. Nor does he have to contend with the downstream contamination that the leaking water main exacerbates. The leaking water combines with sewage from leaking sewers. The people who suffer the consequences of the problem are unsuspecting, downstream. They don't know what they haven't seen. They haven't been forewarned. Last year when a railroad car crashed and overturned into the upper Sacramento River, the effects were immediately known and people downstream were alerted. You couldn't save the fish, but those using wells could boil their water. Unfortunately, no one downstream from the millions of uncovered miles of failing water lines can protect themselves.

2.3 Combined Overflows

A similar problem occurs with combined sewage overflows (CSOs). There are 1,100 combined sewer systems in the U.S., and more than 300 of them are known to have overflow problems.[3] The problem is not one of failing water systems or deteriorating sewer systems. Rather, it is one of economics. Communities that designed and built combined sewer/storm drain systems saved money in the short term, but did not anticipate the decades of growth, which has rendered these systems obsolete. What was an accepted industry standard in the beginning of this century is now unacceptable. In fact, it has become dangerous. The consequence of these combined systems can be as devastating as the problems I described above.

On a project in the Northwest, where our firm replaced a large-diameter brick sewer built in the early 1900s, there were numerous days when work was suspended due to heavy rainfall. This combined system discharged raw sewage and rainwater directly into a great river. I can personally tell you that on more than once occasion, I stood with my superintendent on the river's edge, not believing what I was seeing—raw sewage flowing into the river because the treatment plant could not process the influx added by the storm.

Correcting documented CSO problems, however, is just the first step that must be taken. All 1,100 combined sewer systems need to be augmented so they are either a storm system or a sewer system, not both.

Sewage is escaping and contaminating our aquifers. A marked increase in contaminated water is infiltrating our open sewer systems to be carried to the treatment plants. Therefore, we are paying to treat contaminated water that should be retained by the aquifers. We try to construct bigger and better treatment plant facilities, while treating the source of the problem as a "stepchild." An incisive, rigorous attack at the source—the failing infrastructure—will swiftly and effectively stop the contamination of the water supply.

2.4 Summary: Disappearing Fresh Water Supply

Given the deteriorating state of our water and sewer infrastructure, we must act immediately. I don't need to tell you the importance of fresh water to everyday life. Leaking water systems, deteriorating and failing sewer systems, and combined overflows are jeopardizing that basic need. We are destroying the water we have, not by using it for drinking, bathing, cooking, and manufacturing, but by not maintaining adequate facilities to treat the water after we use it.

On the positive side, a concerted effort to correct any of these problems automatically addresses the interrelationship of the other system failures. Furthermore, along with the immediate benefit of ensuring a healthy water supply and waste disposal system for all Americans, correcting these problems will have an immediate and continued benefit on the economy. Through the infusion of capital expenditures into the public works sector, we have the ability to "jump start" the U.S. economy.

3.0 THE SOLUTION: CLEAN WATER INVESTMENT, AND THE ECONOMY

The solution to the crisis of our water and sewer system deterioration is close at hand. We are at the ready. And as we solve the problem, we will be creating employment, increasing private sector profitability, increasing labor productivity, increasing private investment, and increasing the tax base. The Clean Water and Safe Drinking Water Acts are good for the American economy in more ways than one.

3.1 Creating Employment

There are hundreds of thousands of trained men and women of the construction industry currently out of work. They too are at the ready. The support groups: pipe manufacturers (clay, ductile

iron, steel, concrete, plastic); material suppliers of sand, gravel, cement, asphalt; manufacturers of construction machinery and related equipment (earth moving equipment, and ancillary industries that supply parts, labor, engines, tires, hydraulics, etc.) are waiting to turn on their assembly lines. In addition, we have the necessary engineering support (consulting, design, architectural, construction management) and agencies (inspectors, engineers, administrators). Universal in its impact, the list continues, multiplying and perpetuating itself with each and every new contract.

According to a recently released job creation report prepared by Apogee Research, Inc. for NUCA, as many as 57,400 direct, indirect, and induced jobs are created for every $1 billion invested in water and wastewater infrastructure.[4] Two million able-bodied men and women in the construction trades, together with thousands of second and third tier subcontractors and their employees, are out of work and ready to go.

3.2 Profits, Productivity, and Capital Stock

I am not an economist, but every day I see the link between water facility investment and economic growth, both in the short and long term. It is an obvious fact that pipes in the ground are a precondition for housing, consumer services, and industrial and agricultural production. In a more immediate sense, each of my construction jobs employs workers, puts food on their tables and clothes on their backs, generates capital investments in heavy construction equipment, and increases demand for manufactured and raw materials. Further, the federal government's long-term return on investment can be measured by increased private profitability, enhanced labor productivity, and increased investment in plant and equipment. In other words, the economy as a whole is strengthened and the corresponding expansion of the tax base enables the federal government to recoup its investment.[5] There aren't too many federally-aided endeavors that can boast such positive benefits.

3.3 The Facts Are In

The relationship between clean water construction and the economy goes far beyond the provision of safe drinking water and sanitary disposal of sewage for the protection of public safety and health. Respected scholars and economists, many of whom are making presentations during the EPA conference on "Clean Water and the American Economy," have demonstrated that clean water investment induces higher private sector profits, spurs private investment in plant and equipment, improves labor productivity, and best of all, pays for itself through the creation of a larger tax base.

I can see it for myself every day on the job site, and it is clear that our international competitors are getting the message as well. Both Japan and Germany have taken the investment lead in public infrastructure, while the U.S. is ranked 55th in the world for public capital investment. It is incredible to think that Japan will spend over $3 trillion in the next 10 years for infrastructure.

4.0 CONCLUSION

The sewer and water pipeline infrastructure are often interrelated. The leaking sewer system contaminates the fresh water supply. Leaking water supply systems and combined sewer overflows create over-capacity problems at treatment plants, resulting in bypassing insufficiently treated sewage, during periods of high flow, into oceans and rivers, causing further destruction of these natural resources. Consequently, our country faces a disappearing and unusable fresh water supply.

Federal participation and financing is essential if we are to rectify this national problem. Over the last 12 years, there has been a lot of controversy about whether the "trickle down effect" is working the economy. I have seen how the "trickle down effect" is working; however, it is not the economic trickle down. It is the leaking water and sewer infrastructure that is contaminating our nation's water supply. The politicians will hopefully vote to reauthorize the Clean Water Act at a level of $5 billion annually and redirect the trickle down effect where it belongs: into the economy. It really all boils down to making repair

and construction of water and wastewater infrastructure a national priority, especially when you consider that in 1992, the federal government spent more that five times as much on federal program administration ($13 billion) as we did on water and wastewater investment ($2.4 billion).

Less than a month ago, at a meeting of the National Utility Contractors Association, I mentioned this upcoming conference. My colleague, a fellow contractor from a northeastern state, turned to me and said, "Gerry, do you know that in our home we have had to boil water for the past six months?" Apparently, bacterial contamination in two separate water systems has affected water use for 114,000 people in Rhode Island. The simultaneous contamination problems are unrelated, but I was shocked. That is unbelievable in the United States in this day and age. Most important, the dilemmas we are living with and facing are all foreseeable and all preventable. Everyone benefits from repairing the water and wastewater infrastructure: environmentalists, labor management, government, communities, and most of all, our children for generations to come.

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Water Infrastructure and Economic Development

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The Massachusetts Water Resources Authority is the wholesale water and wastewater utility that serves two and a half million people in sixty-one communities in and around greater Boston. My chief job as our agency's new Executive Director appointed last January, is to bolster public support for its large and very costly program of infrastructure replacement and rehabilitation: a program now expected to be paid for almost entirely from ever-rising water/sewer bills to be sent to homeowners, landlords and businesses in our service area.

My hope today is to share with you some simple insights and questions which come from my short but intense exposure to the issues before us. I also hope to suggest to you that our experience at MWRA is one that more and more communities across the nation may face as numerous unfunded federal mandates in the environmental area (and other areas) are translated into program burdens for local citizens.

Here are our major projects in construction as proposed by ourselves or mandated by Congress or EPA for supposed completion by the end of the year 1999:

- Our new Deer Island Sewage Treatment Plant which will be the nation's second largest: $4.0 billion;
- Rehabilitation, modernization and extension of a 228-mile sewage collection system: $581 million;
- CSO remediation: perhaps $771 million;
- A critically-necessary new water supply aqueduct: $387 million;
- Rehabilitation and modernization of water supply pipes and pumping: $395 million;
- A new drinking water filtration plant: $794 million.

Our funding? A capital investment program by century's end likely to total $7 billion, with only $350 million or so currently projected to be derived from federal assistance.[1] All the rest has been, and will be, supported by our issuance of revenue bonds secured and repaid with interest by rate revenues exacted from the ratepayers.

Our rates? Ballooning, as the new debt service requirements from each of our periodic large bond sales first enters and then stretches into the future in our annual operating budgets. Homeowner water/sewer rates in our area have risen an estimated 530% since 1986 to the point where our Boston ratepayers now hold top spot in a recent Ernst & Young national study. Projected escalations for a four person homeowner family march ahead from $535, the current estimated level for 1992-93, to $1296 by the year 1999 with no promise that will be the end of the upward staircase.[2]

Our political environment? Our rate increases and the perception of their impact on customers' abilities to make their mortgage payments, pay their heating bills or profitably operate their businesses were neatly captured recently by one of our staff. Looking ahead to our major state political

elections in 1994, he said that the only uncertainty is whether MWRA rates will be the largest issue in the election or the *only* issue in the election. A recent study suggests that over 100,000 households in our service area have limited incomes such that payment of water/sewer charges would already force direct competition with their purchases of other basic life necessities.[3] The vehemence of our exponentially increasing rates in Eastern Massachusetts ought to give real pause to all of us who care about completing the infrastructure and environmental improvement objectives we would like to see in a perfect world.

So in a few months on the job what have I done and what have I learned in trying to address these issues?

I first should say how delighted I am today to meet Professor David Aschauer of Bates College for the first time.[4] It is no understatement that I have put his name in lights during a flurry of meetings with businessmen, elected officials and civic groups like the Chamber of Commerce that I conduct as a spokesperson for the agency. Let me tell you about the overall message we have tried to craft and how Dr. Aschauer's thesis has fit into it.

My speech to every group states that our agency's basic mission has three goals. First, to deliver the environmental benefits that are our court-ordered basic reason for being. Second, to contribute to economic development. And third, to do so only on the basis of affordable water/sewer rates.

On the first point, the key is that our environmental mandate, long conceived principally as the ending of sewage pollution in Boston Harbor, is really fundamentally to assure the very cornerstone of public health for the citizens of our service area. Quality drinking water and effective sewage disposal are the basic environmental services of all communities, recognizing what is essential to preserve public health and welfare. A century ago, new waterworks systems throughout the cities and towns of this country began a revolution in our standards of health and our standards of living, basically ending epidemics in our urban area and extending life expectancies everywhere. Then clean water worked a miracle. Perhaps the program was too successful. Now, clean water at nominal cost is taken for granted. The services of delivering and disposing of water are even harder for the public to appreciate because our water/sewer public works are usually invisible, far away in the watersheds or buried in the streets. How much easier it is to persuade people that you are spending money on something important when you are inconveniencing them everyday with your project by building something they will see when they use, like a highway, a transit project or an airport! It takes Hurricane Hugo or Hurricane Andrew, and then only in a few communities, to remind us what our world would be like without clean water.

So I never miss an opportunity in a public speech to try to sharpen and simplify the old-fashioned environmentalist focus of our work. I always stress that our job has to do with the water you use in your home—the shower, the toilet, the kitchen faucet, the clothes washer and the garbage disposal. I talk about the river of sewage—passing through our treatment plants and into the harbor just hours after it leaves your house—flush by flush, shower by shower, to make up a volume into Boston Harbor that exceeds the natural flows of the Charles, Mystic and Neponset Rivers combined. We show slides of water main breaks in hundred-year-old 48-inch pipes and we show sewage discharge plumes at the harbor's edge. We invite people to see our facilities in each of their cities and towns. Rain may fill the reservoirs and gravity may help to move the water, but nothing else in our system works without attention and maintenance, even if the promise of our projects is reduced to the basic assurance that the same clean water will reliably flow in and out of the same plumbing in your house, and be discharged back to nature with reasonable respect for environmental standards.

Then we shift the talk to economic development. Here is the line, with Dr. Aschauer's work at its center, that I have probably used a hundred times:

> *Today, on our Deer Island project alone we now have $1.6 billion of contracts in construction and 1600 craftworkers on the job site everyday. Their paychecks are critical to their families and to helping to pull all of us out of this terrible economic situation. But that's not the most important news about our project's role in economic development. Think not just of "pump-priming," as only the first order of economic benefit. Even more significant for economic development is that this kind of investment in our* ***public*** *infrastructure, our economists tell us, is the best and most efficient investment we can make toward our critical long-term social goal of improving the productivity of* ***private*** *investment. This will help restore and perpetuate our national economic vitality.*

I illustrate the point by speaking about Genzyme Corporation, a bio-tech firm which recently choose Boston as the location not just for its research headquarters, but also for its first manufacturing plant for miracle drugs. Genzyme is nothing but a new kind of brewery: a vat, clean water, and fancy enzymes instead of hops. Could Genzyme have brought this seminal manufacturing activity to Boston without the assumption that quality water supply was as good as guaranteed? Could we ever afford to let it be otherwise? And what does that mean for the investment necessity of replacing century-old 48-inch water mains?

We try, in effect, to get the environmental story and the economic development story to merge. Our forthcoming annual report will feature a fishing charterer who reports that our efforts to date have already brought healthier fish to a visibly cleaner Boston Harbor—and helped his business. We will also have a bagel maker who is about to bask in our notoriety. He wrote to us that our pure water supply is the key to the quality of his superior bagels.

Now we come to the third interdependent goal of our program: affordable rates. What would happen if the political result of ratepayer resistance to our growing rates were a collapse in the political consensus for our work? We benefit, it is true, from the fact that some of our work, including the expensive construction of the new Deer Island Sewage Treatment Plant, follows legal mandates enforced by a federal district court judge. It is one thing, however, for the judge to exercise judicial power to assist in siting and expediting unpopular facilities, which the judge in Boston has shown the will and the courage to do. It is quite another, I think, to imagine wholly adequate judicial solutions if our program should shipwreck on the reef of ratepayer revolt. This is a question I do not wish to test.

What is an affordable rate for water/sewer services? The greater Boston area is, even in today's economy, a relatively wealthy part of the country. But real people, not John Median or Jane Average, actually pay water/sewer bills. EPA once proposed that 1.75% of household income might be the proper guideline at which water/sewer expenditures would be considered burdensome. We believe today that nearly one-third of the households in the MWRA service area spend at least 2%, not 1.75%, on their water and sewer bills. Our projections are that by 1995 nearly one-half of the households in our service communities will be at about that level or above and by 1997 nearly two-thirds of these households will reach that level.

Delinquencies in customers' payment of water/sewer bills are increasing. We also have documented cases, for example, of commercial laundries and bakeries in our service area that have closed their doors, blaming their water/sewer bills. I get letters from real people—people whose budgets have no leeway—who have been forced to sell their homes and no one can quarrel that rising rates have directly contributed to their economic surrender. We at MWRA can listen to stories about ourselves on the talk shows every week: one favorite theme is that no one should buy a house in the MWRA service area given the prospect of our forthcoming rate increases. The best news of the last six months released from MWRA was that we had "cut the 1992 rate increase." But it wasn't much solace when you read the small print. All

we had really done was cut a projected 36% annual increase in our wholesale charges to only 19%. Rallies at the State House for the abolition of our agency are a recurrent political activity in Boston.

My typical public speech then ends with a warning that the environmental and economic benefits—let's call them necessities—of our program may never be met. Our program might never in fact be completed and our infrastructure progress could shift again into the reverse gear of deterioration and neglect. These are real threats *unless* we can avoid crippling ratepayer burdens by returning to the federal government a much larger funding role for our project. You can imagine some of the sub-texts: our environmental agenda is a *national* agenda; our economic purposes are in pursuit of our *national* prosperity; our most successful infrastructure modernization programs—highways and airports—draw upon dedicated *national* revenue sources in correct recognition that our infrastructure assets are national assets. I close with a call to action; we really have no choice, even if it is an uphill fight, but to unite our local constituencies with each other and those around the country to fight for substantial new federal funding for our most basic environmental programs.

Now let's refocus on the theme of economic development and turn to two specific issues concerning Dr. Aschauer's thesis that I believe are embedded in my case to promote MWRA's own infrastructure investment program. The most important part of my presentation is to impress upon the audience the necessity for renewed federal funding in really significant amounts. This argument obviously implies one major qualification or concern about Dr. Aschauer's thesis. I believe that in Boston unless we obtain prophylaxis against rate shock, either by means of higher federal funding or by some other means, the economic development and productivity benefits of the infrastructure investments may be more than offset by the economic drag of prohibitively high water/sewer rates. I have learned that Dale Jorgenson of Harvard reaches this conclusion or raises similar questions about Aschauer's thesis, undoubtedly with much greater sophistication and economic precision. I do not have an economist's answer, but I do try to turn the issue into another way of emphasizing the note that fairness plays in a federal funding role. No one locality—Boston or any other—should bear distinctly local negative and distortional economic impacts from complying with national agendas for investment in environmental protection assets.

Another point also strikes me as provocative and needing more thought as applied to our situation. Proposed refinements to Dr. Aschauer's thesis include examination of the differences between the productivity gains from various specific types of infrastructure investment. This has taken several forms, but the one that particularly interested me was that the largest gain from any form of infrastructure investment might be found in the rehabilitation and maintenance of assets already in place. This had great appeal because of one of our special challenges. MWRA must not let the mandates for new facilities to meet increasingly stringent new regulatory requirements—specifically secondary treatment and CSO remediation for wastewater and filtration of already high quality surface water supplies for drinking water—financially smother our ability to maintain and modernize the antiquated pipes, pumps and valves which are the fundamental components of the public health utility service we provide. The problem is, of course, that that line of thinking could lead to a very different prioritization for expending our limited affordable capital resources than the prioritization that now is mostly driven by "action-forcing" regulation and enforcement by EPA and the Department of Justice.

All this leads to the conclusion that for those of us in operating agencies who are trying to bring about the renewal and extension of our water resource infrastructure—both on the pure water and the wastewater side—the economists have as yet only provided intriguing but inconclusive morsels of real policy guidance or real support in the arena of public opinion. The two areas I have just touched on are clearly topics on which our agency is very eager to hear more from the community of economists.

First, what do economists think about the likely economic impact of steep rate increases and our high projected rates? Should we consider the matter not as a question, as we principally have to date, of "affordability?" Should we shift the discussion to the sustainability of economic development in our service area in the face of the water/sewer rate levels projected in our community? How do we use these

arguments to enhance our prospects for greater federal funding or other more broadly based vehicles for capital investment?

Second, how can economists weigh into the question of prioritizing infrastructure investment at a time—even if that time might soon be rosier than it has recently been—of scarce resources and compelling competing demands? Among environmental policy-makers one hears increasingly about the need to get more "science" into the implicit or explicit cost-benefit judgments embedded in every exercise of legislative or regulatory jurisdiction. I strongly hope that economists as well as scientists could sit at the table where national priorities are set for environmental programming so as to give full account to the secondary economic implications of these policy choices. Boston rate impact issues provide a compelling case study.

I took my new job seven months ago because I am utterly convinced of the importance of water and sewer services and the need to assure their adequacy in our community for our own and coming generations. The small dramas we play out in our agency—keeping our systems going, planning for the future, executing some important capital projects, relating all of this to the service needs of our customers—are tangible parts of the larger environmental movement that, to my way of thinking, is the most significant social and political development of our time.

But I have had a very sobering thought recently, sparked I am sure by the policy and program discussions in the presidential campaign. Is there anyone left in America who is not convinced that our health care sector is a national disaster? Too much focus on high-tech interventions at the very margin of health benefits; systemic neglect of preventive health and community health; inauspicious returns in overall measures of health protection as judged against similar countries; costs rising so fast and so high as to be a major drag on productivity. From time to time those of us privileged to work today in the environmental sector, as contrasted to the health care sector, might do well to take a sobering look in the mirror. Are we so certain that fifteen years from now we will not have followed the errors of the health care sector and replicated its seeming deficiencies?

MWRA, I hope, will continue to maintain, enlarge, and improve the water and sewer systems of greater Boston. We shall, I hope, meet the mandates of new regulation. We will also, under no circumstances, willingly return to an era of under-investment and deterioration of the priceless infrastructure stock inherited from our visionary predecessors. As an aside, thinking of infrastructure investment, can you imagine that the entire Quabbin reservoir system known to many of you as one of the world's great political and engineering achievements in water supply, was completed in 1939 at a cost of $53 million? That is about $775 million in 1992 dollars if inflated by reference to the ENR—a bargain by anybody's theory of return on investment and impact on economic development. So in our hearts we know Dr. Aschauer must be right. But for those of you in this audience who are our regulators at EPA and are also advocates as environmentalists for our program objectives, I should point out the cautious language of our bond market disclosure which accompanies each invitation to buy our bonds. It warns that our concern about rates leads us to believe that we must find new sources of capital or new sources of revenue or we may be forced to reduce the scale or slow the pace of our projects.

To the economists in the audience, we warmly invite your thoughts, insights and suggestions about how we best can execute the somewhat perilous fiscal and political mission on which we are engaged. We certainly are delighted to have your interest in our projects.

REFERENCES

1. There are many estimates of the national investment requirements for water and sewer systems. The recent EPA needs survey of capital requirements for sewer systems as submitted to Congress stands at $110 billion over the next twenty years. The ten states leading the needs list are New York, California, Florida, Massachusetts, Texas, New Jersey, Ohio, Michigan, Illinois and North Carolina.

2. "The Cost of Clean," a pamphlet recently published by the Association of Metropolitan Sewage Agencies (AMSA), makes a national projection which shows Annual Household User Fees at $150 in 1990, $275 in 1995, $505 in 2000, $925 in 2005 and $1095 in 2010. AMSA states: "Annual household user fees are now doubling every six years. They are projected to rise at an even greater rate in the future due to increased local funding of capital projects, increased operation and maintenance costs associated with higher level of treatment and newly mandated environmental programs. The issue of increasing user fees heightens political pressures as rate increases impact the users, especially those on fixed incomes."

3. National Consumer Law Center, Inc. The Impact of Rising Water and Sewer Rates on the Poor: The Case of Eastern Massachusetts. Boston. 1991.

4. Dr. Aschauer's contribution is highlighted in an excellent short and non-technical summary of infrastructure investment issues including an extensive bibliography: Cuciti, Peggy L. "Infrastructure and the Economy: Serious Debate in the Profession, "Municipal Finance Journal. Volume 12, pp. 73-81. November 4.

Luncheon Address by Keynote Speaker

Environmental Issues

Anne Meagher Northup
State Representative
Kentucky General Assembly

It is nice to be in Washington today and among friends. While the statement, "Who am I and why am I here?" took on new meaning at the vice presidential debate last week, it does seem to be an appropriate beginning to any discussion of complicated issues. Since I am elected to office, I suppose some would dub me a politician—something not easy to admit these days, especially in this town. Because of my educational background, I consider myself somewhat of an economist. As a member of the Kentucky General Assembly, I come with a state perspective. As a member of the EPA Environmental Financial Advisory Board, I have developed national and international perspectives. It has been my experience—political and economical, local and national—that public policy suffers from a real disconnect in communication and understanding. It is with these diverse perspectives that I speak today on the reauthorization of the Clean Water Act.

The assumption that I am facing a friendly audience today is significant because in the past two years that has not always been the case. It has often been my unenviable task of following state government officials who make a habit of castigating the federal government for issuing mandates without providing the funds necessary for the enormous capital expenditures needed to implement them. I don't suppose EPA regulators would ever be the most popular folks around, while at the same time, I don't believe that state and local government officials understand the importance of the federal government establishing and enforcing national standards. This is especially true because of the countless pollutants being dumped into the air, ground, and water. These local officials fail to comprehend the *public health* implications of these environmental regulations. They do not seem to understand that, while it is a good idea to protect our rivers and streams for the sake of natural diversity, they more importantly also save lives.

So, even if the federal government cannot provide 100% grants to cities and states to implement the necessarily rigorous standards envisioned in the Clean Water Act, it is vitally important for these standards to exist. When it can be established that a specific agent is harmful to life, that substance must be regulated in whatever fashion is most appropriate.

Nationally, the environmental movement is past the era of justifying its existence and its mandates and into the era of developing funding mechanisms to correct and prevent pollution from occurring. In truth, the cost of designing, building, and maintaining facilities to meet our needs is becoming staggering. Ten years ago when we thought of an EPA mandate, we thought of air pollution or waste water. Today, regulations extend to drinking water, hazardous waste, clean air, and cleanup of previously polluted sites, to name a few. The costs of these efforts are becoming prohibitive in view of the countless other pressing needs confronting this nation.

For years we have lived in a country where there seemed to be no limits. Whenever there has been a major need, the federal government picked up the bill. Witness: when health care for the needy became a problem—Congress enacted Medicaid; when health care for the aged was needed, Medicare; and when our nation needed a new national transportation system—Congress funded the interstate highway system. And when we first realized the necessity for cleaning up our waterways, we saw the advent of EPA

grants. For this reason, the mentality at every level of government was to look up to the next larger entity and ask for a handout. This created a mind-set among local officials that the federal government would foot the bill for all environmental programs. This has also created an unfortunate attitude in the public and private sectors that the money to pay for these programs would come out of someone else's pocket.

Today, we recognize that the federal government is "out of money." Unfortunately, it is only of late that we have begun to recognize that there have always been limits to its resources and we have reached them. At the same time, most of our states are constitutionally unable to incur a general obligation debt and are suffering the same fiscal pressures as the federal government. Furthermore, the states that seem to have the greatest infrastructure needs also seem to have the largest human needs. If you look at the states that have the most acute drinking water, waste water, and solid waste problems, they tend to be the same states whose social service support systems and Medicaid are now in shambles, facing bankruptcy. Do you allocate scarce resources on obvious human needs such as health care, housing, education, or do we build sewage treatment plants? The political conflict here is, do you spend money on people or projects?

However, the limitation of federal and state resources has created unique opportunities for creative thinking and innovative solutions. Instead of looking to Washington, state and local governments have, by necessity, been forced to come up with their own answers and money. I believe it has created a new feeling of self sufficiency where individual initiatives and leadership are making a difference. Those closest to the problem, given the proper tools, are more likely to address them quicker and cheaper than if EPA dictated solutions from Washington. In the area of environmental protection, this is positive change. While environmental policy may be national, and even global, the solutions that work best and have the deepest impact are inevitably and necessarily local.

The Clean Water Act and the State Revolving Funds that they created serve as the best example of environmental success in this country today. That success can be measured in several different ways. First, it has reflected what many think is an appropriate and balanced federal role. It has allowed the EPA to set sound, consistent wastewater standards and establish an enforcement mechanism. More importantly, is has provided the seed money for the State Revolving Fund. These funds provide each state with an ongoing source of funds to build, expand and improve wastewater facilities. No matter what other competing needs and political expediencies exist, this trust fund will continue for wastewater needs.

The significance of this program cannot be minimized or overlooked. By creating a partnership between federal, state, and local governments and also a shared responsibility for funding, the taxpayer has been well served. Compared with glacial speed with which the EPA has implemented the Superfund clean-up portions of RCRA, today the State Revolving Fund is the "Desert Storm" of the environmental movement.

Second, the states have considerable flexibility in establishing their State Revolving Fund so that they can best meet the unique needs that exist in their communities. These funds are administered close to home and by those who ultimately use and benefit from them. Keeping their administration out of Washington is decidedly more efficient and ensures the money can not be reabsorbed by Congress if the political winds change at that level.

But the most important result of State Revolving Funds is the change they have had on small communities. While these communities may feel threatened by enforcement of the Clean Water Act, they have been *enticed* by the low interest loans. These loans have provided the real impetus for small communities to clean up. When I was first elected five years ago, I was amazed by the number of small communities in Kentucky that bragged about being debt free. Of course, they had *no* infrastructure and therefore, no opportunity for economic development whatsoever.

Today, that mentality is changing. As local officials put together a project using SRF funds, they begin to do capital planning and depend on existing community leadership—public and private. The

increasing demand for SRF funds reflects the changing mentality of communities, learning to depend on themselves and search for resources close to home. This is also important because it introduces concepts such as planning into the vocabulary of local government officials. In the past, the "planning" word has been defiled almost as much as is the "tax" word. In the Kentucky General Assembly, I have witnessed rural legislators rushing to their desks to vote "No" on a particular bill simply because it had the word "planning" in the title. Now, local officials and others have begun to think about what they want their community to be 5, 10, 20 years down the road. Thinking about a sewage treatment plant's capacity leads to discussions about economic development, roads versus mass transit, educational needs and how they are all related. This, in and of itself, is dramatic.

In Kentucky, we have many examples of success as a result of our State Revolving Funds. This year, for the first time in many years, the beach at Old Fort Boonesboro, near Lexington, Kentucky, was open all summer. This beach is on the Kentucky River where wastewater from many systems were in violation so often that the river was unusable for recreation. Every one of those systems is now in compliance.

Another success story is the City of Jenkins in far eastern Kentucky who was given an EPA grant for 75% of the cost of their wastewater facility. However, because of its poor financial conditions, the city was unable to get a loan for even the 25% balance. Eventually, the city gave up the grant entirely in order to use State Revolving Funds. The entire project was financed through this program, the city built the facility and is making its loan repayments, and, thus, for the first time, is establishing credit.

And finally, the City of Elizabethtown received an EPA grant in 1981, but outgrew this facility by 1985, due to the economic development as a result of its close proximity to an interstate and Ft. Knox. As a result, the state had to stop issuing the necessary environmental protection permits and industrial expansion had almost completely halted. Because median income was still low, Elizabethtown couldn't borrow the money through conventional channels. By securing a $9.2 million loan at 2.2% interest, Elizabethtown was able to build a new facility that it could afford. Its businesses are now expanding and the community is actively seeking additional development.

While the SRFs have had a significant impact in Kentucky, our needs still overwhelm our financial resources. In the area of waste water, our state's short-term needs are $50 million. The long-term cost needs of building adequate sewage treatment plants are $390 million over the next ten years. If you include the unsewered areas of Kentucky, the costs soar to near $1.5 billion, which is far beyond the means of the Commonwealth. The full reauthorization of the Clean Water Act through 1999 provides the only hope for Kentucky realizing its clean water goals.

If Kentucky, and indeed the nation, are to meet the environmental challenges of the future, we will have to leverage every available dollar from every entity into this area. This means that governments with limited resources will have to ensure that their programs attract other investment—especially private money.

Recognizing the need for sound financial advice, the EPA established the Environmental Financial Advisory Board in 1989 to begin formulating strategies to pay for a clean environment. Rest reassured that there are few politicians on this board. Besides myself, there is the mayor of Indianapolis, a member of the Senate and a member of Congress. Rather, the board is made up of real pros from the public and private sector with considerable expertise in the area of finance of public purpose projects. This board has already produced six advisories detailing changes in public policy that can substantially increase the amount of money available to fund environmental facilities. It would be a shame if in the course of the reauthorization of the Clean Water Act, Congress and its staff failed to consider the proposals made by some of the best minds in the country today regarding financing these projects. Now is the time to provide cities and states with the tools to stretch the finite amount of money available to solve the seemingly infinite environmental problems confronting them.

I would like to recommend several amendments in federal law that are included in the EFAB advisories. These changes should be considered in the context of the reauthorization of the Clean Water Act.

First, redefine a publicly owned waste water treatment facility as one allowing less than 100% public ownership if it serves a public purpose. By making this change, the $100 billion already invested in wastewater facilities could be leveraged to attract significant amounts of private investment to pay for capital improvements. This is one way to protect the progress and investments we have made in the past twenty years. Some of these facilities are at an age where they need substantial upgrading and expansion.

Second, reclassify all state and local environmental bonds as tax-exempt government bonds, if the bonds are to be used exclusively to finance the provision of public-purpose environmental services. Changes that were made in the federal tax code in 1986 should be reversed to encourage investment in environmental facilities. This would save states and local governments billions of dollars in interest costs, increase the volume of environmental bonds issued, and yield a net gain by the year 2000 because of the private sector productivity and profits that would result from increased investment.

Third, State Revolving Funds should be allowed to support a public-private partnership for wastewater services. After all, these services are public-purpose and offer more communities the opportunity to stay in compliance and support economic development.

Fourth, change the time limit of the SRF loans from 20 years to 30 years. As originally conceived, the fund was to cease to exist by 1994. Twenty years seemed reasonable in order to promote a turnover in funds. With the reauthorization, a 30-year term will not overly restrict the funds, provide more affordable loans to poorer communities and allow for economic development in subsequent years to help pay for the facility.

Fifth, eliminate grants at the federal level. This sort of pork barreling is a terrific disincentive to small, poor communities to tackle their own problems. Furthermore, since it comes out of the state's allocation, it often deprives communities with higher priorities in the same state from receiving expected funds. Everything about federal grants runs counter to the self-sufficiency principles of this program. If Congress must make grants, don't allow them to come out of the state's allocation—require them to be an independent appropriation.

On behalf of the Commonwealth of Kentucky, I have several other recommendations. First, review the allotment formula for each state. While the formula is supposed to be based on population and needs, on either one (or a combination of both) of these criteria, Kentucky should be getting more dollars.

Second, allow the use of SRF funds for collector sewers, if sewers are necessary for the community. One of the biggest problems we face in Kentucky is that of the unsewered portions of the state. The ground is not able to accommodate septic tanks, but the community can only afford a sewer system if the waste water system *and* the collector system are financed through the State Revolving Funds.

And finally, allow more discretion in the application of the Davis-Bacon requirements. Many small communities in Kentucky have no union shops. The federally mandated wage rates are so out of sync with local wage rates that the cost of the project is increased by as much as 15%.

In closing, I would like us to consider the major theme of the presidential debate. How can we create jobs—good jobs in this country? As the military industrial complex is shrinking, we have to look for new, growing industries. By encouraging private investment and participation in our environmental industries, we not only get closer to reaching our environmental objectives, but we also create good jobs in exportable industries using new technologies.

As you can probably tell, I am not one of those politicians that believes that protecting the environment and creating jobs through economic development are somehow conflicting propositions. Probably the biggest gap or difference I perceive in discussing this and other environmental problems is between economists and other government officials in Washington and the people I know and work with in Kentucky who are responsible for implementing these programs. The mayors, county judges, and community leaders have not been involved in the development of our national strategy to clean up the environment. On a philosophical level, they understand the public health considerations, as I previously mentioned, but do not grasp the connection between providing clean drinking water, sound waste management, and attempting to curb air pollution and the ability of their community to provide a sound, bright future for its citizens. Because of the enormous cost of implementing all of EPA's goals to protect the environment, I believe it would behoove all of us to concentrate more of our efforts toward environmental financial education. I believe one way of doing this is for EPA to require more local financial participation in all of their programs similar to that which exists in State Revolving Fund programs for waste water. This would mean the local business community would become involved in planning the solutions to their area's environmental problems. In that way, they would see the costs associated with not addressing environmental concerns on the front end of development projects. Furthermore, because some of the money would be coming out of their pockets, they would seek the most cost-effective solutions. In the course of the reauthorization of the Clean Water Act, I believe this issue should serve as the focus of the debate. How do we encourage the best partnership of resources: federal, state, local, and private to pay for environmental facilities. I would like, therefore, to stress this point: while the federal role may be to appropriately establish sound consistent environmental standards, it should not establish overly strict limits for State Revolving Funds, and enact changes in tax laws that have the effect of limiting the funds for these facilities.

Today, business has every incentive to become a partner with community leaders to comply with established mandates. Without question, laws such as the Clean Water Act are the essence of our federal government system. Without it, we would not and could not function as a nation.

So, I would challenge all of you in this room to view the process of reauthorizing the Clean Water Act as an opportunity to make a strong program even more effective, an innovative program even bolder, a vitally important program an even more crucial element in this nation's efforts to be more competitive globally, while at the same time, preserving and enhancing the earth's environment. This is a monumental challenge—yet one that is achievable.

It's been a pleasure addressing a group that understands the consequences of inaction and has been involved in developing programs and legislation that improves the lives of the citizens of this great nation.

Monday, October 19, 1992

Session 2: Balancing Water Demand in Agricultural and Other Economic Sectors

SESSION SUMMARY

MODERATOR: Alan M. Fox

PRESENTERS:

Kenneth Cook—Paper Unavailable

Kenneth D. Frederick—*The Future of Irrigated Agriculture*

John K. Hosemann—*Economic Issues for Farmers in the Rewrite of The Clean Water Act*

Katherine Reichelderfer—Paper Unavailable

The Future of Irrigated Agriculture

Kenneth D. Frederick[1]
Senior Fellow and Director, Renewable Resources Division
Resources for the Future

ABSTRACT

Irrigation has been an important contributor to the past growth of agriculture in the United States. Starting from less than 1% of the land in farms in 1900, by 1982 irrigation accounted for one of every eight acres under cultivation and nearly three of every ten dollars of the value of the agricultural output.[2]

Total factor productivity (the ratio of all outputs to all inputs) of U.S. agriculture grew at an annual rate of 1.2% from 1949 to 1974, a 35% increase over the twenty-five years.[3] Although irrigation's contribution to overall agricultural growth cannot be quantified with any precision, there is evidence that it was substantial. Irrigated acreage more than doubled between 1950 and 1977 to surpass 50 million acres. Not only has irrigated acreage grown significantly while total harvested acreage remained virtually unchanged, technological change within the arid and semi-arid areas has been higher on irrigated farms.[4]

Higher yields and a greater concentration of higher-value crops under irrigation account for the fact that the average value of the output from an irrigated acre is nearly 2.4 times the average for dryland farming. Irrigated yields exceed those for dryland farming by an average of 54% for corn for grain, 97% for wheat, 33% for soybeans, and 67% for cotton (see Table 1). All the rice, 70% of the orchards, more than half of the vegetables, and about one-third of the cotton are irrigated.[5] While much smaller percentages of grain acreages are irrigated (e.g., 13% of the harvested corn and sorghum and 6% of the wheat), the combination of improved yields on irrigated farms and the increase in the relative acreage devoted to irrigation accounted for 28% of the national increase in corn production, 20% for sorghum, and 12% for wheat from 1950 to 1977.[6]

Irrigation also expands the land base on which productive agriculture is possible. Perhaps 10 to 13 million of the nation's most productive lands in the arid West would be producing little, if anything, of value in the absence of irrigation. Initially, irrigation was almost exclusively concentrated in the arid and semi-arid areas of the seventeen western states where controlled water inputs are often essential to high-yield agriculture. These states still account for about 85% of the nation's irrigated acreage and 75% of the value of the irrigated output. Indeed, more than half of the value of the agricultural output in the West is produced on irrigated lands. In California, the leading agricultural state, irrigation accounts for 82% of the total value.[7]

Although irrigation is not as essential to successful farming in humid regions, supplemental irrigation increases yields and reduces risks associated with the weather, especially on sandy soils which are relatively poor at retaining water within the root zone of a plant. Since 1950, irrigation in the thirty-one eastern states has grown at more than three times the rate in the West. Yet, with the exception of Florida, Arkansas, and Louisiana (where about half of the combined value of the agricultural output is now irrigated), dryland production continues to account for more than 90% of the value of the output.

1.0 SIGNS OF STRESS

1.1 Declining Rates of Growth

The nation's total irrigated acreage actually declined in the last decade as the sector has come under considerable stress. As of the mid-1980s, irrigation was about 10% below the peak of just over 50 million acres reached in the late 1970s. The general malaise that has gripped the agricultural sector in recent years contributed to the decline. But longer-term factors are also involved. Most importantly, western water supplies are becoming increasingly scarce and costly.

Past growth of western irrigation was driven in large part by the availability of low-cost water. The earliest developments involved diverting surface waters to relatively level riparian fields that could be irrigated with gravity flows. Water costs rose as investments in reservoirs, pumps, and canals were required to increase assured supplies and to move water to more distant lands. But federal subsidies often insulated farmers from these cost increases. Bureau of Reclamation projects now provide full or supplemental irrigation water to about eleven million acres with subsidies that for some projects were estimated in excess of $1,500 per acre and as high as 97% of the full project costs.[8] Where low-cost or subsidized surface water was not available, groundwater was likely to be tapped for irrigation. Low-cost energy and technological breakthroughs such as improved high-speed engines and turbine centrifugal pumps in the 1930s and center-pivot sprinklers in the 1950s encouraged the growth of groundwater use.

Water scarcity is not a new phenomenon that has just started to impact the growth of irrigation. To the contrary, water has constrained the rate and location of western irrigation for at least the last three decades. Indeed, the recent decline in the total acreage under irrigation can be viewed as a continuation of a longer-term trend which can be explained, at least in part, by changes in the availability of water supplies within the West's best agricultural areas.

Both the annual rate and the absolute level of growth of irrigated acreage in the West have declined steadily since 1950 according to agricultural census data. For instance, the growth of irrigated acreage averaged 4.5% or nearly a million acres per year from 1945 to 1950. In contrast, average annual growth was only 1.1% or 400,000 acres from 1969 to 1974.[9] Irrigated acreage declined from 1978 to 1982. The major regional shifts underlying the overall decline in the growth of western irrigation are further indication of the stresses within some of the better agricultural areas. Nearly four of every five of the net additions to western irrigated acreage between 1945 and 1954 were in a southern belt which includes all of California and Arizona and parts of Texas, Oklahoma, and New Mexico. In the subsequent two decades, the contribution of this southern region declined to 31 and then to 1% of the net change in western irrigation. In the southern High Plains of Texas, which alone accounted for one-third of total increase in the decade immediately following World War II, irrigated acreage had started to decline as early as the mid-1960s. By this time the center of irrigation growth had moved to the northern plains. More than 90% of the net additions to western irrigation from 1964 to 1974 were in Kansas, Nebraska, and eastern Colorado.[10] Since 1978, Nebraska and North and South Dakota, where the growing seasons are considerably shorter, have been are the only western states to experience a net increase in irrigated acreage.[11]

1.2 Competition for Western Surface Water

The increasing competition for limited surface water and the high costs of developing new supplies underlie the declining growth described above. Data on water supply and use conditions suggest the nature of the constraints confronting potential new irrigators as of 1975. With the exception of a few areas with relatively poor growing conditions, there was very little, if any, slack between average year stream flows and total water use (defined as the sum of instream needs and offstream consumption) in much of the West. Moreover, total water use exceeded average stream flow in 24 of the 53 western water resource regions. These 24 water-scarce regions accounted for much of the better growing areas and about two-thirds of the West's irrigated acreage in 1975.[12]

While irrigators are finding it increasingly difficult to establish additional surface water rights, economic factors are diverting some of the supplies initially used in agriculture to other uses. User rights to western surface waters were granted free to those who first diverted the water for a beneficial purpose. The earliest users acquired the most senior rights and could continue to withdraw their full share even in times of shortage. As the largest and often the earliest users, irrigators have senior rights to much of the West's water for as long as they continue to use it or until they voluntarily transfer their rights.

Although the irrigator pays nothing for the water itself and probably only a modest fee for transporting it to the farm, the opportunity costs of using water for irrigation rise when farmers have opportunities to sell water for other uses. Since irrigation is a relatively low-value use, water is being attracted away from agriculture to municipal, industrial, mining, and other uses with growing frequency.

Instream uses were generally ignored by western water law. Water rights were established by diverting stream flows, not by enjoying the beauty of a free-flowing stream or the fish it supports. Recently, however, instream flow values have attracted considerable attention from state legislators, courts, and environmentalists. Minimum stream flow legislation to promote uses such as fish and wildlife enhancement, hydropower production, recreation, pollution control, and scenic amenities has been adopted or proposed in several states. The Public Trust Doctrine has been employed in some court decisions to question the legality of water withdrawals that threaten to destroy the ecology of aquatic environments, the preservation of which is viewed as being in the public interest.[13] As society places higher values on instream water uses and tries to compensate for their past neglect, it will be increasingly difficult to maintain former levels of agricultural water use.

The state-granted water rights held by irrigators are also threatened by the failure to quantify Indian and federally reserved water rights. These potential claims are based on vast Indian and federal landholdings in the West and federal court decisions supporting the view that these lands have accompanying water rights sufficient to accomplish the purposes for which the lands were reserved. Moreover, since these rights date back to the time when the lands were set aside, they have priority over most of the water rights granted under state law. Providing for Indian and federally reserved claims to western water could well come at the expense of some of recent agricultural users.

1.3 Groundwater Mining

Since the mid-1950s, the expansion of western irrigation has been based largely on groundwater. From negligible levels in the early 1930s, groundwater withdrawals for irrigation rose to 31 maf in 1955 and 58 maf in 1980, when they represented 38% of irrigation withdrawals in the West.[14]

While groundwater stocks are vast and far exceed surface water supplies, economic considerations constrain the supplies of potential use to irrigators. Increasing pumping lifts and rising energy costs worsened the economics of groundwater use for many irrigators over the past decade.

Pumping exceeded aquifer recharge in 1975 by more than 22 million acre-feet (maf), equivalent to 40% of the annual groundwater withdrawals for irrigation. In the Texas and Oklahoma High Plains alone, mining from the Ogallala aquifer was about 14 maf a year, equivalent to the average annual flow of the Colorado River.[15] As of 1983, groundwater supplies underlying more than 14 million acres within the eleven leading groundwater irrigation states were falling by at least half a foot annually. [16]

Mining affects water costs both by increasing the lifts and by decreasing the saturated thickness and, therefore, the yield of a well. The effect of increased lifts on water costs is likely to be small, probably less than 1 to 2% a year, until investments in larger wells and pumps are required to maintain flow levels. At that point, the impacts on costs become much more significant and irrigators may find it more profitable to simply use less water. Investments in water-conserving technologies may enable irrigators to reduce water use without adverse impacts on crop production. A more likely strategy during periods of low

crop prices and tight credit may be to cut back on the acreage irrigated and the rate of water applied per acre. Under this alternative, the costs are incurred in the form of reduced production.

Rising energy costs produced the most dramatic cost increases for some groundwater irrigators during the 1970s. Energy price shocks were particularly great in the High Plains where the availability of almost free natural gas to power irrigation pumps had been a major factor in the rapid expansion of irrigation. Many of these irrigators faced very sizeable increases in energy costs as the nation adjusted to the OPEC embargo. The resulting sharp rise in water costs forced a major transformation on a region that had been characterized by relatively inefficient and wasteful irrigation practices. For some farmers this meant returning to dryland farming. For most farmers, however, more water-conserving crops, seed varieties, cultivation techniques, and irrigation practices enabled them to adapt to higher water costs.

Initially the states placed no controls on groundwater use and landowners were granted absolute ownership of the underlying water. Most western states, however, switched to the appropriation doctrine and began imposing controls on groundwater use as mining conflicts between the rights of surface and groundwater users and a number of other problems arose. Even though new pumping permits are supposed to be granted only where additional pumping will not adversely affect existing users, the laws have seldom been applied to prevent depletion of an aquifer. Arizona's Groundwater Management Act of 1980 moves the furthest in mandating an eventual balance between pumping and recharge and in restricting irrigation within designated groundwater management areas.

1.4 Environmental Problems

High and generally rising salinity levels in several western river basins pose the principal environmental threat to irrigation. High salt levels in the soil or water impede plant growth, and can eventually render land worthless for agriculture. All irrigation water carries salts, and concentrations increase as water evaporates, is transpired by plants, or passes over saline soils. High salt concentrations currently threaten agricultural productivity in the Lower Colorado, the Rio Grande, the San Joaquin, and several other river basins.

The nature of the salinity problems differ among basins. In the Colorado, high-quality headwaters (containing less than 50 parts per million of inorganic salts) pick up salts from irrigation return flows as well as from natural sources. By the time the water reaches Mexico or the Imperial Irrigation District in Southern California, salt concentrations have increased about 11 to 15 fold, reaching levels that are detrimental to irrigation as well as municipal and industrial water uses.[17]

In California, repeated irrigations on naturally saline soils with poor drainage are producing waterlogging on the west bank of the San Joaquin Valley. As the water tables rise, oxygen is unable to get to the roots and capillary action produces very high salt concentrations near the surface. About 300,000 acres are already adversely affected, and with present management techniques the problem area is expected to double within a few decades.[18] Saline water can be removed from individual farms with subsurface drains if there is someplace to put the drainage. The valley is still seeking an economically and environmentally acceptable way of disposing of the huge quantities of drainage water generated.

Policies designed to curb environmental insults inflicted by the agricultural sector also threaten current irrigation practices in some areas. The closing of the canal carrying irrigation drainage from the Westlands Water District (the San Joaquin Valley's largest irrigation district) to Kesterson Reservoir 82 miles to the north illustrates this type of threat. Selenium, which is essential to some animals at very low levels but becomes toxic at higher concentrations, is one of the naturally occurring trace elements in the drainage delivered to Kesterson. The mineral first entered the vegetation and small animal life of the reservoir and increased to lethal concentrations as it moved up the food chain. When it became clear that the drainage was converting Kesterson into a deathtrap for many of its birds, the Secretary of Interior arranged to close the canal as of June 1986 to avoid further violations of the Migratory Bird Treaty Act. The

Westlands is still seeking affordable and environmentally acceptable solutions to their drainage problems. Removing some of the lands from irrigation may need to be part of any eventual solution.

Current concerns about keeping agricultural chemicals out of water supplies may lead to restrictions on pesticide use that would affect irrigators as well as other farmers. California's Safe Drinking Water and Toxic Enforcement Act of 1986, better known as Proposition 65, is a case in point. The use of some pesticides will be banned under the act. Depending on how the legislation is interpreted and implemented, Proposition 65 could have major impacts on the state's agriculture. Similar legislation is being debated in other states, and the U.S. Environmental Protection Agency is considering bans on leachable pesticides in areas where groundwater supplies are threatened. Although little is known about the likely impacts of such policies on farmers, the uncertainties are apt to discourage some investment.

2.0 SOME REASONS FOR OPTIMISM

To summarize the previous discussion, irrigation, especially in the seventeen western states, played an important role in the growth of U.S. agriculture during this century. However, the rapid growth of irrigation was based on easy access to inexpensive water, and those conditions no longer exist. Moreover, existing irrigators will be under increasing pressures to reduce current water use levels in order to meet the rapidly growing demands of municipal and industrial users, to restore some of the values lost through past neglect of instream flows, to bring groundwater use in line with recharge, and to mitigate environmental threats from current irrigation practices. Yet, as is discussed below, there are reasons to believe that (if justified by agricultural price levels) irrigators can adapt to these pressures in ways that will ensure continued growth in the total value of irrigated production. Future growth in the western states will depend on increasing the returns to water rather than, as in the past, increasing water use. Fortunately, there are opportunities for raising the returns to water in irrigation by improving the efficiency with which the water is delivered to the plants or by increasing the value of the output produced with a given amount of water.

Surface water irrigation efficiencies depend on both the conveyance losses incurred delivering water from its source to the farmgate and the on-farm losses in getting water from the farmgate to the root zone of the crops. From the perspective of the system or region as a whole, the significant losses are those which cannot be recovered through return flows or groundwater recharge for later use. From the individual farmer's perspective, efficiency is measured as the ratio of water received at the farm to the water utilized by the plants. Higher water costs give irrigators increased incentive to improve on-farm efficiency even if the on-farm water losses are recovered by others in return flows.

Irrigation systems differ widely in their relative uses of water and other inputs such as capital, labor, and management skills. The most efficient systems in terms of water use generally require more of these other inputs. In the late 1970s, a government task force established to assess the potential for improving irrigation water use efficiency estimated that an investment of $14.6 billion in conveyance and on-farm systems was required to achieve state-of-the-art improvements in the irrigation systems of the 17 western states. These investments, however, would only provide an additional 3.3 million acre-feet of water for new uses. The Task Force recommended a $5 billion increase in expenditures on water conservation measures spread over three decades. They estimated that these measures would reduce gross annual diversions by 15 to 20 million acre-feet and make 2 to 5 million acre-feet available for new uses.[19]

At current water values, only the most attractive of these investments are likely to be economically justified. The implied average costs of adding an acre-foot to annual water supplies through the recommended conservation measures is somewhere between $1,000 and $2,500. While these costs are not out of line with prices being paid for water rights in some areas of the West, they are well above the values of water for most agricultural uses. About 90% of the consumptive use of western irrigation water is applied to crops for which the marginal value of water is less than $100 an acre-foot; nearly half is for crops with marginal water values of $30 an acre-foot or less.[20] Thus, the present value of a permanent increase in net water supplies is less than $1,000 per acre-foot for all but the higher value crops.

Farmers are often able to conserve water at significantly lower costs. For reasons provided above, however, farm-level water savings may overstate regional savings because they do not allow for return flows. Nevertheless, farmers' perspectives are important since they guide on-farm investments. More than 60% of the West's irrigated lands use gravity to distribute water by flooding fields planted to close-grown crops or through furrows for row crops. With gravity systems, only about half or, where the soil is sandy and the field uneven, considerably less of the water delivered to the farm may reach the plant. Farm-level efficiency for these systems can be improved perhaps 20 to 30% through investments in tail-water recycling (to capture water at the bottom of the field for reuse) and laser-leveling (to eliminate runoff). Under conditions characteristic of many areas, it might cost from $10 to $50 an acre-foot to conserve water through these investments.

Sprinkler irrigation systems, which are used on about 36% of the West's irrigated lands, can produce water-use efficiency levels of about 80% even on sandy, hilly terrain. Sprinklers, however, tend to be considerably more expensive then gravity systems. Center-pivot systems, for instance, cost in excess of $300 an acre installed and about $15 in energy for each acre-foot applied. On the other hand, center-pivots require very little labor to operate. Drip or trickle irrigation systems deliver virtually all of the water to the root zone of the plants. Installation costs, however, are about three times those for a center-pivot system and would be considerably higher with the closer spacing required for row crops. Moreover, the pipes used to deliver the water to the plants are difficult to farm around. Consequently, fixed drip systems are not suitable for close-grown and most row crops which together account for over 90% of the irrigated acreage. Mobile trickle systems which attach trail lines with emitters to center pivots or other mobile sprinkler systems have been introduced into the High Plains as a means of reducing both evaporation losses and energy use.[21]

Not all of the opportunities for conserving or increasing the returns to water require large investments in new irrigation systems. Improved irrigation scheduling, which applies water only when it will be used most effectively by the plant, may actually produce higher yields with less water. Irrigation scheduling services utilizing models and computers to analyze data on crop responsiveness to water, daily weather records, soil moisture levels, infiltration and evaporation rates, and other factors are now available in many areas to assist farmers in making irrigation decisions. As water costs rise it may become profitable to irrigate less even if lower yields are a likely result. For instance, water use can be reduced by about one-third with only modest declines in yields by simply irrigating alternate furrows.

A common response to rising water prices is to switch to less water-using crops. In particular, some growers have replaced corn with sorghum or wheat as water became more costly.

Agricultural researchers are developing seeds, chemicals, and management practices that will help farmers adapt to higher water costs. Chemicals that reduce the amount of water a plant transpires, seed varieties providing high yields with lower water inputs, and agronomic and irrigation management techniques that improve yields per unit of water are being developed on experiment stations and in some cases are being adopted by irrigators. Since it has only been within the past decade that researchers have paid much attention to developing technologies particularly suited for conditions of water scarcity, a more concerted, long-term research effort is likely to produce major breakthroughs in the future.

In spite of the growing opportunities for increasing returns to irrigation water, farmers attracted by offers of high prices are selling water to municipal and industrial users. The much higher water values that are often characteristic of non-agricultural uses have led to predictions that such transfers would lead to the demise of irrigation in large areas. Such forecasts seem unwarranted, however. Water transfers occur gradually and are not likely to affect more than a small percentage of agricultural water rights for the foreseeable future. Because of the current dominance of irrigation in western water use, large percentage increases in non-agricultural water uses can be met with relatively small percentage reductions in irrigation use. For instance, nearly 90% of the consumptive use of western water is for irrigation. Thus, a 10% reduction in irrigation use would almost be sufficient to double the water available for municipal and industrial uses.

The water rights of irrigators could suffer from efforts to satisfy the increasing values and legal status being attributed to instream uses or when Indian and federally reserved water claims are settled. From a national perspective, however, the impacts on irrigation are likely to be small. The higher values placed on instream uses in recent years have made it more difficult to increase diversions from many western streams for consumptive uses. But since instream uses are non-consumptive in nature and since some of the higher instream values (including those likely to be associated with federally reserved rights) occur in the upper reaches of a river, downstream diversions can be consistent with meeting these instream uses. Since irrigation is apt to be the dominant use for Indian water for the foreseeable future, abrogating the rights of existing users to settle Indian claims would have little net impact on agricultural water use.

The strong complementarity between irrigation practices that conserve water and those that reduce the environmental problems associated with irrigation is another encouraging factor for the future of irrigated agriculture. Limiting the rate and quantity of water applied to levels that can be fully absorbed within the root zone eliminates the erosion, sedimentation, and water-quality degradation associated with irrigation. Unfortunately, eliminating runoff will lead to the accumulation of salts within the root zone. To prevent these salts from damaging productivity, additional water must be applied occasionally to leach excess salts from the soil. Even though some of these salts are likely to show up in neighboring streams or underlying aquifers, improved water management practices can go a long way toward reducing the environmental costs of irrigation while conserving scarce water supplies.

3.0 SOME FINAL THOUGHTS

Economic factors, especially crop and energy price levels, will be important to the future growth of irrigated agriculture. All farmers have been affected by the low crop prices of recent years. But since their yields and production costs are generally higher, irrigators' profits tend to be more sensitive than those of other farmers to agricultural prices. High crop price levels encourage yield-increasing investments, of which irrigation is an important option. On the other hand, high energy prices are likely to affect irrigators more adversely than other farmers. Irrigators pumping from considerable depths and distributing water under pressure through sprinkler systems are particularly vulnerable to energy price levels.

In the humid eastern states, irrigation growth will continue to be driven in large part by the demand for agricultural crops. Drought, which increases the relative attractiveness of irrigation, can also be an important inducement for irrigating. Eastern irrigation is likely to continue growing faster than the overall agricultural sector. Yet, outside of Florida, Arkansas, and Louisiana, irrigated production will remain a relatively minor part of the total on all except the high-value specialty crops.

In the West, the impacts of increasing water scarcity on regional development are inescapable. Rising real crop price levels can offset higher water costs and encourage additional groundwater pumping. But the lure of additional profits from irrigation would not alter the trend for more of the region's water to flow to municipal and industrial uses for which water values are much higher than in irrigation. Nor would it do much to increase the flow of public funds for irrigation projects which are criticized for their adverse impacts on the environment and instream water uses as well as for their questionable economics. Higher crop prices would, however, make irrigators more inclined and better able to respond to rising water costs with investments designed to increase the returns to water.

No set of policies will alter the underlying fact that water is becoming an increasingly scarce and valuable resource in the West. Historically, both the federal and state governments sought to attract settlers to the West by assuring them access to low-cost water. State laws provided the security of permanent water rights, and federal projects and subsidies helped ensure reliable flows of affordable water to agricultural lands. Currently, the persistence of some of these laws and policies provide the wrong incentives and make it more difficult to transfer water to new uses in response to changing conditions. In many states, for instance, water rights are encumbered by restrictions on use and procedures which make transfers costly, time-consuming, and uncertain. Restrictions on the use of federally supplied water curtail both the opportunities for transferring water from Bureau of Reclamation projects to other areas and uses and the

incentives to conserve this water. Such laws and policies isolate some irrigators from the increasing scarcity of water and encourage them to continue irrigation practices appropriate for a period when water was a free resource. Unfortunately, when an illusion of plenty is artificially created in some areas, water is made increasingly scarce in others.

The laws, institutions, and attitudes that allocate and manage western water are changing. Water marketing is becoming increasingly common throughout the western states as is evidenced by the emergence in January 1987 of a monthly newsletter to report on new developments, transactions, and trends.[22] Several states have passed laws in recent years declaring water marketing to be a beneficial use and, therefore, not cause for loss of a water right. In July 1986 the Western Governors' Association adopted a resolution endorsing improved water use efficiency as a primary goal and promotion of voluntary water transfers as a primary means of achieving it. Even the Bureau of Reclamation has come to recognize a need to change their mission from "one based on federally supported construction to one based on effective and environmentally sensitive resource management".[23] As the incentives are altered to more nearly reflect underlying resource availability, the growth and prosperity of irrigated agriculture is likely to closely reflect that of the overall agricultural sector.

The foregoing discussion implicitly assumes the nation's climate will remain essentially unchanged. In view of the widely held consensus among climatologists that increasing concentrations of carbon dioxide and other radiatively active trace gases in the atmosphere will lead to a global warming and substantial, but unknown, changes in precipitation patterns, this assumption becomes increasingly questionable as we move into the next century. Global climatic modeling is not sufficiently advanced to predict what these changes might mean for the agriculture of specific regions. Regional water supplies could be substantially curtailed even with no reduction in precipitation as evapotranspiration rates rise with average temperature levels. On the other hand, water supplies might rise as the global hydrological cycle is accelerated by the warming. The added uncertainty, however, provides further justification for both institutional changes that will make irrigators as well as other water users more responsive to underlying resource conditions and research designed to develop better ways for adapting to increased water scarcity.

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Economic Issues for Farmers in the Rewrite of The Clean Water Act

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ABSTRACT

This paper discusses the central economic issues farmers and ranchers will face in the reauthorization of the Clean Water Act. Given the wide variation among farm types, farm regions, farm cultural practices and weather, generalized rules and centralized controls for dealing with nonpoint source contamination are likely to be very costly and produce limited real environmental gains for the money spent. The paper discusses the distribution of the cost of solutions of nonpoint source contamination and the implications of these cost burdens for the family farm competitive structure, U.S. farmer international competitiveness, farm income and asset values, rural development and the impact on new entrants.

A lack of site-specific farm-level data on nonpoint source contamination is a major obstacle to evolving real solutions to serious nonpoint source agricultural problems if and where these do exist. Given the conflicting farm and nonfarm economic and environmental interests, the lack of site-specific farm-level scientific data on nonpoint source linkages makes a case for bold new approaches to marry the incentives of private ownership and the efficiency of private resource management with the discipline of the market to solve nonpoint source problems.

"Taking action without knowledge is like throwing darts with a blindfold."

Meiners/Yandle

INTRODUCTION

Sorting out the economic issues to be dealt with in the rewrite of the Clean Water Act is an humbling experience. The approach in this paper is to focus on some fundamental economic issues. Should the fundamental economic issues get swept aside, there are obviously still many serious issues with which farmers must struggle.

Partial review of technical research and earlier economic papers reveals certain point source pollution issues pertinent to nonpoint source pollution. Technology-based, command-control, "zero-based" policy and regulatory approaches have not worked effectively or efficiently for point source pollution problems. These approaches are not likely to work for nonpoint source problems either. It is time to abandon the status-quo and move on to bolder, more creative solutions that put water quality improvement as the central policy focus rather than federal micro-management of farm inputs and resource uses.

A new approach based on water quality outcome standards requires some recognition of the basic economic relationships that have made U.S. agriculture what it is today, a science-driven and highly efficient industry facing the challenges of a competitive world marketplace. If policymakers insist on applying the discredited command-control, technology-based regulatory controls to the farm sector, they should understand that there will be substantial economic implications and the weakening of one of the last world-class industries in the United States.

One reason for including these Figures 1, 2, and 3 is to point out that had U.S. farm technology been frozen at the 1910 level, the U.S. would have to cultivate 1.222 billion acres to produce the output that U.S. farmers currently produce on 300-400 million acres. Technology and innovation is *pro-*

environment. It has released vast land and water resources for other activities. Goklany and Sprague[1] discussed this point in detail.

Another reason for including these productivity perspectives upfront is to remind ourselves what this policy debate is *all about*—raising farm costs and lowering these positive trends.

Long-standing increases in U.S. farm productivity are based on a massive investment in scientific discovery, trial and error on and off farms, with both private and public research and development. In addition, over the last 100 years, billions of dollars of private and public money have gone into technology transfer that positions U.S. agriculture as the world-class competitor it is today.

Finally, the central point here is that farmers simply do not have a similar scientific basis on which to make business judgments and decisions about what they are/are not contributing to nonpoint source contamination. We simply do not know, *in site-specific farm-level terms*, the linkages between modern farm practices and water quality. This detail data is absolutely essential in order to evolve the policy options—and ultimately the common law legal remedies—which can improve water quality where serious problems do exist.

It is simply not good enough to make sweeping allegations and generalizations about the *possible* links between modern U.S. farm practices and water quality without scientific proof of cause and effect *at the site-specific farm level.*

In simple terms, an individual farmer has the scientific data and know-how to produce 75 bushels per acre wheat on his land and similar land. What he/she now needs is access to the scientific data and know-how to produce 75 bushel/acre wheat *and* a specified quality of runoff and groundwater from that same acre of wheat.

Figure 4 depicts the principal challenge which U.S. farmers will face in the decades ahead. By the year 2000, world population will increase by 1 billion people. In 50 years, world population is expected to double from 5.5 to 11.0 billion people. New technology will no doubt play a major role in meeting this fundamental challenge. But so will land and water resources in the United States.

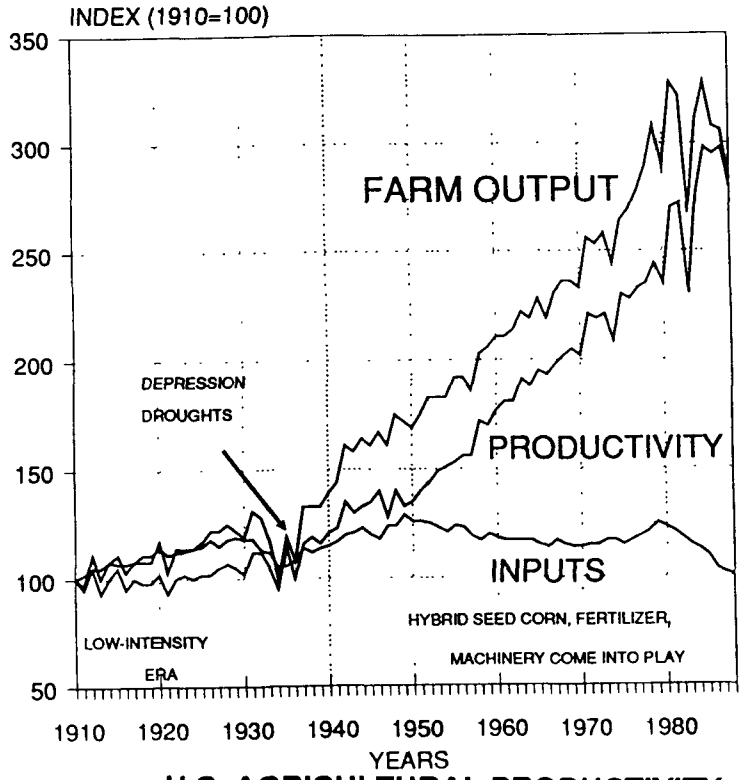
Figure 5 illustrates the 1975-1990 trends in world grain production and utilization. If world grain consumption increases only by population growth at 1.4% per year, by the year 2000 the world will need 16% more grain. How will this be done?

Figure 6 illustrates the 1975-1990 trends in world grain acreage and world grain yields. World grain acreage increased between 1975-1982 and declined steadily thereafter. In fact, the longer-term trend shows a steady decline in world grain acreage. World grain yields, on the other hand, with a few exceptions have trended steadily upward over the 1975-1990 period. Yield increases have offset the decline in the grain production area.

To meet the world population—and hopefully income—increases in the years ahead some combination of yields and acreages will need to increase. Environmental pressures worldwide will surely continue to put downward pressure on increasing acreages for production. To close the gap, yields will have to increase even more so, but there are no dramatic breakthroughs on the horizon and there are numerous obstacles in areas, like biotechnology, which hold potential for farm productivity and environmental gains.

FIGURE 1

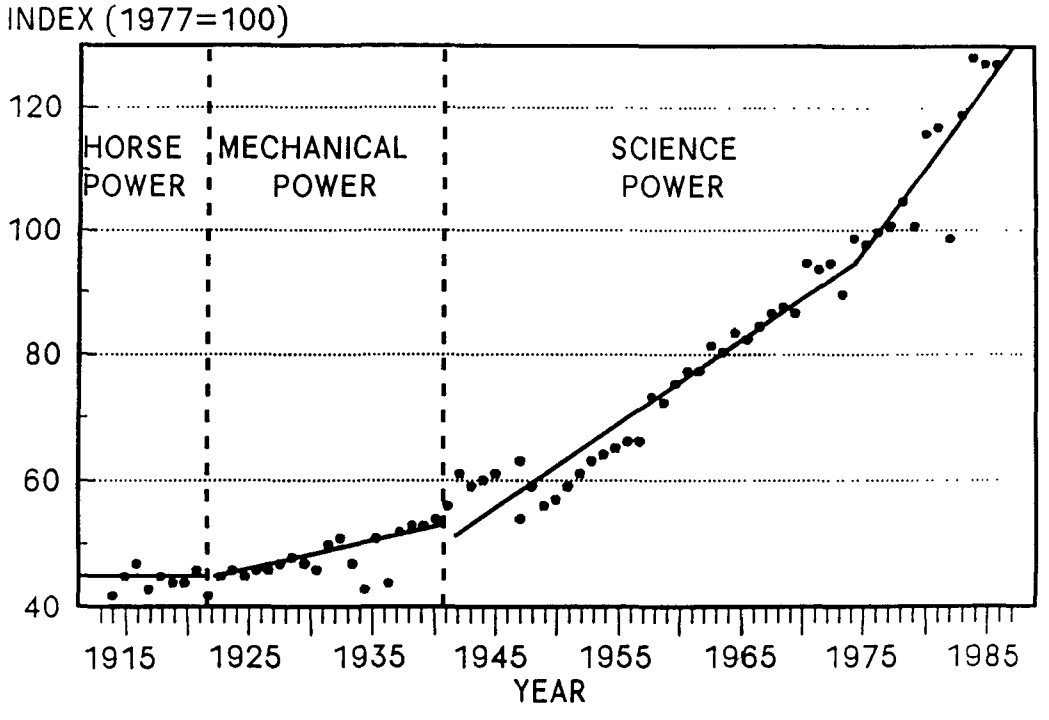
OUTPUT and PRODUCTIVITY RISE STEADILY; INPUTS FALL



U.S. AGRICULTURAL PRODUCTIVITY

75 YEARS OF GROWTH

FIGURE 2



Source: Agricultural Chartroom, National Council of Farmer Cooperatives

EOCW2.DRW
MBG-DC

FIGURE 3

PEOPLE FED BY ONE U.S. FARM WORKER
1870 TO 1988

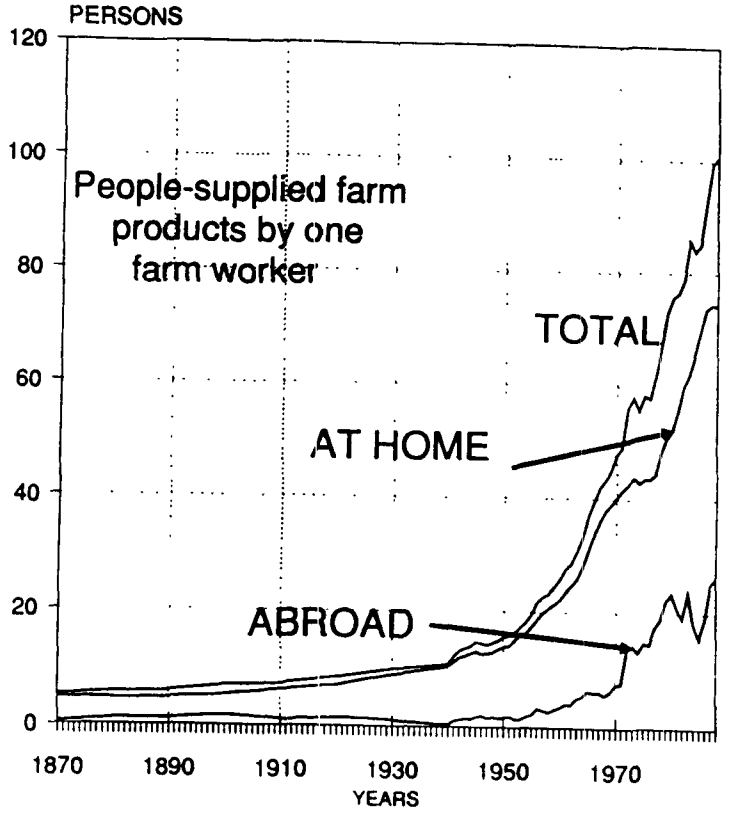
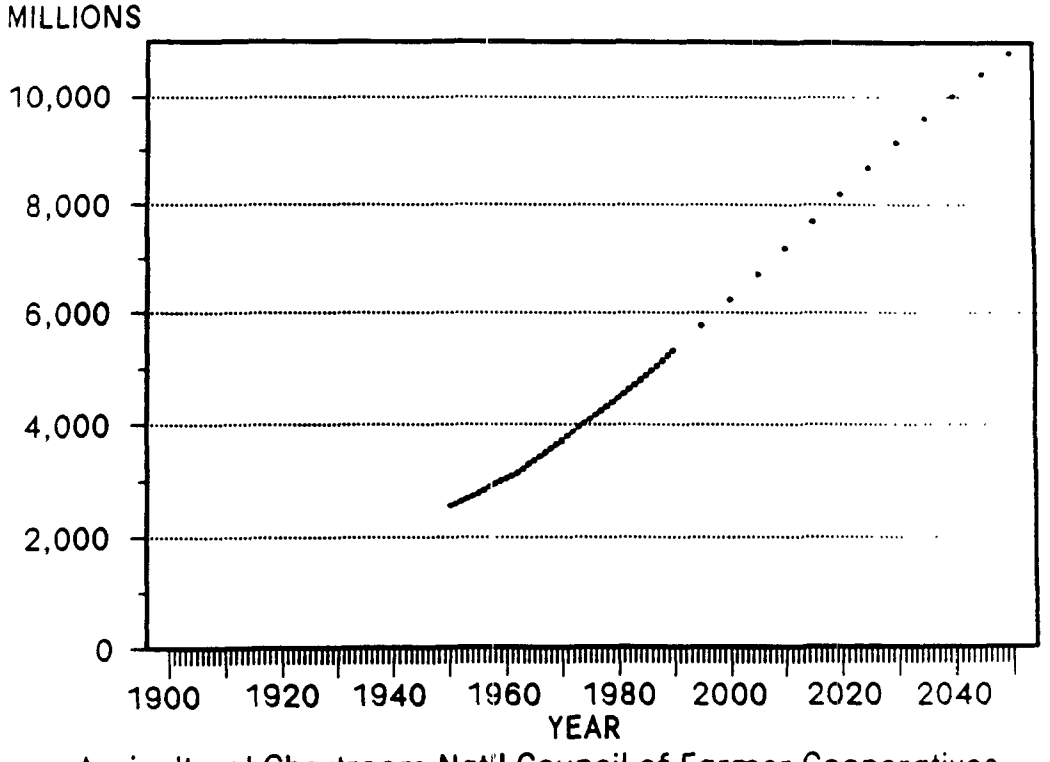


FIGURE 4

WORLD POPULATION GROWTH



Source: Agricultural Chartroom, Nat'l Council of Farmer Cooperatives

FIGURE 5

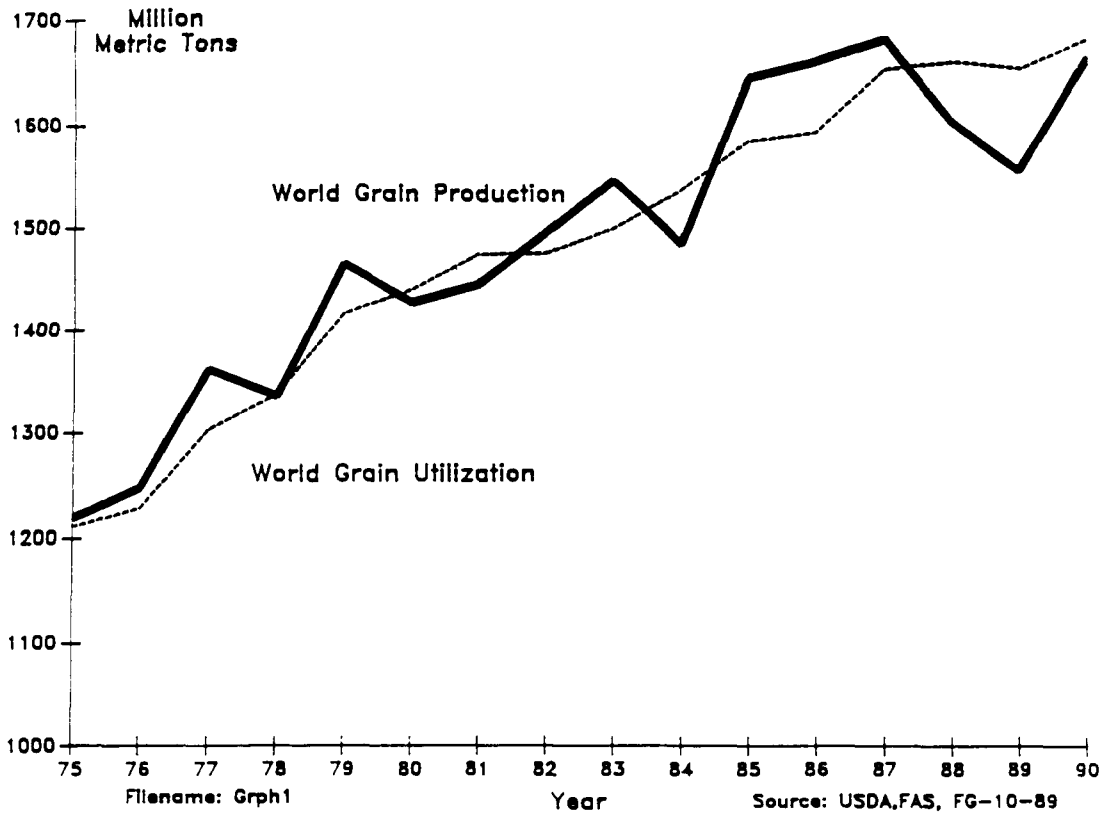
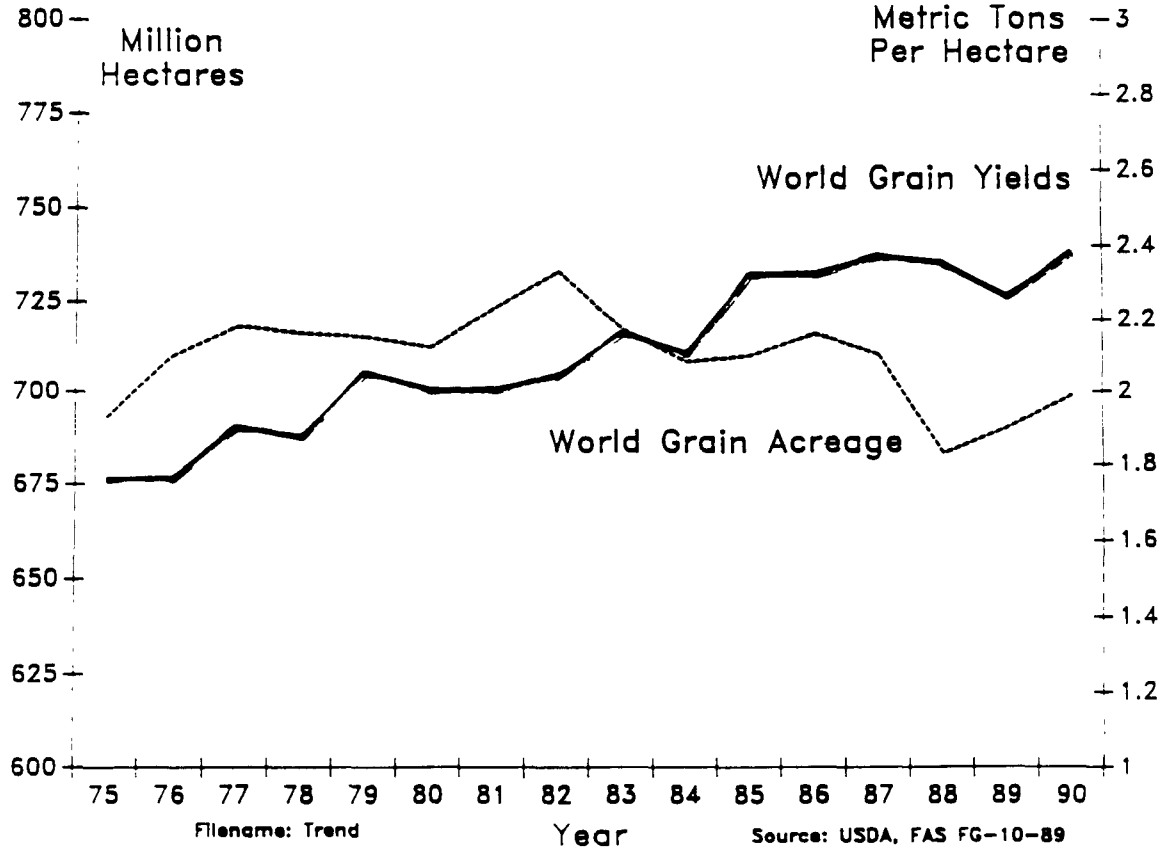


FIGURE 6



Ruttan[2] assesses the situation and prospects as follows:

"Now in the closing years of the 20th century we are completing one of the most remarkable transitions in the history of agriculture. Prior to this century almost all of the increase in food production was obtained by bringing new land into production . . ." Yet in the next century, almost all increases in world food production must come from higher yields—from increased output per hectare. This shift from expanding crop area to increasing land yields has been underway in most of the developed world since the turn of the last century . . .

As we look toward the future, however, we know that the demand increases will be large. The demands related to population growth and improved incomes in the developing economies will be exceedingly high. During the next several decades, growth in food and feed demand rising from growth in population and income will run upwards of 4.0% per year in many developing countries. Many will experience more than a doubling of food demand before the end of the second decade of the next century. . .

Several developments suggest that gains in agricultural production required over the next quarter century will be achieved with much greater difficulty than in the immediate past. Difficulty is currently being experienced in raising yield ceilings for the cereal crops which have experienced rapid yield gains in the recent past. The incremental response to increases in fertilizer use has declined. Expansion of irrigated area has become more costly. Maintenance research, the research required to prevent yields from declining, is rising as a share of total research effort.

Further, the institutional capacity to respond effectively to these developments is limited, even in the countries with the most effective national research and extension systems. Indeed, during the 1980s, many countries have had difficulties maintaining their agricultural research capacity at levels achieved in the 1970s. . .

. . . Almost all increases in agricultural production over the next several decades must continue to come from more intensive use of land currently in use. Improved crop and animal productivity will come from better plant and animal breeding, more effective animal nutrition, and more efficient use of technical inputs including chemical fertilizers and pest control chemicals.

Even so, the productivity gains from conventional sources are likely to come in smaller increments that in the past . . ."

Policymakers rewriting the Clean Water Act will need to make sure that they recognize the economic pressure on U.S. farmers from these underlying trends. The world food balance is too precarious to adopt policies which will adversely impact U.S. yield and acreage opportunities in the years ahead.

1.0 ISSUE NUMBER ONE—PROPERTY INCENTIVES

The first major economic issue that all farmers now worry about is the right to own property and to use it efficiently.

The confusion about federal wetland delineations among at least four federal agencies, the passage and now implementation of the Coastal Zone Management Act (CZMA) amendments, endangered species, FIFRA, and Senate Bill 1081 to rewrite the Clean Water Act all have command-control regulations for farm activities and have added to the risk and uncertainty in the U.S. farming business.

Farmers respond to incentives. The incentives to own and manage private resources is probably the most powerful economic incentive from the farmer's perspective. The idea of owning and improving the farm resource base motivates farmers to take the risks that lead to long-term farm productivity gains. The incentive to pass on a productive farm unit to heirs or to sell the unit based on its productive value is a powerful motivation for farmers.

Ownership of property is the right above all others that enabled the common man to ascend from serfdom. It is the most basic of human rights which are essential to freedom and progress. Property ownership and its use is essential as a stimulant to productive effort. Unless people can feel secure in their ability to retain the fruits of their labor, there is little incentive to save and expand the fund of capital—the tools and equipment for production and higher living standards. Farmers are feeling less and less secure in their rights to property and, as a result, their incentives are diminished.

Markets cannot exist without property ownership. Private property produces an efficient use and allocation of scarce resources. Any infringement on property rights reduces the efficiency of our economic system, raises output costs, and lowers living standards.

The right to own and use property causes individual farmers to better cope with variations in annual income in order to accumulate wealth by building a productive asset base over time. Ownership and control motivate farmers to create wealth through innovation.

The systematic erosion of the right to own and use property is now causing farmers to seriously wonder if they will only be left with the ownership responsibilities of paying taxes, mortgages and insurance, but without the right to use the resources efficiently. Do policymakers wish to trade off farm productivity gains for uncertain surface and groundwater improvement? Rewriting the Clean Water Act will strike at the heart of the economic incentive structure on which U.S. agriculture depends.

Command-control policy approaches where government specifies "the correct" technology, if applied to nonpoint source problems in agriculture, will have serious negative farm productivity implications for the longer term. Negative motivation stifles innovation, raises costs, and reduces productivity.

If anything has been learned from recent developments around the world, it should be that central command-control approaches do not work. Now is the time to invigorate, not denigrate, the institution of private ownership and control and use it to everybody's benefit in solving water quality problems. This is at the heart of the economic incentive structure of U.S. agriculture. Solving nonpoint source pollution problems must work in harmony with private property values and the incentives of ownership.

Current wetland regulations are the antithesis of using the incentives of property ownership. Farmers have been penalized for good faith efforts to construct and conserve bona fide wetlands. Others have been left with no use of their property, substantial fines, hours of red tape, confusion, and lost productivity. The new Clean Water law must reject these precedents.

2.0 ISSUE NUMBER TWO—SCIENCE MISSING

A second economic issue in the Clean Water Act rewrite is the fact that we simply cannot prove the cause/effect linkage between specific farm level activity and water quality. Broad generalizations, allegations, and nonscientific monitoring (Clean Water Act, Section 305B State Reports to EPA) are not sufficient to make policy recommendations for widespread changes in farm practices. We must do better.

It is not good enough to say that answering the scientific cause/effect relationships is "too costly" or "impossible." It will be even more costly to *not* discover the scientific relationships between activities and practices on individual farms and water quality. This point is made frequently in the literature by economists who have avoided the trap of aggregation and focused on the micro implications of farm level water quality policy issues.

In the textbook, *Environmental and Natural Resource Economics,*[3] Tietenberg argues as follows:

> One way to tailor the policy is to focus, at least initially, on those pollutants causing the most damage. Unfortunately, there is very little hard information available on the damages caused by nonpoint pollution. This makes it difficult not only to set priorities for controlling various categories of nonpoint pollution, but also to secure the efficient balance between controlling point and nonpoint sources.
>
> How should policy makers react to this uncertainty? Watson and Ridker [1982] set out to answer this question by quantifying the costs associated with various policy approaches. **They specifically considered the cost of being wrong in the sense of making one policy choice (a strict focus on point sources) when another choice (a balanced program of controlling point and nonpoint sources) was appropriate.**
>
> Their results indicate that **the cost of being wrong is so high that the government would benefit from investing time** (by delaying implementation of the most stringent point source controls) **and resources (by conducting research on the intensity of nonpoint pollution damages and costs)** before making a specific policy choice that could prove to have been a serious mistake. **Sometimes procrastination can be efficient!** [Emphasis added by author.]

In a paper, "The Impacts of Nonpoint Source Pollution Regulations on Mississippi Agriculture"[4], Hurt and Reinschmidt give the farm-level application of Tietenberg's argument:

> Ultimately, the question of what constitutes acceptable levels of erosion control and water quality will be the overriding issue facing agriculture and society. **Resolution of this issue will require substantial increases in both technical and economic research.** Technical research is needed to provide more and better information about the physical parameters of the water quality-agricultural production relationship. Economic research is needed to provide more and better information about benefits-costs and their distribution among the various segments of society and over time. The penchant of agricultural economists is to address the aggregative, longer-term, broad, general policy type issues regardless of the quality of technical information available . . .
>
> Many specific tasks and questions must be identified prior to designing and conducting the research. One of the first tasks is to specify in detail the practices and activities included in each **crop production/erosion-pollution control system.** For example, the following items must be specified: [Emphasis added by author.]
>
> - Each tillage practice and its timing;
> - Each pesticide application and its timing;
> - Each fertilizer application and its timing;
> - Harvesting procedures and residue management; and
> - Other erosion-pollution-production practices affecting the variables of interest.
>
> Ideally, a set of systems would be specified spanning the range of alternatives available . . .
>
> Once a practical set of alternative systems has been identified the research must be designed to address certain questions about each system in the set. Some of these questions are:
>
> 1. What are the expected yields and costs per acre and their variability and distribution over time?

2. What is the expected erosion, what is its distribution within a year and over years, and what is its relationship to water quality?

3. What is the expected sediment, nutrient, pesticide, and toxic chemical content of runoff and its distribution spatially and temporally?

4. How would the answers to the preceding questions differ for alternative soil-slope-rainfall situations?

5. What are the relationships among the variables identified (interaction)?

Ribaudo in his article "Agriculture and Water Quality"[5] further clarifies the issues:

> **The contribution of cropland or other nonpoint sources to pollution varies from one location and time to another. Identifying which land and land use is subject to substantial loss of sediment, nutrients, and pesticides is difficult without expensive monitoring systems. The variability of climate, soil traits (erodibility, hydrological features, ability to bond with chemicals, productivity for crop production), a watershed's ability to absorb pollution, and other factors make it difficult to evaluate how much a single field or farm affects water quality downstream....**
>
> **All factors affecting water quality and resulting economic damage must be considered before implementing water-pollution control efforts.** For example, the Corn Belt generates substantial erosion and sediment because it uses land extensively for farm crops. However, regions with dense populations, high incomes, and concentrated industry such as the Northeast and the Lake States will feel the effects of water pollution more than a region like the Corn Belt that may have greater erosion problems but fewer people to feel its effects. **But, off-site damage associated with water pollution cannot be measured directly and the links between farming and affected water uses are not well defined. Many assumptions are made to estimate off-site damage, and both methods and data for estimating damage need to be improved . . .**
> [Emphasis added by author.]
>
> Ground water contamination occurs only in certain places, making it difficult to draw a broad perspective on pollution issues. Sites cannot be compared because data for individual wells are inconsistent. Evaluating the full extent of ground water pollution is made even more difficult by variations in well depths, sampling periods, chemicals tested for, land uses above contaminated sites, soils, and biologic, hydrologic, and geologic characteristics . . .

The facts of the matter are that the variability among practices on farms, among different farm units, among different farm regions is so great that applying the "one-size-fits-all," command-control regulatory approach to nonpoint source problems will erode farm productivity gains and ultimately reduce U.S. agriculture to a second-rate international competitor. The rest of the agricultural world will not remain idle while the U.S. plays trial and error with water quality policy for farmers.

Appendix A contains the maps and well testing data for two Ohio counties. These maps and data clearly illustrate how command-control, centralized rules for water quality will not work even within a township, much less within a county or within a state, region or the nation. Flexibility and positive incentives should be the key words in the Clean Water Act rewrite.

All agricultural systems must be site-specific and flexible enough to allow changes in management practices when Mother Nature throws a curve. This year's crop season has been an excellent example of widely variable weather events with which the farmer must cope. If a farmer plans to "no-till" a field but excess rain causes harvest machinery to leave ruts, the farmer needs to be able to smooth out the

ruts with tillage without being charged for violating a conservation compliance plan. This kind of environmental enforcement has lost credibility with farmers. The environment is not improved, but the farmer's costs are increased.

3.0 ISSUE NUMBER THREE—DIVERSION OF HUMAN CAPITAL

The regulatory pressures of wetlands, clean water, endangered species, coastal zone management, and the anti-technology media hysteria that currently drives the policy debate are already imposing costs on farmers in terms of the human intellectual capital that is now diverted to unproductive regulatory activity.

More and more time and resources are being diverted from finding better ways to produce the bushel, bale, pound, and hundredweight to regulatory compliance. This is a cost not captured by most analysts. It is not captured in conventional data series. A day spent discussing whether a parcel of land is/is not a wetland is a day lost from thinking, planning, anticipating, studying the farm enterprise. A day spent worrying about future legal liabilities because current farm practices may not satisfy future federal regulators is a day lost for improving the farm business.

Command-control regulatory mandates for farmers are at odds with the basic nature of the business—production, enthusiasm, and excitement for what lies ahead. Command-control is negative, unproductive, and backward looking. More and more farmers of all ages, particularly younger operators, are being turned off or away by the obstacles they now have in land and water regulations. An industry cannot grow when its intellectual capital and entrepreneurs are discouraged by a clouded and risky regulatory future.

4.0 ISSUE NUMBER FOUR—LOWER ASSET VALUES

Constraints on farm resource ownership and uses will sooner or later translate into a lower income stream as land uses are restricted. With income potential reduced, asset values will surely decline. This economic issue poses substantial considerations for farm financial institutions, rural schools, and other institutions dependent on the tax base. Rural development will be penalized in the process of more federal water quality micro-management.

It is not true that farmers can find economic Utopia through restrictions in asset uses with the prospect for longer-term, higher commodity prices. This is not the way the world works. These lessons were learned through the production and marketing programs in the 1950s and 1960s and relearned in the early 1980s, as U.S. market shares declined, stockpiles accumulated, and government costs increased.

In the very short run, the idea of causing farm resources to be used less in order to drive up prices may hold. But longer term, a new equilibrium will be found unless all players in the world marketplace are forced to obey the same U.S. nonpoint source land and water rules. This is not a likely prospect.

Reichelderfer recognized the basic economic tradeoffs in her paper "Water Quality Legislation Affecting Agriculture."[6] She stated:

> As the prevalence of stricter environmental legislation increases, tradeoffs among the following sector-wide consequences will need to be considered:
>
> - Higher commodity and consumer prices;
> - Lower direct government expenditure for commodity price support;
> - Changes in farm income distribution, including:

- -- Higher feed costs and lower income for livestock producers,
- -- Higher aggregate income from crop production,
- -- Reduced income for producers directly affected by restrictions;

- Reduced demand for the services of upstream agricultural services (farm input industries);
- Less business for downstream agricultural industries (e.g., food processing); and
- Improved environmental quality, including safer drinking water for farm households and livestock.

Policymakers who fail to learn the lessons of resource use restrictions via regulatory controls or outright limits on farm production have not accepted the realities of the globalization of agriculture. Nor have they learned the economic lesson that living standards for all citizens cannot be improved by redistributing a smaller farm production pie. The pie must be made larger through the incentives of the marketplace and the spur of competition that allows free individuals to evolve creative low-cost solutions to water quality problems and at the same time fully participate in the increasing world demand for food, feed, and fiber.

5.0 ISSUE NUMBER FIVE—ZERO MUST GO

Extending the technology-based, command-control policy and regulatory regimes to nonpoint source problems raises the fundamental economic issue of zero pollution. Zero pollution is simply an uneconomical and impractical policy goal.

In a forthcoming paper "The 1991 Clean Water Act: Reauthorize, Reform, or Repeal?"[7] Meiners and Yandle write:

> Scientific evidence about the consequences of pollution tells us that we can stop short of zero discharge for many pollutants, but that we should strive for zero for certain toxic materials. **The old fixation on zero pollution is a barrier to effective, lower cost control.** If ambient quality standards are set for receiving waters, or the amount of pollutants that may be discharged are established, decision makers can solve the resulting problem. They know where they are headed; they must then find the most effective way of getting there. [Emphasis added by author.]

The overall environmental debate and the water quality debate seems to have matured beyond the naive notion that zero pollution is a workable policy goal. The debate seems to be refocusing not on the "either/or" questions, but rather the "how" question.

"How" do producers solve real environmental problems where these do exist at the lowest possible cost? With this question now being asked by mainstream policymakers, the debate has shifted away from the policy goal of zero pollution. This long-standing policy goal implied that producer and consumer costs do not matter. A shift from the goal of zero pollution to a goal of water quality improvement will be welcomed by farmers.

We now know that in the case of surface waters, streams can assimilate certain levels of pollution naturally. This should mean that scarce resources can now be allocated where these would yield the largest water quality improvements (and environmental gains).

In summary, abandoning the zero discharge and policy goal, except for proven toxic substances, should go a long way toward evolving real solutions to real nonpoint source water quality problems. Establishing realistic standards for water quality improvement is a substantially different objective than chasing the goal of zero pollution with ever-broadening command-control regulations and government-mandated technology.

Once realistic standards are set for runoff-water from farm operations all participants will have a clearer idea of where they are headed. Ideas for "how to get there" will soon emerge if other economic fundamentals like respect for private ownership are not violated and incentives are in place to find low-cost remedies.

Shifting away from the unrealistic goal of "zero discharge" and on to performance standards will mean a shift by regulators away from trying to micro-manage inputs to monitoring output. Competition forces cost minimization. Competition rewards genius, creativity, and entrepreneurship of those who innovate to meet the specified water quality standards. It punishes those with higher costs.

Farmers will respond as they always have to competitive forces provided the incentives are in place. In rewriting the Clean Water Act, policymakers would see substantial environmental gains to real problems *if* they make it clear that the policy is aimed at output results not input controls and that competition will be the driving force.

6.0 ISSUE NUMBER SIX—COST AND ENVIRONMENTAL EFFECTIVENESS

The Coastal Zone Management Act amendments made very detailed management recommendations for farmers for grazing, erosion, nutrients and pesticides, irrigation, and confined animal facilities. These measures and practices are well on their way to becoming the "farming law" in the states impacted by the CZMA. Policymakers are likely to extend these rules to the rest of the nation via the Clean Water Act reauthorization. At least two points need to be made.

First, it is not enough to look at the "macro" impacts of the proposed changes in farming practices in CZMA states. Totaling up the aggregate costs of Best Management Practices (BMPs) will in all likelihood mislead policymakers to believe that CZMA will not "cost very much."

The real cost of the CZMA regulations of land and water used in farming will be the cost imposed at the farm (firm) level of decisionmaking. For example, what will the new regulations do to the crop-livestock mix on a particular farm, the timing of field operations, production practices, size and structure of the farm unit? And to what alternative uses might the capital cost of the new regulations been used to make the farm more competitive? Perhaps more significantly from the standpoint of many producers, the potential risk and liability of "being wrong" has proven to be a high cost in trying to comply with wetland regulations.

Secondly, the environmental effectiveness of the proposed regulatory measures have not been proven. Before imposing the proposed regulatory costs on the CZMA farming region (or the nation's farmers via the Clean Water reauthorization) policymakers should know whether these actions will, in fact, improve water quality. For example, the 100-horsepower tractor pulling the appropriate tillage equipment has proven far superior for runoff water control than terracing.

The lack of understanding of the *real* costs of more land and water restrictions on farmers *and* the uncertainty about the environmental effectiveness of various regulatory prescriptions should cause policymakers to look for superior approaches which will: (a) discipline cost and (b) evolve the best and lowest cost methods for improving water quality. This would mean a complete shift in regulatory focus *from* micro-management of *all* farm activities that involve land and water *to* management of output, (i.e., setting realistic water quality standards, a timetable, and incentives for achieving these new standards).

7.0 ISSUE NUMBER SEVEN—RISK ASSESSMENT

It has been said before but it is worth noting again that once the links between water quality and nonpoint source problems have been identified in site-specific terms, the next step should be to determine what the risks are to both human health and to well-defined environmental values. Simply put, farmers cannot stay in production if zero remains the federal policy goal of acceptable risk for humans, plants, and animals.

As things now stand, the levels of chemicals allowed in the water are based on standards which have no scale for comparing relative risks from manmade chemicals to risks from "natural" chemicals. Present methods of risk assessment must be revised based on science and not the politics of the promise of risk-free living.

8.0 ISSUE NUMBER EIGHT—ECONOMIC IMPACT/IMPLICATIONS FOR NEW ENTRANTS

Those who fail to accept the globalization of the U.S. economy and particularly of U.S. agriculture will insist on extending the command-control technology-based prescription to nonpoint source contamination problems. Absent scientific proof of the cause-effect linkages between site-specific farm-level activities and production practices, such a generalized approach will penalize those farmers who, for whatever the reasons, are already at or below common-sense acceptable discharge levels. If this happens, one can expect the cost of production to rise unnecessarily for those who are already doing a "good job."

The example of mandating concrete bunkers for fertilizer and fuel storage facilities comes to mind. For those producers (and/or their supply cooperatives) who have superior management plans and practices and who have never had spills or leakage, this is an unnecessary and added cost. It contributes nothing to farm-level productivity improvement. A more enlightened approach would be to enact policies which reward, not punish, better managers. Markets are much more efficient at the reward/penalty process than regulators.

Farm structure will definitely change if command-control, technology mandates are extended to nonpoint source problems. New entrants—those without accumulated capital resources—will be forced to choose between investing in innovative farm production methods or pollution control investments which add nothing to farm productivity.

Increased federal pollution control mandates will translate into farm consolidations. Fewer and larger farm units which are financially equipped to "do what the regulators tell them to do" will soon emerge. This process is already underway. Many farmers are already to this point when they contemplate the cumulative effect of wetlands and fertilizer and pesticide aspects of their operations. Given the age of some farmers, present costs and future liabilities are not worth staying in business.

Instead of the traditional competitive, family-farm diversified structure, U.S. agriculture will be headed toward a corporate-state centralized large-scale farming system of a public utility variety.

Prescribing technology for pollution control will ultimately lead to federal regulators prescribing crop and livestock practices, and production and marketing controls. The only unregulated farm activity that will remain will be rates of return. Regulation of returns will surely follow once the centralized food production system leads to politically unacceptable food prices or unavailable supplies.

U.S. agriculture will, by discouraging young creative producers, be left with the exact opposite outcome—producers who know little about the art forms of food production and a lot about responding to federal regulators. Such an outcome is not indicative of growth industry status. Several analysts have noted the unequal distribution and impact of environmental regulations. These costs will fall disproportionately large on small- and mid-sized farm operations.

Ribaudo[8] captures many of these points:

Laws aimed at protecting water quality will affect farmers' pocketbooks. Farmers in critical or sensitive watershed areas could be faced with such actions as:

- Taxes on nitrogen fertilizer and pesticides.
- Mandatory soil conservation management practices, with or without government cost sharing.
- Bans on certain pesticides known to leach into ground water in significant quantities or known carcinogens.
- Regulations on land uses, on types of land on which chemicals can be applied, and on the quantity of chemicals used.
- Mandatory management practices for applying chemicals (for example, requiring injection instead of mixing chemicals with irrigation water).

Any of these actions could change farmers' operations. They could have to:

- Reduce inputs, particularly nutrients and pesticides.
- Use structural practices such as grassed waterways to reduce runoff and associated pollutants.
- Change tillage or other management practices.
- Change land use, such as altering the intensity of the crop rotation or converting land from row crops to hay.

Any of these changes could cut incomes if production costs increase, yields decline, or both. If fertilizers and pesticides are taxed, farmers will face higher production costs. Constrained fertilizer use will reduce crop yields. If specific pesticides are banned, farmers will have to shift to either more expensive or less effective chemicals, or cultivate more land.

Curtailing nitrogen use or banning heavily used pesticides **could mean yield losses for most major crops.** Pesticide suppliers could be hurt sharply by widespread bans on some chemicals. And, **farm income and corporate profit losses could be substantial....**

Restrictions on farming could affect local economies and the distribution of cropping activities. For example, some regions would face considerably greater yield losses than others if wide-ranging pesticide, fertilizer, or sediment restrictions are imposed. Regions affected less by environmental controls would acquire a competitive advantage over more affected regions, and production of crops that are affected by bans would shift to less affected regions. **Sensitive watersheds targeted for control would become less competitive as production costs rise for affected crops.**

Widespread changes in agricultural production, brought about by legislation to protect water quality, could affect crop prices. For example, banning important pesticides such as the triazine herbicides could significantly reduce corn yields and increase corn prices. Farmers would benefit from the higher prices, but consumer costs for food would rise from current levels. However, most steps taken to protect water quality likely will be local, not national, in scope . . . [Emphasis added by author.]

Richardson[10] explained what would happen to the economic viability of a representative 1,360 acre dryland Texas cotton farm under alternative conservation compliance regulations. Farms *forced to comply* with the High Residue-Basic System (planting a low residue crop in combination with a high residue crop) were shown to experience substantial reductions in net farm income, net worth, and their probability for survival. The approach by Richardson, et al, should give policymakers a clue as to what will happen to farm income, agribusiness, and the rural economy through water quality mandates at the farm level. In summary, if higher water quality is pursued through policies that change farming systems—crop mixes and cultural practices—there will be reductions in farm income. The economic reason for this outcome is that farmers are already profit maximizers. Farm system changes will increase upfront costs, likely mean higher annual operating cost and increase yield risks.

9.0 ISSUE NUMBER NINE—RURAL DEVELOPMENT

A regulation-induced reduction in farm numbers will surely translate into reduced opportunity off the farm in rural areas and communities. Larger farm units are not as likely to do business locally. These units will be large enough to buy direct from input suppliers, bypassing the services of local farm input suppliers. Maintaining the competitive family farm structure through a new focus on water quality standards would not have this negative impact.

10.0 WHERE FROM HERE?

Extending the proposals in S. 1081 and the Coastal Zone Management Act amendments to the Clean Water Act reauthorization will not be in the economic interest of the nation or farmers. Water quality improvements will be meager for the tax money spent and costs imposed on farmers and the private sector generally. These provisions violate the fundamental principles of property ownership and common-sense knowledge about the nature of the farm business. Water quality will not improve in proportion to the money spent and there will be extensive restructuring and dislocation among farmers and within rural America.

Citizen controls, controls on technology and farm practices, task forces without farmers (who have a major stake in the legislation), controls on conservation reserve program acreages and animal waste facilities, controls on fertilizer sales and use—these are the basic tenets of S. 1081.

S. 1081 simply follows along the same command-control path as the Coastal Zone Management Act amendments which have already extended the heavy regulatory hand of the federal government. The Coastal Zone Management Act considers livestock production not as an end in itself, but rather as a tool in overall "ecosystem" management. New production facilities will be expected to be built according to new management measures. There is no administrative vehicle for farmer input in the gamut of provisions that will negatively impact their lives and businesses. Both the CZMA and S. 1081 ignored the economic fundamentals discussed in this paper. We hope that Congress will not sweep these aside in the Clean Water Act reauthorization.

Given the significant economic implications for farmers and rural America, farmers are very concerned that the Clean Water Act rewrite should have substantial input from the Senate and House Agriculture Committees. Those bearing the economic brunt of this new law should have something to say about its provisions. There will not be a farm or rural community that will not be adversely affected by this forthcoming legislation. At a minimum, there should be extensive field hearings on this legislation.

Should Congress fail to recognize the fundamental economic issues raised in this paper, at a minimum, lawmakers should consider the following practical issues as it rewrites the Clean Water law.

Nonpoint source programs should be voluntary and emphasize the use of cost/benefit effective best management practices.

Nonpoint source information, incentives, technical assistance, and cost share programs with landowners are essential to success of a nonpoint source program. Limits on agricultural conservation payments should be removed. The concept of "trading" to reduce overall discharges should be considered as a potential incentive to land owners.

Water quality programs should be on a watershed basis using a "worst case first" approach.

Increased scientific research and evaluation is needed to determine the true extent and sources of pollution.

States should retain primacy for designating uses, determining impaired waters, establishing standards and criteria, and developing and implementing appropriate response programs and plans. Site-specific problems require site-specific responses. Development of state plans should rely heavily on local input.

State water rights and water allocation systems should be preserved for existing and future projects.

The current scope of the Clean Water Act should remain that of clean water and should not be expanded to one of biological diversity.

Any Clean Water Act reauthorization should include reform of Sec. 404 provisions affecting wetlands.

11.0 CONCLUDING COMMENTS

The real agenda in the national water quality debate is that the cost of further restrictions on point sources is very high relative to potential environmental gains and, therefore, it will be "cheaper" to impose restraints on agricultural activities (nonpoint sources). This naive assessment could produce substantial unintended economic consequences and little water quality improvement if policymakers fail to account for the importance of fundamental economic issues for the typical farm enterprise.

Further, in a recent Resources for the Future[9] assessment of the nation's renewable resource base, Frederick stated:

> The quality of a water body can be defined in various ways, including the effluents it receives; its chemical, physical, and biological attributes; and the socioeconomic benefits and costs associated with specific uses. The *National Water Quality Inventory: 1986* (U.S. Environmental Protection Agency, 1987) assessment of surface-water quality is based on state reports indicating whether state water resources are capable of fulfilling the uses designated by the states. The results of the inventory suggest that nearly 18% of the assessed rivers, lakes, and estuaries were capable of only partially supporting their designated uses, and that 7% were too polluted to support any designated uses. These percentages may overstate the national magnitude of the water-quality problem because the states tend to focus their monitoring resources on the waters most likely to have problems. Only 21% of the nation's rivers, 32% of the lakes, and 55% of the estuaries actually were assessed for the 1986 inventory. **If all the water bodies that were not assessed for the 1986 inventory had fully supported their designated uses, then 95% of the river miles, 92% of the lake acres, and 86% of the estuary areas would have supported their designated uses** (Fedkiw, 1989). Although this conditional calculation probably understates the extent of the nation's surface-water quality problems, it does help establish a range that suggests from 74 to 92% of all surface waters fully supported their designated uses. [Emphasis added by author.]

If Frederick's analysis is correct, now is hardly a time for policymakers to panic by adopting massive federal command-control policies and programs to further improve a relatively small percentage of the nation's surface water. Surely more cost-efficient and environmentally effective policies can be found which build on the long-standing conservation ethic of farmers, property ownership and control, market-based incentives, competition, and scientific research.

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Appendix A

- *Auglaize County "A Summary of Nitrate Concentrations..."*
- *Auglaize County dot map*
- *Tuscarawas County "A Summary of Nitrate Concentration..."*
- *Tuscarawas County circle map*

WATER QUALITY LABORATORY, HEIDELBERG COLLEGE, TIFFIN, OHIO 44883

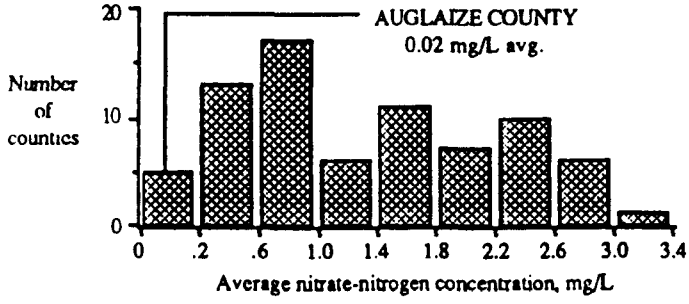
AUGLAIZE COUNTY

A Summary of Nitrate Concentrations in Private Wells

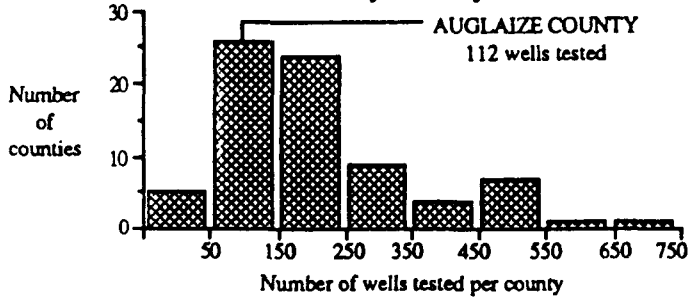
SAMPLES COLLECTED MARCH 1988

The concentrations of nitrate + nitrite-nitrogen, given in milligrams per liter (mg/L), were measured in 16,166 private wells from 76 Ohio counties. The following bar graphs indicate how Auglaize County compares with the other counties in terms of average concentration, number of wells tested, and the number of wells registered. The pie charts indicate the proportions of wells falling within four nitrate concentration ranges for Auglaize County and for all wells tested.

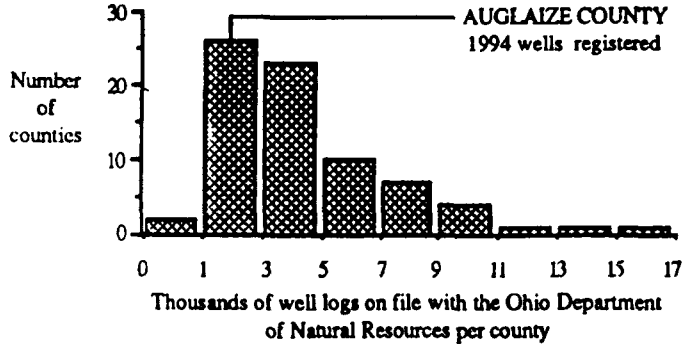
Average nitrate concentrations by county



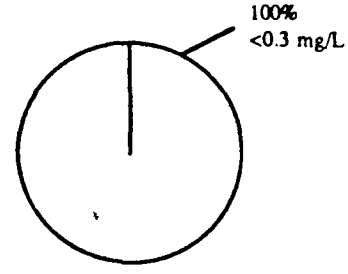
Number of wells tested by county



Number of wells registered by county

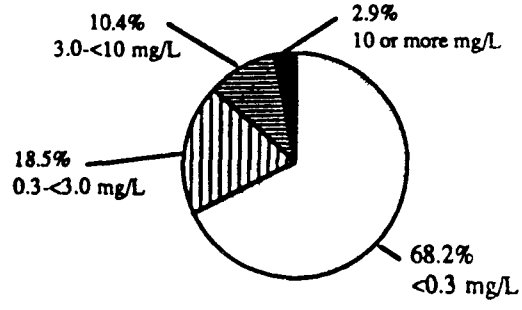


Nitrate concentrations in Auglaize County (average 0.02 mg/L)



112 wells tested

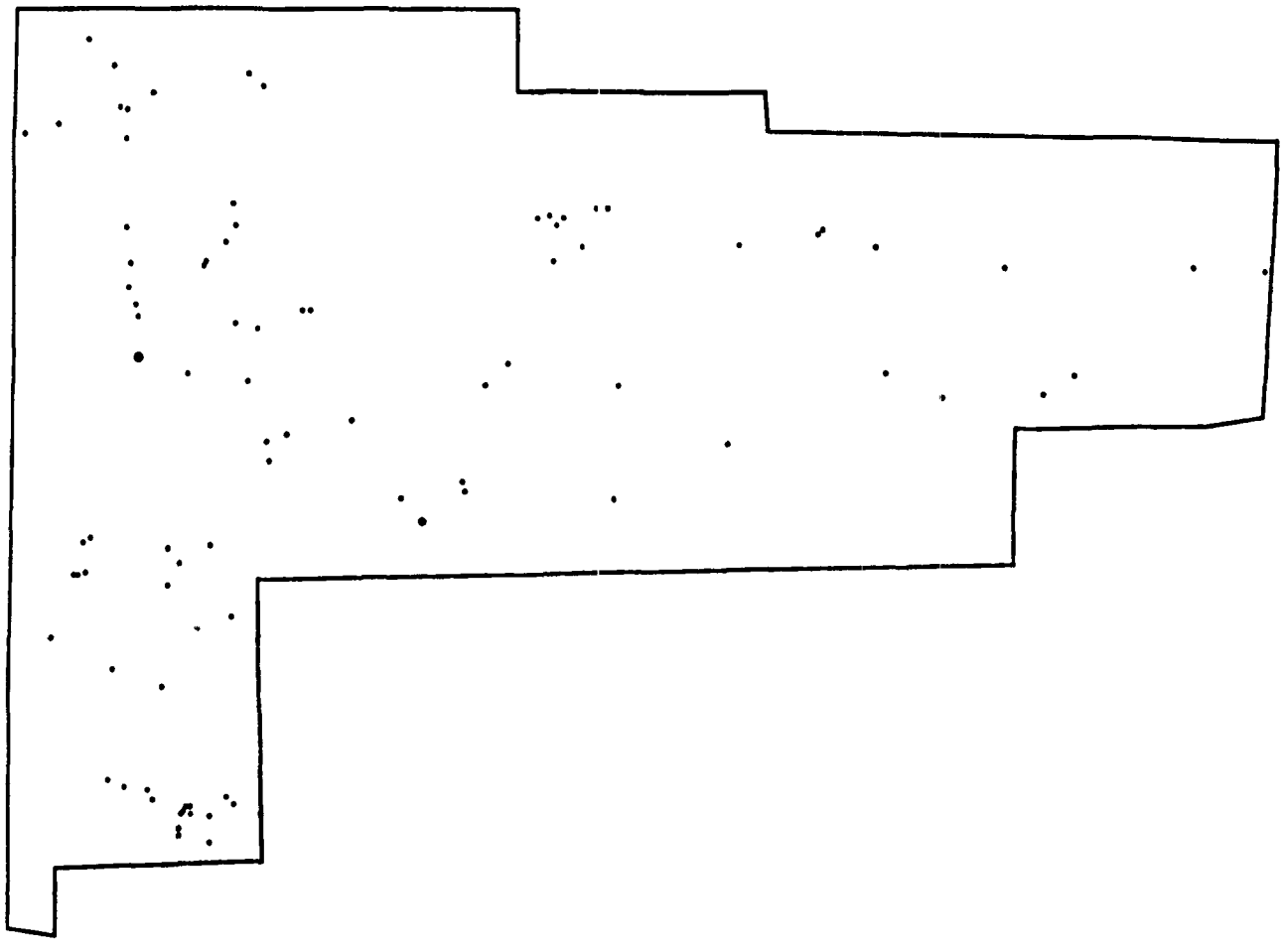
Nitrate concentrations in all wells tested (average 1.32 mg/L)



16,166 wells tested

Source: *Nitrate and Pesticides in Private Wells of Ohio: A State Atlas*

AUGLAIZE COUNTY



• 0.0 - 0.3 mg/L ○ 0.3 - 3.0 mg/L 3.0 - 10.0 mg/L more than 10.0 mg/L

Source: ***Nitrate and Pesticides in Private Wells of Ohio: A State Atlas***

WATER QUALITY LABORATORY, HEIDELBERG COLLEGE, TIFFIN, OHIO 44883

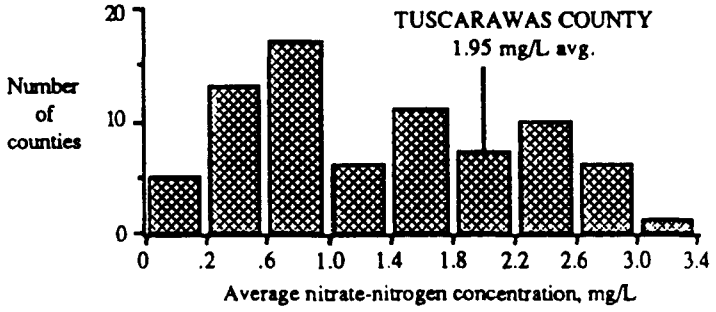
TUSCARAWAS COUNTY

A Summary of Nitrate Concentrations in Private Wells

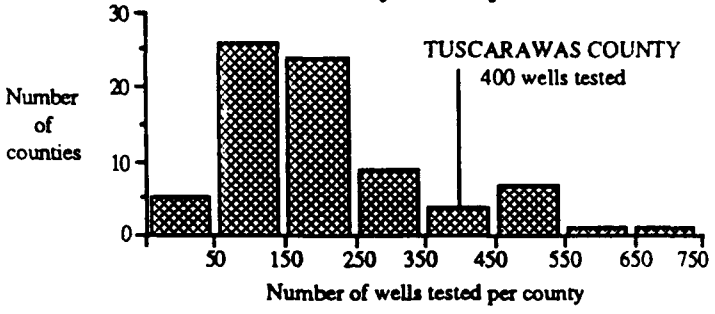
SAMPLES COLLECTED DECEMBER 1988

The concentrations of nitrate + nitrite-nitrogen, given in milligrams per liter (mg/L), were measured in 16,166 private wells from 76 Ohio counties. The following bar graphs indicate how Tuscarawas County compares with the other counties in terms of average concentration, number of wells tested, and the number of wells registered. The pie charts indicate the proportions of wells falling within four nitrate concentration ranges for Tuscarawas County and for all wells tested.

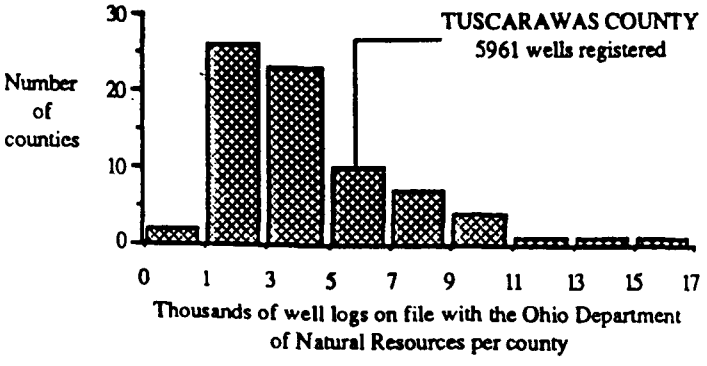
Average nitrate concentrations by county



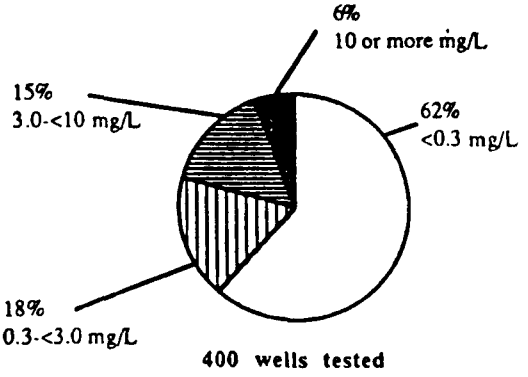
Number of wells tested by county



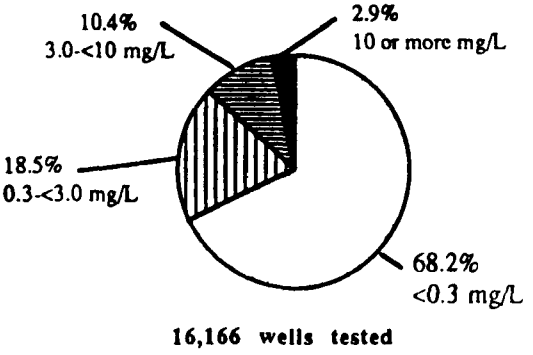
Number of wells registered by county



Nitrate concentrations in Tuscarawas County (average 1.95 mg/L)

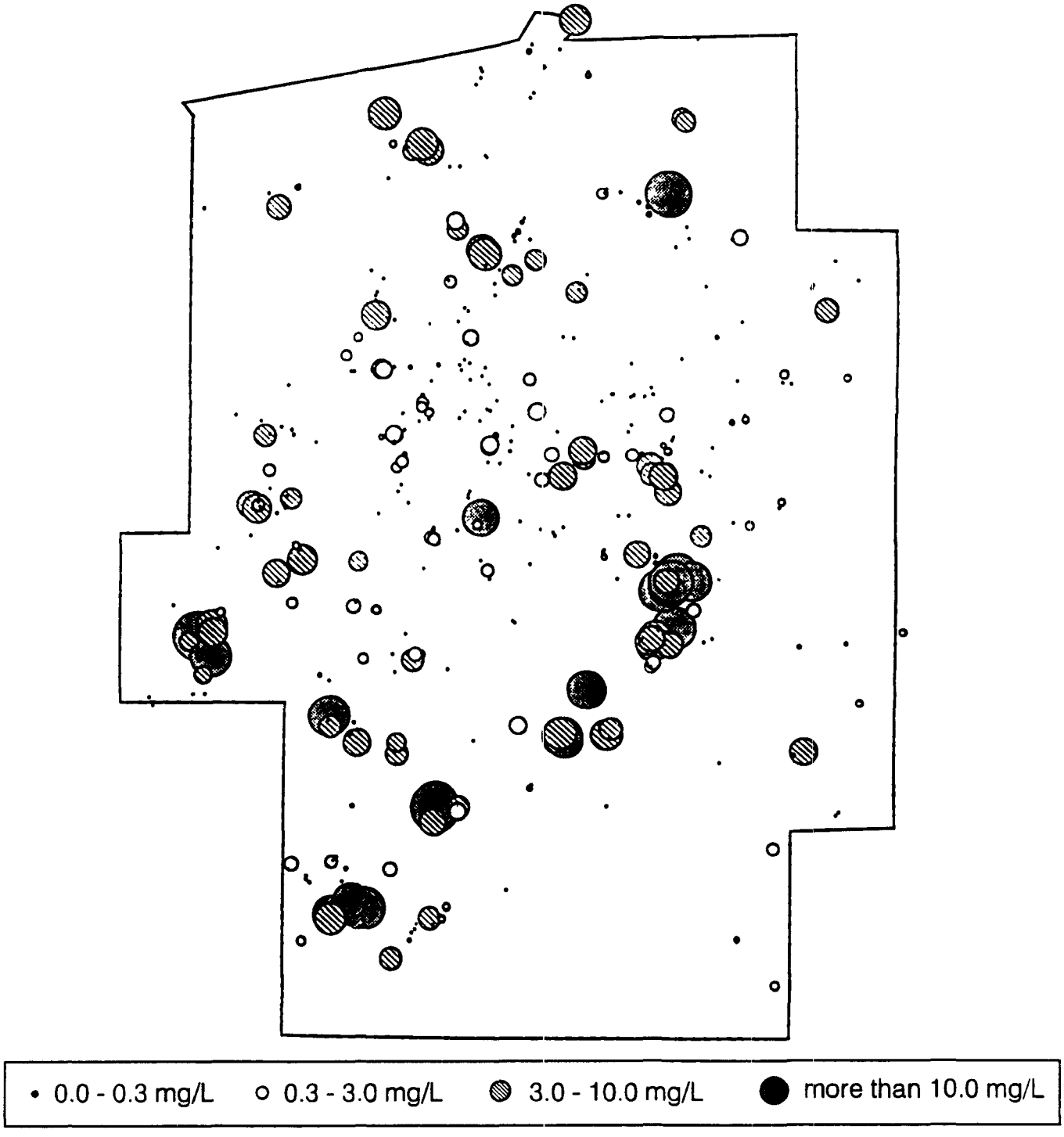


Nitrate concentrations in all wells tested (average 1.32 mg/L)



Source: *Nitrate and Pesticides in Private Wells of Ohio: A State Atlas*

TUSCARAWAS COUNTY



Source: *Nitrate and Pesticides in Private Wells of Ohio: A State Atlas*

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Evening Address

Fred Krupp
Executive Director
Environmental Defense Fund

I'm really glad to be here to talk about clean water and the American economy. And it's a special pleasure to talk to you, professionals in the area, who have a role to play in the amendment of the reauthorization of the Clean Water Act. It reminds me of what Humphrey Bogart told Claude Raines: "I came to Casablanca for the waters." I hope that I can add to this program by outlining what I think are EDF's ideas and my ideas about how we can harness market forces to save America's vast and abundant supply of water resources.

I think any discussion needs to start, and undoubtedly you've already started today, by noting the many successes we've had throughout the 20 years under the Clean Water Act. Especially with the worst sources of pollution—municipal sewage treatment, industrial facilities—these are much improved. The Cuyahoga River doesn't catch fire any more. But it's more than that. Raw sewage is no longer discharged into the rivers on a daily basis, only when it rains.

But NOAA also reported in a study released last year that toxic substances are declining in coastal organisms—stable or declining. So what we've gotten from the unprecedented amount of environmental regulation in the past few decades is solid progress on our most serious water contamination problems. And for the role that you have played in that, I congratulate you, because undoubtedly much of the success is due to the people right here.

But the hard part is that, in the last few decades, we have been confronting a handful of water pollution sources, the factories and the sewage treatment plants. And now we have to confront a myriad of sources, runoffs from fields, from lawns, from cars, and from highways. And it is because of those nonpoint sources that the Great Lakes are still imperiled by toxic contamination. It's because of those nonpoint sources that we still have a tremendous pollution problem that affects our waterways.

Last year, the Nature Conservancy reported that one-third of the common fish, two-thirds of its crayfish, and nearly three-fourths of its mussels are rare or imperiled. Michael Huglow from NOAA, the director of hydrology, predicts severe water shortages in the nineties.

I think we have to develop and enforce strict regulations to reduce pollution from point sources. I don't mean to imply that that job is over. But I think we also have come to the point where we need to recognize that nonpoint pollution is the chief culprit which has been invading the regulatory structure that we have out there.

As EPA estimated in 1989, of 17,000 polluted water bodies, rivers, and lakes, only 600 of them are polluted exclusively due to point sources; the others are a combination. And according to some estimates, perhaps as much as 60-70% of remaining pollution comes from nonpoint sources pollution entering our waters.

We have to admit that, for this sort of pollution, the Clean Water Act has been a failure. So that's the challenge before us. If municipal sewage treatment and industrial facilities were the challenges of the seventies and the eighties, nonpoint source pollution is the challenge of the nineties.

Bill Reilly said it best when he said clearly the problem is enormous. It's because this type of pollution is so hard to pinpoint, and because almost everyone contributes to the problem, it largely defies traditional command and control regulatory approaches.

Nonpoint source pollution is the sort of pollution that I believe requires a radically different approach. And I think we need to make way for the different approach in the amendments that are written for the Clean Water Act or through other means that make it easier for EPA to include incentives and other structures into experimenting with new methods into the Clean Water Act. And perhaps the conference can serve a role and recognize the importance in showing a new direction for nonpoint sources.

Now let me say once again, because I don't want to be misunderstood, that we need to continue plugging away command and control measures where appropriate. But for a different tool to supplement command and control measures that has great potential, I'd use the words "market incentives" to describe what I mean for that set of different tools.

What we need are policies that set goals, but leave the technical solutions up to business, governments, and consumers. The best example of this, of course, is the 1990 amendments to the Clean Air Act, tradeable pollution permits with regard to sulfur dioxide, to reduce sulfur dioxide emissions in this nation by 50% from electric power plants.

The reason that nonpoint sources are harder to control is that they come from so many sources. It's axiomatic, isn't it? And that's what makes the existing command and control dictate system in the potential. It's so hard to micromanage so many diverse sources. We just can't permit and regulate every parking lot and every farm yard. Instead, we have to look for a diverse array of opportunities and a variety of solutions.

Before I describe some of the ideas that have begun to be generated in this area, I think I should stress that there is more that needs to be done under existing authorities. I don't want to gloss over that. EPA reports that almost 90% of all sewage treatment plants and an even higher percentage of industrial facilities still meet federal and state water pollution control requirements.

But those requirements don't necessarily go far enough. Discharges and traditional pollutants, especially oxygen demanding waste from sewage treatment plants, do continue to impair our nation's waters, killing fish and aquatic animals. In many cases, these organisms, the mussels, fish, and other shellfish, are declining because we haven't controlled point sources thoroughly enough.

Combined sewer overflows are a very special problem, and as you know, they continue to spew billions of gallons of untreated wastewater into our nation's most valuable coastal waters, routinely causing closing of shellfish beds and endangering the safety of these waters.

Also, in many cities we're still allowing factories to dump too much industrial waste into our sewer systems that weren't designed to accept them. This continues to foul the treatment plants and contaminate the sludge which further causes a problem when it keeps the sludge from being used as a useful product.

All this is a far cry from what the nation had in mind when it passed the Clean Water Act in 1972, calling for the elimination of discharge of pollutants into navigable waters by 1985 and the prohibition of discharge of toxic pollutants and toxic amounts.

So the fact that these sources are meeting the EPA standards is cold comfort to Americans that can't eat the fish that they catch or drink the water set before them, or swim where their parents and grandparents swam. The public wants to know why the standards are being met and they still cannot eat the oysters. And I think it's a good question and points up the need to do more in both point and nonpoint sources.

Toxic substances are also a special category and it may be necessary to ban the discharge of highly dangerous and persistent toxic chemicals which have so contaminated our ecosystem. So I will just reiterate that there is much more we can do by enforcing existing clean water regulations, and we should be doing everything we can to do just that.

I don't think it's enough just to educate people out of the behavior which causes nonpoint pollution. I know Bill Reilly has said that education is the key, but we can't expect all farmers to use less fertilizers and pesticides, or all backyard mechanics to dispose of their oil properly, or all timber companies to change their harvesting measures simply by telling them that their current practices are wrong.

That's why economic and market incentives are so important, and why this conference is so important. We need to use educational messages to build a stronger environmental ethic. But we need to undergird those educational messages in that new ethic, with incentives and price signals that make it in people's economic interest to do the right thing.

What are some of these market-based solutions to water pollution? I want to mention pollution charges and market barriers, and then go on to discuss tradeable allowances, which I think offer somewhat more promise.

Pollution charges do have strong appeal because they provide incentives to businesses and consumers to reduce emissions. They can help internalize the cost of pollution and thereby force businesses and consumers to factor costs into their decisions. The excise tax on chlorofluorocarbons enacted by Congress three years ago, the gas guzzler tax, and the container deposit laws in so many states are all examples of pollution charges.

But one can imagine such an approach being used in the water pollution area. Why shouldn't there be, for instance, a tax on motor oil, to encourage each consumer to return and dispose of used oil properly instead of just pouring it into storm sewers? And perhaps a charge on fertilizers, pesticides, or other agricultural chemicals could also encourage the more efficient use of these products.

But I think that before we conclude that market incentives are synonymous with pollution charges, which they are not, we need to remember that there are problems with pollution charges and there are other market incentives for us to work with. The problems with pollution charges basically involve if you set the charge too low, the system explodes. You create the fiction among citizens that you have addressed the problem, but the charges are too low to actually affect behavior, so you are not reducing pollution enough. This has been a problem with many of the pollution charges that we have imposed to date.

You also have the problem that you are all sitting there thinking, perhaps, of the resistance of the American public to charges, because charges seem like taxes. Some would argue they are taxes, and clearly the reaction in this campaign and in other years to things like gasoline taxes points to the political problem there. Nevertheless, there is a role for pollution charges. My role here today is just to suggest that role is somewhat limited.

The second sort of market mechanisms that have a quick ability in the area of water pollution is removing perverse incentives or market barriers. There are lots of government policies which are incenting people to do the wrong thing, and we should get rid of as many of those as we have the political will and the courage to do (for example, the U.S. Forest Service sale of publicly owned timber below cost, which is wasting tax dollars, depleting our natural riches of overgrowth forest, and damaging our watersheds all the while).

Another example is the commodity price system and the income support programs that penalize farmers for leaving land fallow, that also penalize farmers for rotating crops. A farmer who accepts price supports cannot rotate to another crop unless he already has a base for that crop. Allowing a field to lie fallow lowers the five-year average used to compute payments. Thus, these farm programs, which

incidentally enroll some two-thirds of America's crop land, actively discourage practices that would reduce the need for pesticides and fertilizers.

Now, moving off pollution charges and the removal of these perverse incentives; I think they both have a role. They should be part of the market approach that we undertake. But the most underrated set of market-based solutions involves tradeable allowances. And it is the one that we should aggressively pursue, both for point sources and nonpoint sources in the water pollution area.

Under such a system, we could identify impaired water bodies and problem pollutants, and establish an overall reduced need to meet water quality standards, and allocate allowance levels among the point and nonpoint sources in these waters. Instead of mandating specific controls or numerical limits on each source, a trading system would allow them to buy and sell the allowances, leaving to the market the most cost-effective and innovative means to achieve or even exceed water quality goals.

The advantages of trading are numerous. Setting a cap or target level and allowing trades directly would address the volume of pollution, but they leave the technical solutions to each discharger to devise solutions that are most cost effective and unique to each situation. It brings the pollution control and entrepreneurial dynamism absent from the conventional command and control system.

The cost of compliance in an allowance trading system can gradually decline as entrepreneurs develop technological improvements that lower costs. For the first time with a program of tradeable allowances, the entrepreneur gets value from overcontrolling. And because there is value in overcontrolling, there is impetus to develop new methods of control.

An example I heard the other day from one of my colleagues on the president's commission, Dick Clark of Pacific Gas and Electric, is that when Congress was considering passing the conventional system to deal with sulfur dioxide, 112 plants were straightjacketed to do the same thing, with the same type of scrub runner on each plant. There was no incentive for anyone to come up with any different technology.

Instead, Congress passed a law that said we have to reduce sulfur dioxide by half, but you decide how to do it. If you overcontrol, if you overreduce your sulfur dioxide, you can sell that overcontrol to somebody else. Suddenly, entrepreneurs within Dick Clark's company, the largest utility in America, Pacific Gas and Electric, and inventors outside the company are rushing to him to say, we have a new way to reduce sulfur.

That's the sort of creative outburst that we have to unleash in the area of water pollution, specifically in nonpoint sources. That system, I might say, has received sort of the ultimate recognition in that the Chicago Board of Trade is actually going to start trading these pollution allowances next year.

I think, though, there are some real world examples of this sort of thinking starting to take hold in the water arena: EPA has cited the success of the Dylan bubble to reduce phosphorus discharges from point and nonpoint sources in Lake Dylan, Colorado. In this case, local governments bid this interest. The Denver Water Board and EPA came together to stop further degradation of Lake Dylan while allowing continued development of the watershed, to take advantage of the projected cost effectiveness of nonpoint source control as relative to point source measures.

The Colorado Water Quality Commission and EPA allowed point sources to cut back on their phosphorus reductions by one pound for every two pounds they removed from the watershed through investments in nonpoint controls. In one case, a town on the shore of Lake Dylan redesigned its storm water collection to reduce phosphorus discharges and thus can earn credit for its sewage treatment systems.

In that case, it was more efficient to reduce nonpoint discharges of phosphorus than it was to make expensive changes to the sewage treatment plant. Now the nonpoint trading has not occurred in the Lake Dylan case because of the decline in the area's growth and also because of lower than expected control

costs for the point sources; however, the new trading program did help catalyze the achievement of a regional water quality goal, and a workable trading system is in place should it be needed in the future.

EDF has developed a similar program in a far larger and more complex area of North Carolina's Tarp Pamlico River basin. This is an area that drains 12,000 square miles of land, including parts of 17 counties, and supports a population of 500,000 people. The river has experienced a serious nutrient problem in recent years, with agriculture being the major source. There has been a phenomenal increase in hog farming operations and in the number acres of soy beans, wheat, and corn that have been planted in the recent past.

Now what happened here, unlike the Lake Dylan situation, is that the need was to reduce nutrients now, as opposed to prepare for future growth. Like the Lake Dylan situation, the burden was going to be imposed on the municipal sewage treatment plants, and they would have had enormous costs to reduce the discharges.

The State of North Carolina, having determined that the river had too many nutrients going into it, had notified the local governments to reduce discharges from the sewage treatment plants. Now the local governments were, understandably at that point, complaining, why should they have to bear the responsibilities and costs, which farmers, the major sources of nutrient pollution, did not have to bear at all?

We shared that concern. It was inequitable and we're also dissatisfied with the limited scope of the state's nutrient reduction plan. And so we worked with local governments and state officials to design a new basin-wide plan that includes a trading program. Let me briefly outline the features of that program.

First, the discharges in the basin are funding the development of a model to help us understand the nutrient dynamics of the basin, including the relative impacts of different nutrients, different source categories, different loading points, and to help establish a long-term nutrient limit for Tarp Pamlico. EPA, I should mention, is also helping to fund the development of a land management model under the program.

Second, pending completion of the model and establishment of a long-term nutrient goal, the point source discharges would have to achieve the same overall reductions required by the state through a series of step-down annual nutrient reductions.

Third, instead of in-plant improvement, the dischargers can achieve the required reductions by payments to the state's agricultural cost share program to pay for installation of agricultural BMPs to accomplish the same reduction goal.

Fourth, the dischargers have conducted engineering evaluations at existing treatment plants to identify cost-effective improvements to reduce nutrient discharges. The results so far are that local governments in the Tarp Pamlico basin have found an improvement and produced reductions of 10% below their 1991 allocations. By 1994, these facilities will be at least 35% below 1989 levels.

Funds are also now available for targeting the most serious nonpoint sources, and the development of a more effective targeting and tracking system is underway. However, there are difficulties with such a system. We're still uncertain about the relative effectiveness of nonpoint source control, especially the actual reductions achieved, and how permanent those reductions will be.

So the mechanism in the Tarp Pamlico basin to distribute funds also seems somewhat weak in that the money from the trade, instead of going to a specific down-point program, goes to a fund administered by the state. I think that runs the risk of being influenced by political pressures, instead of documented needs. And it also puts government in a position well beyond monitoring and enforcing, which

may not be at all ideal if what we are talking about is setting up a system that creates an entrepreneurial dynamic.

Our involvement in Tarp Pamlico, however, has taken us into the finer points of tradeable allowances to reduce point and nonpoint source water pollution. And I think it suggests several general lessons that we should think about and try to incorporate into market mechanisms when we reauthorize the Clean Water Act.

First, we need more information from each basin impaired by pollution, including the contribution by nonpoint sources, as well as point sources, the goals for reductions by each source, and monitoring to determine compliance. It's very important to have a basin-wide approach, with enforceable basin-wide loading limits.

Second, the authority over nonpoint source controls should rest as close to the local level as possible and be based on natural watersheds, with point sources left for the state and federal officials to control.

Third, ultimate authority for implementation should rest with state and federal government, with the federal government if the state does not accept the authority, with interstate commissions for basins that cross state lines.

Fourth, local governments should be able to choose from a range of mechanisms, trading, BMPs, effluent fees and others. I don't want to oversell allowances as the only answer. I think flexibility to choose the most workable mechanisms should, however, be the core feature.

Fifth, and most important, the program established by the Clean Water Act should avoid specifying technical solutions for dischargers to meet the goals. States could approve plans for each basin, with oversight by EPA.

The crucial feature of this program to reduce water pollution from nonpoint sources has to be to develop enforceable goals while maximizing flexibility in fostering diversity. We should let market forces decide what works best. It may be wetlands restoration or some other tool that we can't envision now. The key thing is, the Clean Water Act should be spurring that flexibility and allowing the best intelligence to come to the fore.

In conclusion, let me say that it is early on in our thinking. I don't have all the answers, as you can see. We've really just begun to think about this. But I think we know enough to be excited by the potential of market mechanisms and to be cautiously optimistic that this is a way that we can solve our remaining serious water pollution problems.

We're on to something here. EDF is working hard to develop more specific strategies, and we need your help to develop strategies along these lines. Bill Reilly has said, nonpoint pollution challenges us to seek creative solutions. One thing I know for sure is that we're beyond the point in the next Clean Water Act of settling for more studies.

We've had enough good experiences with the few programs that have taken place, that we should try to establish a framework in the Clean Water Act now to facilitate trading and other mechanisms. We must stop the slide of water quality in America. And the potential for market-based solutions is real enough that we must be aggressive in developing these solutions.

Tuesday, October 20, 1992

Session 3: Recreation and Tourism

SESSION SUMMARY

MODERATOR: David G. Davis

PRESENTERS:

Charles F. Gauvin—Paper Unavailable

Mary Jo Kealy—*Clean Water and Recreational Use Support: Has the Clean Water Act Made a Difference?*

W. Douglass Shaw—*Recreation and Tourism Benefits from Water Quality Improvements: An Economist's Perspective*

R. Lawrence Swanson—*The Costs of Marine Debris Wash-Ups On New York and New Jersey Beaches*

Clean Water and Recreational Use Support: Has The Clean Water Act Made a Difference?

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ABSTRACT

The Nation's lakes, rivers, and ocean waters are frequented by Americans at leisure. Surveyed citizens over 12 report annual participation rates of 76% in swimming, 59% in fishing, and 27% in motorboating, for example. Others simply enjoy viewing aesthetically pleasing watersites. The language of the Clean Water Act (CWA) reflects the importance that Americans place on water-based recreation by expressing goals in terms of recreation use support. We attempt to demonstrate that the CWA has been good for recreation, but that there is still room for improvement. Values for three pollutants, biochemical oxygen demand, total suspended solids, and fecal coliform, are used as indicators of use support both with and without the CWA. For the 630,000 river and stream miles (Reach File 1) included in our model, simulations suggest that further reductions in discharges by point sources would do relatively little to improve the quality of these three pollutants. However, reductions in nonpoint sources could produce improvements that surpass past water quality achievements.

1.0 INTRODUCTION AND BACKGROUND

The Nation's lakes, rivers, and ocean waters are frequented by Americans at leisure. Surveyed citizens over 12 report annual participation rates of 76% in swimming, 59% in fishing, and 27% in motorboating, for example[1]. Others simply enjoy viewing aesthetically pleasing watersites. The language of the Clean Water Act (CWA) reflects the importance that Americans place on water-based recreation by expressing goals in terms of recreation use support. We attempt to demonstrate that the CWA has been good for recreation, but that there is still room for improvement. Values for three pollutants, biochemical oxygen demand, total suspended solids, and fecal coliform, are used as indicators of use support both with and without the CWA. For the 630,000 river miles in our model (i.e., Reach file 1), simulations suggest that further reductions in discharges by point sources would do relatively little to improve the quality of these three pollutants. However, reductions in nonpoint sources could produce improvements that surpass past water quality achievements.

By limiting this preliminary analysis to just three pollutants, we cannot draw any conclusions about beneficial use support attainment. However, this analysis is illustrative of and provides a framework for a more complete assessment. To more fully characterize beneficial use support within the present modeling framework, it remains to control for both toxicants and nutrients. Also, it remains to extend the framework to include more rivers and streams as well as to bring lakes, and estuaries into the analysis.

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[1]President's Commission on Americans Outdoors

The objectives of this study are to develop and apply a methodology for assessing the effects that the Act has had on surface water quality over the past 20 years and to evaluate alternative national policies for improving water quality. Surface waters are complex hydrologic/chemical/biological systems in which the effects of pollution are often poorly understood. We developed a model, the Clean Water Act Effects Model (CWAEM), to relate changes in discharges to changes in water quality and beneficial use attainment of the Nation's rivers and streams. The beneficial uses include recreation activities such as boating, fishing, and swimming. Although our current emphasis is on recreational beneficial uses, other beneficial uses (e.g., drinking water, non-use values, commercial fishing, industrial uses) may also be enhanced by the water quality improvements associated with the different policy scenarios.

Before the CWA, there were literally thousands of uncontrolled point sources, particularly in urban areas. Also, many municipalities had primary waste treatment only, and much of the "secondary" treatment was less than adequate in many others. With the aid of the Construction Grants program, a direct outgrowth of the CWA, municipal treatment plants upgraded substantially. "As of October 1990, most major point sources were meeting their permit limits: 15% of major municipal plants and 13% of directly discharging industrial facilities were in significant noncompliance with applicable permit conditions" (U.S. EPA, 1992:xix). Finally, the CWA has had a significant effect on control of toxicants, principally from industry. "EPA estimates that toxic pollutant loadings to POTWs have decreased by up to 75% through pretreatment" (U.S. EPA, 1992:142). The rates of noncompliance with pretreatment requirements (i.e., approximately 14 to 17% of significant industrial users) are similar with those for the major industries in the NPDES program. However, these statistics do not reflect the failure of 39% of POTWs to fully implement their approved pretreatment programs (U.S. EPA, 1992:142). Although the current scope of this study does not include evaluation of toxic pollution reduction, work is continuing to develop methods for the evaluation of toxicants in the current analysis framework.

Programs to reduce nonpoint sources of pollution have lagged behind point source controls (U.S Comptroller, 1977 and U.S. Council on Environmental, 1979). These nonpoint sources include runoff from agriculture, construction, and urban areas and from areas such as forests. The 1990 National Water Quality Inventory Report to Congress ranks agricultural runoff as the leading source of use impairment in rivers and streams. Other major sources of impaired rivers, streams, lakes, and estuaries include: hydrologic/habitat modification, municipal discharges, storm sewers/runoff, resource extraction, and land disposal.

Beneficial use determination remains an inexact science--one subject to considerable debate. Relevant use information is available in State 305(b) reports, which summarize beneficial use support by State, and in national water quality monitoring databases such as the USGS NASQUAN network and STORET. Use of the 305(b) reports is limited because of the inconsistency in assessment methodologies used by the States and limitations on the extent of monitoring done by the States. The Environmental Monitoring and Assessment Project (EMAP), currently being developed by EPA, will provide a statistical evaluation of the overall quality of the Nation's waters; however, results will not be available for several years.

The approach used in this study is to develop a national water quality model that can simulate existing conditions and, for example, the following alternative scenarios:

- No CWA - Conditions had the CWA never been passed and no other legislation been enacted in its place;
- Zero discharge - Conditions had the original CWA goal of eliminating ALL dischargers been reached; and,
- Reduce non-point source loadings by half - Conditions if these reduced loadings occur over and above current conditions with the CWA.

Refinements to the model will permit a much richer set of policy simulations.

Two studies undertaken in the early 1980s are relevant to the current work. The first effort, led by Resources for the Future (RFF), built a national surface water network with point source and NPS loadings assigned to 1,051 nodes. This work used a variety of data sources for loadings, flows, and modeling parameters. The RFF model has been used to evaluate point source controls in combination with agricultural sediment control. The second study of direct relevance is the COGENT model, undertaken by the EPA Construction Grants Program. COGENT used the NEEDS survey databases and the USEPA River Reach File 1 (RF1), a much more detailed river network than that used by RFF. The objective was to model the water quality changes resulting from treatment plant construction. COGENT modeled effects in terms of improvement in dissolved oxygen (DO) concentrations. Detailed sensitivity analyses showed that the model was very sensitive at low flows and shallow slopes, which are the conditions under which waste treatment has the most effect. Because the model results could vary widely with very small changes in input parameters, more detailed calibration efforts were needed. Based on results of these earlier studies, we developed a modeling effort that uses a more detailed network than the RFF model and, in response to model sensitivity issues, applies simpler model kinetics than COGENT.

2.0 CONCEPTUAL FRAMEWORK

The conceptual framework for the analysis is shown in Figure 1. The boxes with solid lines represent attributes of the framework that are include in the present analysis; whereas, the boxes with dotted lines identify anticipated extensions. Beginning in the upper left hand corner and moving clockwise, the CWA limits discharges from point sources and nonpoint sources into the nation's rivers and streams. Ambient water quality improves and, therefore, supports additional beneficial recreational uses such as fishing and swimming. These beneficial uses provide benefits in terms of improved health and economic well-being of humans. They also relate to the improved health of the ecosystem. These changes in ambient water quality, beneficial use support and economic and health benefits all provide a basis for assessing the effectiveness of policies for controlling discharges. The results of this preliminary and incomplete assessment cannot be used to inform the choice of policies for controlling discharges. However, the model design can accommodate the necessary refinements, which if carried out, could be used to evaluate and compare policy scenarios.

A guiding principle in developing the CWAEM is to start with relatively simple model kinetics and parameters so that model behavior can be evaluated effectively. After these simple relationships are fully understood, the model can be expanded to more complex kinetics and parameters.

Using the framework in Figure 1, CWA effects can be evaluated with two state variables:

- With and without the CWA implemented
- 1990 and early 1970s.

Various scenarios are possible using these two state variables, including:

- 1990 with CWA implemented
- 1990 without CWA implemented
- 1990 with zero discharge
- 1990 with NPS loads reduced by half
- Early 1970s without CWA implemented
- Early 1970s with the CWA implemented

Below, we use current conditions (i.e., 1990 with CWA implemented) as the baseline and compare the other model simulations to it. The model outputs are expressed in terms of the number of river and stream miles supporting particular beneficial uses. The parameters that determine beneficial uses in our model are

described next. Then, we conclude this section with a discussion of the limitations and strengths of our approach.

2.1 Selection of Model Parameters

Methods and criteria for beneficial use determination vary, sometimes widely, by State. A uniform method for relating beneficial use to water quality is needed to follow through the conceptual framework shown in Figure 1.

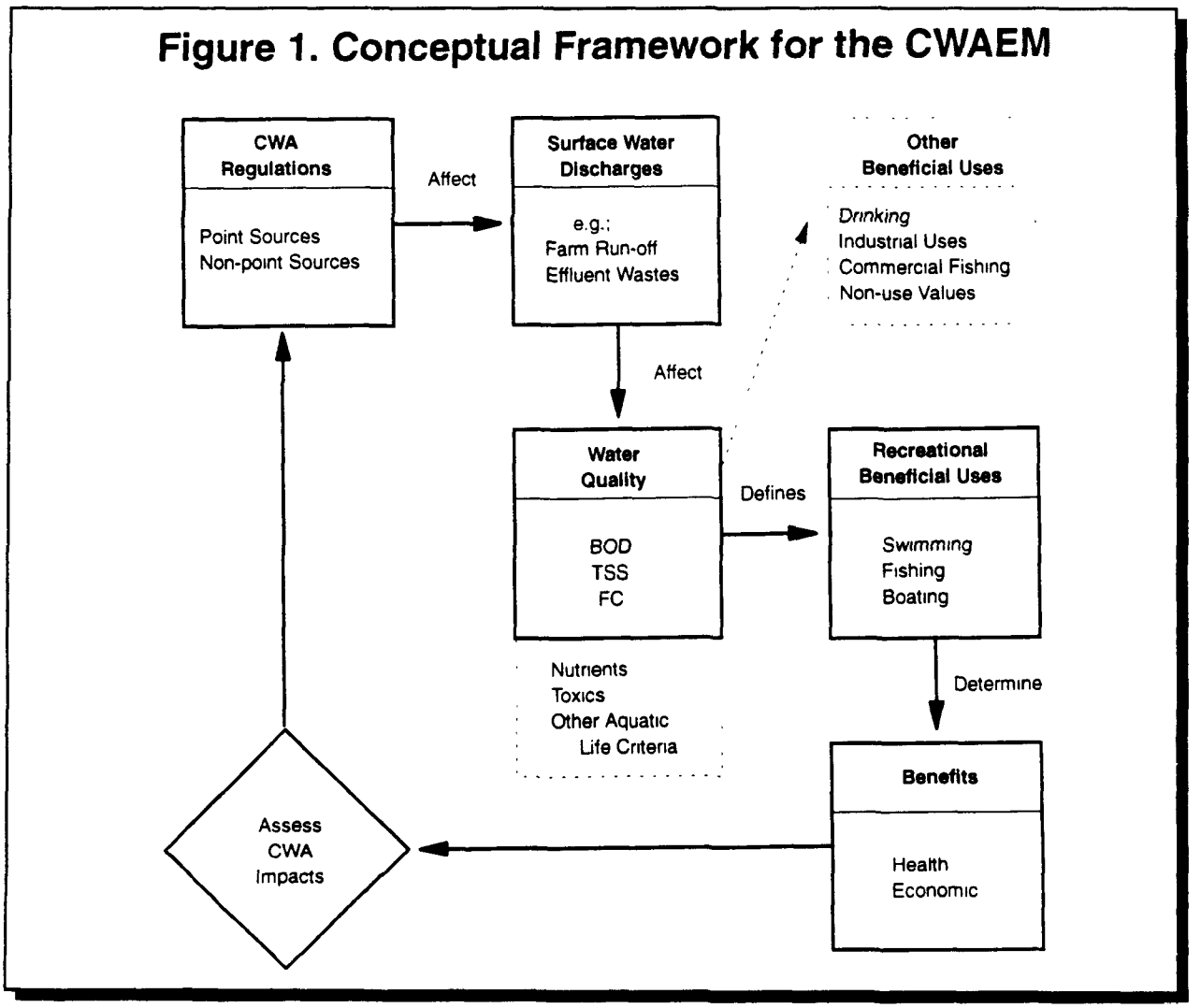

Figure 1

RFF has developed a "water quality ladder" that relates a selected set of water quality parameters to beneficial uses (Vaughan, 1986). The water quality parameters are DO, BOD, turbidity, pH, and FC. In addition to these parameters, toxicants, temperature, and salinity are important influences on recreational beneficial uses. However, this preliminary analysis uses only a subset of these water quality

parameters. A modification of the ladder is feasible using BOD and FC concentrations directly and using TSS as a surrogate for turbidity.[2]

Table 1 shows the modified water quality ladder used in the CWAEM. The model assumes that, if any one parameter exceeds the maximum value in the table, then the water does not meet that beneficial use. For example, to be classified as drinking water, the concentrations for BOD5, TSS, and FC cannot exceed 0.5, 5, and 2,000, respectively.

Table 1

Maximum Value for Use Category

Beneficial Use	BOD_5 (mg/L)	Turbidity (JTU)	FC (#/100 mL)
Drinking[3]	0.5	5	2,000
Swimming	1.5	10	2,000
Game Fishing	2.4	40	10,000
Rough Fishing	3.6	60	10,000
Boating	4.0	100	20,000

BOD, TSS, and FC standards are necessary, but not sufficient for indicating recreational beneficial use support. Nonetheless, they have been selected as the model parameters for the CWAEM for the following reasons:

1. Point source estimates for 1990 and early 1970s are most reliable for BOD, TSS and FC;

2. Non-point source loadings of BOD, TSS, and FC are available by county.

3. Removal efficiencies for BOD, TSS, and FC using conventional primary, secondary, and tertiary treatment technologies are well known and readily defensible. Instream water quality modeling of BOD, TSS, and FC can be performed using simple but highly defensible first-order decay and settling kinetics;

4. A modified water quality ladder can be used for BOD, TSS, and FC to provide a partial assessment of recreational beneficial use attainment; and,

5. The model using BOD and TSS is amenable to a retrospective analysis because waste treatments have consistent and well-documented effects on BOD and TSS

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[2]We apply a one to one correspondence between Turbidity measured in Jackson Turbidity Units (JTUs) and TSS measured in milligrams per liter (mg/l). The original development of the JTU scale was based on a one to one correspondence between turbidity and concentration in mg/l of a stock of a silica solution. Therefore our use of the one to one correspondence between JTUs and TSS goes back to the original development of the JTU scale (Stern and Stickle, 1978).

[3]The inclusion of the category "drinking" is for consistency with the RFF water quality ladder, only. It is not intended to imply that the surface water quality meets the water quality standards under the Safe Drinking Water Act.

discharge concentrations. For instance, taking 1990 discharges to non-CWA levels can be done by changing the existing concentrations to typical primary treatment values. For prospective analyses the model can accommodate a much wider range of pollutants.

Several parameters were considered, but not chosen, for inclusion in the model. As discussed in the introduction, DO modeling on this scale has severe problems with model sensitivity. DO deficits are directly related to use support and are a primary part of most instream water quality models. However, DO was not included in the CWAEM because of the difficulties inherent in national DO modeling. Reaeration coefficients are a primary determinant in how much DO deficit results from BOD decay, and reaeration coefficients are very site-specific. Extensive site-specific data collection efforts are usually required to properly calibrate a DO deficit model. Other components to consider in modeling DO include benthic demands and algae growth. Although DO modeling has great potential value, its complexity is not justified at this stage of model development. pH also presents serious modeling difficulties because of the complex interactions that affect pH, including buffering effects and atmospheric deposition.

Toxicants were not included in the model because methods for estimating the changes in toxicant releases, especially as they relate to the CWA, are not fully developed. Research has begun for future inclusion of toxicants in the CWAEM.

Nutrients are a major cause of use impairment primarily because they promote algae growth. Their inclusion would require the modeling of changes in nutrient loadings due to the CWA, estimation of changes in algae growth, and estimation of effects on use impairment. This type of modeling is quite complex on a local level, let alone on a national level. In addition, issues such as nutrients from atmospheric deposition and phosphorous discharges resulting from phosphate bans must be resolved before nutrients can be included in the CWAEM. Nonetheless, we are investigating databases and analysis methods for inclusion in the model. For example, USGS is developing concentration regressions as a function of loadings in order to explain how loadings may affect water quality.[4]

2.2 Study Limitations and Strengths

This study should be viewed as illustrative, only. In interpreting and using the results of this study, the following limitations apply:

1. Until the model calibration process is completed, the model is not valid for estimating the number of miles supporting beneficial uses. The model does support relative analyses and therefore can explain relative differences in the number of miles that support beneficial uses corresponding to the different policy scenarios.

2. The current analyses use the conventional pollutants, biological oxygen demand (BOD), total suspended solids (TSS), and fecal coliform (FC), as indicators of support rather than absolute determinations. The effects of dissolved oxygen, nutrients and toxicants, for example, are not included. This means that the model using these three parameters only overstates beneficial use attainment when DO, nutrients, or toxicants are limiting factors.

[4]Personal conversation with Dr. Richard Smith, USGS, December 1, 1992.

3. The analysis framework, Reach File Version 1 (RF1), includes over 630,000 miles of the larger rivers and streams in the continental United States.[5] The model results cannot be extrapolated to the remaining river and stream miles, lakes, estuaries, or ocean waters. Although RF1 does not represent a scientifically or statistically based subset of the nation's rivers, it does contain most of the larger rivers and streams and 85% of the point source dischargers in the combined NEEDS/PCS database used in the present study. Further, it is the most detailed national-level hydrographic network known that also contains the critical linkages to point sources, counties, flow estimates, and storet water quality data.

4. Currently, the model is based upon national parameters rather than site-specific or region-specific parameters. This limits the applicability of the model to national assessments.

5. Point source discharges from minor industrial sources and other minor untreated discharges are not included. The point sources used include most municipal discharges plus the major industrial point sources. However, by definition, minor industrial sources contribute relatively minor discharges into receiving waters.

6. Other sinks and sources such as sediment re-release, atmospheric deposition, and influences of wetlands and groundwater on surface water quality are not integrated in the present model.

With the above limitations in mind, this study has the following strengths:

1. The CWAEM uses the most complete and detailed data sources available on a national level. The data are described below. Although this preliminary analysis uses national parameters, it is important to note that the underlying data can support the development of regional versions of the CWAEM.

2. Extensive testing of the model using a wide range of calibration values has shown that, although the absolute numerical estimates vary, the relative differences between scenarios remain fairly consistent across parameter values. With further calibration and validation, the model should eventually support valid estimation of absolute numerical values corresponding to current baseline conditions and the alternative policy scenarios.

3. The model can be used to identify the geographic locations of water quality improvements due to the CWA, for example. Additional analyses concerning economic and health effects are therefore possible. This capability of the model can be improved further using regional, rather than national parameters.

4. The model employs consistent criteria to relate changes in discharges to the CWA goals of beneficial use attainment and is therefore, policy relevant.

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[5]RF1 was completed and installed at USEPA in 1982. It is based on the 1:2,000,000 scale NOAA aeronautical chart hydrographic layer. RF1 contains approximately 68,000 reach segments with approximately 630,000 miles of rivers and streams covering the continental U.S. (Alaska and Hawaii are excluded from RF1). In comparison, the total length of rivers based on compilation of state 305(b) reports estimates 1,221,540 miles and the 1:100,000 scale USGS Digital Line Graph database estimates 3,591,840 miles in the continental U.S.

5. The model will accommodate the inclusion of additional water quality parameters, particularly toxicants and nutrients.

Given the objectives of our analyses, we believe that the strengths of our approach outweigh the deficiencies. Next, we describe the model, including our data sources, sensitivity analyses, and scenario development.

3.0 MODEL DESCRIPTION

Currently, the CWAEM runs on EPA's IBM mainframe computer at Research Triangle Park.[6] The results are saved as data files, which are available for further evaluation. Each scenario requires a separate run of the CWAEM.

3.1 Input Data

A major part of the CWAEM development effort has been expended in developing a valid methodology for assessing the effectiveness of the CWA and in assembling the necessary input data files. These input files are summarized in Figure 2. To date, the CWA has affected pollution release primarily through point source controls, most notably wastewater treatment. Modeling of waste treatment effects can be a key component of estimating CWA effects, and point source discharge data are key to the model development. We reviewed existing discharge data availability, with the following conclusions:[7]

1. For 1990, good data exist for conventional and many toxic pollutants for point sources. The NEEDS88 database is the best source for municipal discharges of conventional pollutants. The Permit Compliance System (PCS) is a good data source for major point source discharges. The NPS data contain separate urban and rural loadings estimates for each county.

2. For the early 1970s, discharge data are very limited. Data on conventional measures, especially BOD and TSS, are available in generalized forms. Toxics data are almost nonexistent. The National Residuals Discharge Inventory (NRDI) is the best overall source found to date, especially for BOD and TSS. The NEEDS88 database contains the 1972 population, which can be used for developing municipal loadings estimates. Industrial loadings estimates will require somewhat more "creative" methods.

3. EPA-Cincinnati has developed a wastewater "treatability" database that covers a wide range of parameters and treatment types. This database is defensible and can be incorporated as needed, especially for toxicants.

The model also includes data on discharges due to the macroeconomic output effects of the CWA. Generally speaking, to the extent that the CWA has increased industry costs and dampened output, the corresponding effluent discharges are expected to have declined. However, a study conducted in parallel to this work (U.S. EPA, 1992) estimates that the changes in economic output due to CWA costs are generally less than 1%. We assume that the level of discharges are related directly to the level of output and incorporate these changes in evaluating the "no CWA" scenario.

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[6]We are investigating transforming the model to a personal computer platform.

[7]We have not conducted an independent assessment of data quality and we are relying upon the quality assurance practices of the data sources. However, USGS is conducting quality assurance on these data and we may run the model using their data when they become available.

CWA wastewater treatment requirements are met primarily with end-of-line treatment with some local pretreatment for toxicants as needed. Once an industrial plant is required to treat wastes, water consumption is usually reduced 30 to 40% through recycling and more efficient water use. This water reduction has little effect on cost and is fairly easily accomplished.

The NPS loadings estimation techniques developed by RFF were determined to be the best approach for the CWAEM. These methodologies develop estimates by county, which can be integrated with RF1. The estimates were updated to 1990 conditions and also developed for 1972 to evaluate pre-CWA conditions.

3.2 Water Quality Model

Water quality estimates are developed by combining data from the files shown in Figure 2 into a reach routing dataset in SAS. Instream estimates of BOD_5, TSS, and FC concentrations are generated using the loading estimates, mixing with mean flows, and then applying first-order decay using the corresponding mean flow velocities (Fair et al., 1971; Weber, 1972; Bowie, et al., 1985). The river flow and velocity estimates are specific to each region in the network and were developed using data from 9,127 gaging stations (Grayman, 1982). The decay kinetics for TSS incorporate a velocity-dependent term to reflect settling. These concentrations are then compared to the modified water quality ladder to determine beneficial use category (fishing, swimming, etc).

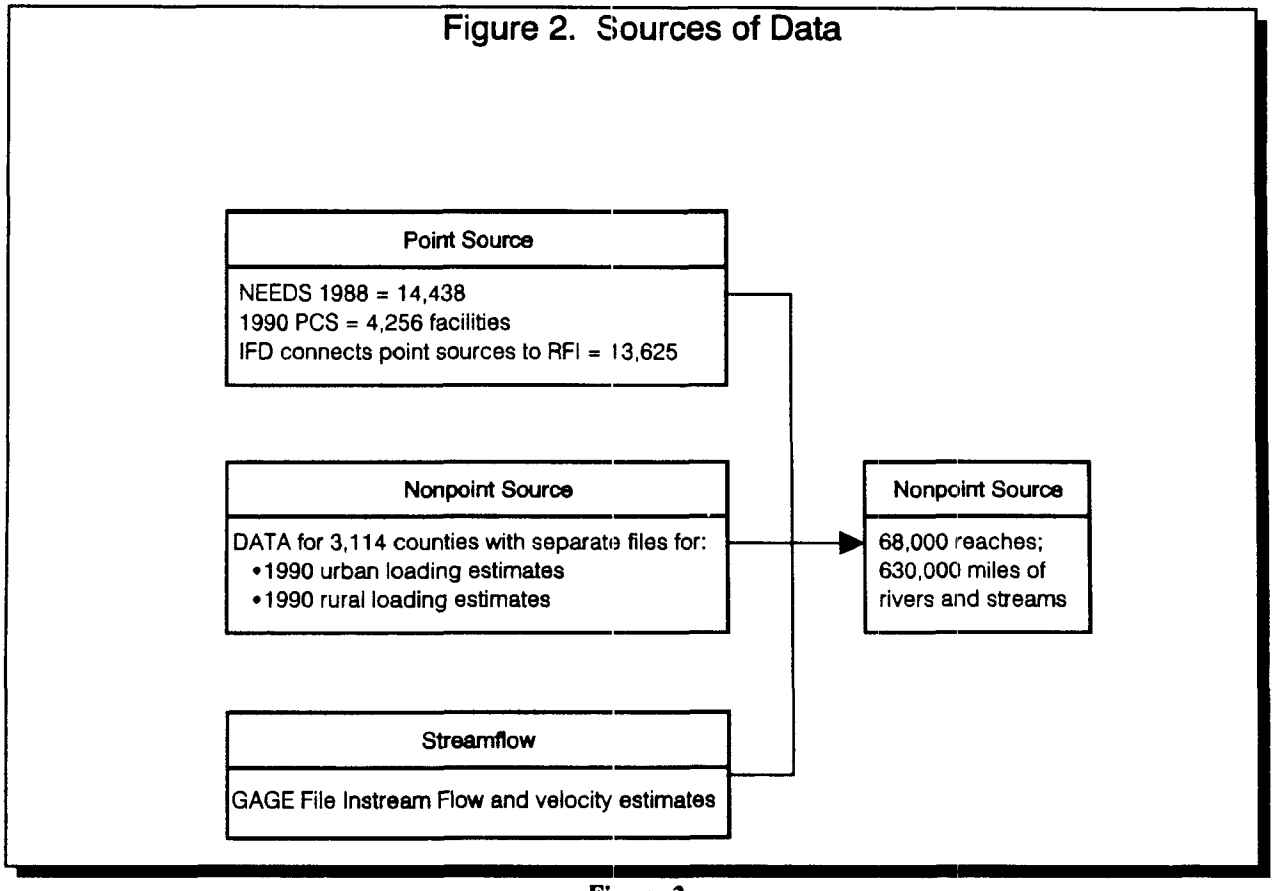

Figure 2

The NPS loads for each reach are divided, with half of the load put in at the top of the reach and half put in at the middle; this distributes the NPS loads along the reach. A uniform sediment delivery ratio (SDR) is applied to the NPS loads before putting those loads into the river. The SDR reflects

the behavior of NPS loadings in that much of the load first goes into smaller tributaries or across other land so that the net load on the river is significantly attenuated. The SDR has a major effect on the net NPS loads, with SDR values of 0.10 or less being common; an SDR of 0.10 translates to only 10% of the NPS load being put into the river model. The CWAEM has been tested and refined using SDR values between 0.10 and 0.01.

The point sources are injected at the river mile as assigned in the Industrial Facilities Discharge (IFD) file. The reaches in RF1 are divided as needed to incorporate the point source and NPS loads. Each of these sections is given a beneficial use classification based on the worst water quality conditions in that section. The entire section of reach is assigned that use classification. A total of 125,357 reach segments are modeled. Total miles for each use category are then tabulated based on the length of that section. Beneficial use frequency statistics are generated showing total miles supporting each beneficial use.

3.3 Model Sensitivity

Sensitivity of the model to load and flow estimates is analyzed. The sensitivity analysis is performed by changing all input parameters by 10% and comparing these results. If the results within the 10% "window" are radically divergent, then the model may be "hypersensitive" to one or more input parameters. In this case, further analyses can determine which parameter(s) are causing the sensitivity, and efforts can be directed to evaluating and perhaps improving the model reliability.

The following model inputs are varied 10% with each run:

1. Reach file flows
2. Reach file velocities
3. Point source loads
4. Nonpoint source loads
5. Use criteria limits
6. Decay coefficients
7. Treatment efficiency assumptions
8. Industrial sector production coefficients.

For the "increased use" run, the coefficients are varied in the direction that will increase use support computations. Similarly, the "decreased use" coefficients are varied in the direction that will decrease use support computations. All of the model inputs are directed monotonically one way or another in relation to beneficial use support determination.

3.4 Scenario Development

This section gives a brief overview of the analysis steps for each of the scenarios.

Scenario 1 - 1990 with CWA Implemented

- Municipal point source loads are generated using NEEDS88, adjusting flow using 1990 population as available, and overriding with 1990 Permit Compliance System (PCS) data as available.

- Industrial point source loads are generated using Industrial Facilities Discharge (IFD) and PCS. IFD is used to get reach and NPDES numbers, and PCS provides loadings.

- Nonpoint source loads by reach are generated using the county estimates and apportioned using the State/county FIPS codes in RF1. The apportioning uniformly distributes loads based on total lengths of reaches by county.

- Reach mean flows and velocities obtained from the GAGE file are merged with RF1.

- The water quality model is run as described in Section 3.2.

- Sensitivity analyses are performed including sensitivity to load and flow estimates as described later in this report.

Scenario 2 - 1990 without CWA Implementation

The municipal and industrial concentrations can be adjusted to reflect primary treatment only. The analyses for Scenario 1 can then be run and the two scenarios compared.

Scenario 3 - 1990 with Zero Discharge

The analysis steps for Scenario 1 are followed, but all point source loads are set to zero. The only loads going into the model are from NPS.

Scenario 4 - 1990 with NPS Loadings Reduced by Half

Again, the analysis steps for scenario 1 are followed, but NPS loadings are reduced by half.

Additional Scenario - Early 1970s Without CWA Implementation (not analyzed for this report)

The following steps could be followed to simulate conditions in the early 1970s without CWA implementation:

- Adjust municipal flow using the NEEDS88 1972 population, adjust concentrations to primary treatment only. Totals can be compared and cross-checked to estimates in the NRDI.

- Adjust industrial loadings by backing out a primary only treatment level and adjusting flows to match output totals for 1970 using factors that compare 1990 to 1970s production levels to adjust flows. Totals can be compared to NRDI values to check overall validity of techniques.

4.0 RESULTS

We report the results from four scenarios. Many other scenarios and tests have been run to verify the proper functioning of the model and to evaluate the key input parameters affecting the results. These tests have shown that a wide range of input parameter assumptions all lead to the same basic conclusions. The results presented here show only changes that lead to categorical variations in use support. Changes that improve the waters but are not enough to effect an increase in a use category are not discussed.

Sensitivity analyses show that the model is not "hypersensitive" to any particular input parameter. Applying the 10% sensitivity factor showed less than 10% change in beneficial use totals. There are, however, two primary input parameters that have "valid" ranges in an order of magnitude--the SDR and the decay coefficients.

Our current state of knowledge supports a range of values for the SDR and the decay coefficients and it is difficult to assign them single values. The model results using ranges of SDR from SDR=0.10 to SDR=0.01 show "reasonable" but widely varying results. This is an order of magnitude range, and further work is needed to determine either a single "best" value or to determine regional values.

The decay coefficients also have a valid order-of-magnitude range. Decay coefficients between 2 and 0.2 per day have been evaluated. An enhancement to the model is being considered that would vary the decay coefficients based on concentration.

"Reasonable" results were determined by comparing the model's results with selected STORET water quality monitoring data as well as best professional judgment. The State 305(b) reports provide some information concerning use support, however these reports are highly variable in values reported and methods used. Selected State values were used where we had in-depth knowledge of the methods and criteria used. The ranges for SDR and decay coefficients were determined from experience with water quality models and review of typical values used in the literature.

The results presented in Table 2 use the current best estimates for valid SDR and decay coefficients. Values of SDR=0.05 and decay coefficients of 2/day are used. Following these results is an analysis incorporating ranges for SDR and decay.

In interpreting the results of the model simulations it is important to keep in mind that they are intended to be illustrative, only. A comparison of the first two scenarios in Table 2 shows a very small percentage difference due to the CWA. However, the gains in river miles that support additional beneficial uses are substantial, especially considering that the miles of rivers and streams that have been cleaned up tend to be in densely populated areas. Table 3 shows the total miles of increased useability due to the CWA alone, if zero discharge were achieved, and with NPS loads reduced by half.

A comparison of the 1990 baseline with the CWA and 1990 with zero discharge indicates that most of the improvement through point source cleanup has already taken place and relatively smaller levels in overall improvement can be achieved by approaching zero discharge.

The far right column in Table 3 shows the dramatic improvements that can be achieved through aggressive control of NPS. This analysis in no way implies that a 50% reduction in NPS pollution is feasible, but it does illustrate the relatively large effect of such a goal.

4.1 Steps of Designated Use

Figure 3 shows miles of improvement attributable to the CWA in terms of how many "steps" of improvement took place. One step, for example, would be improving beneficial use from rough fishing to game fishing. A two-step improvement would be from rough fishing to swimming. The table shows that 618,657 of the 632,551 miles (97.8%) did not change their use support status due to the CWA. A total of 13,894 miles (2.2%) changed use support. The maximum increase possible is five steps, which would represent going from no recreation to drinking water. Note that no miles showed this maximum improvement due to the CWA alone. Note also that these numbers reflect only changes that result in a change in use support; water quality improvements that do not change the designated use classification are not accounted for in the figure.

Figure 3 also shows the additional improvements that would occur if zero discharge were achieved. An additional 3,694 of the 632,551 miles (0.6%) would show improvement over current conditions. Of the 3,694 miles, 2,626 (71%) would experience a one-step improvement with the remaining 29% improving two or more steps. If zero discharge were achieved, a total of 17,588 miles (13,894 + 3,694) would show improvement due to the CWA.

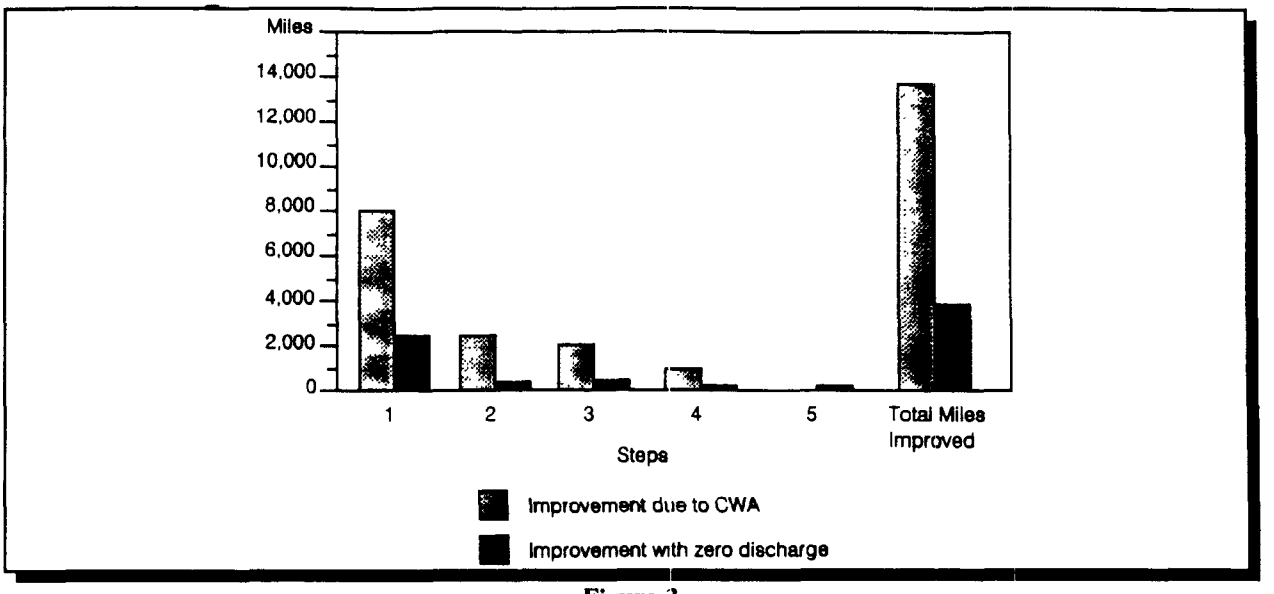

Figure 3
Miles of Improvement by Number of Beneficial Use Steps

4.2 Model Sensitivity

Table 4 shows ranges of results under varying values of SDR and decay coefficients for the scenarios corresponding to the first two columns of Table 3. The ranges are 0.05 to 0.01 for SDR, and 2 to 0.2 for decay coefficients. The ranges are particularly broad, as should be expected when varying the two primary input coefficients by orders of magnitude. The ranges for drinking and swimming are particularly broad, while the ranges for the other uses are significantly smaller. Sensitivity analyses using a 10% change in ALL input data showed a similar pattern with broader ranges for drinking and swimming and much narrower ranges for game fishing, rough fishing, and boating. These analyses indicate that there is significantly more confidence in the results for fishing and boating than those for drinking and swimming.

5.0 CONCLUSIONS

The analysis in the present paper has, in some ways, retreated from the scope of previous efforts and, in other ways, has extended the scope beyond those previous studies. The scope has been reduced in terms of the parameters modeled and types of waters modeled. The RFF studies modeled DO deficits and nutrients while the CWAEM is limited to BOD, TSS, and FC. However, to use the CWAEM for policy analysis, additional pollutants will be incorporated into the model. The RFF studies included lakes and estuaries while the CWAEM is limited to flowing rivers and streams. This reduction in scope is intended to limit the modeling to relatively simple kinetics that can be modeled reliably on a national scale. By using a simpler model, calibration and sensitivity analyses become more manageable and create a strong basis from which to expand the scope as required. We are investigating expanding the model to include lakes and estuaries.

The CWAEM has expanded the scope of previous studies by attempting to link the water quality changes to changes in beneficial use support. The addition of more water quality parameters should enable valid assessments of beneficial use attainment under various policy scenarios. The CWAEM also uses more detailed and updated pollutant loading databases and a more detailed hydrologic network than the RFF models.

Table 2

Impact of Four Scenarios on Number of River Miles Supporting Beneficial Uses

Beneficial Use	Baseline Conditions 1990 With CWA		1990 Without CWA		1990 With Zero Discharge		1990 With NPS Loads Reduced by Half	
	Miles Supporting	Percent Supporting	Miles Supporting	Percent Supporting	Miles Supporting	Percent Supporting	Miles Supporting	Percent Supporting
Drinking[8]	129,406	20.5	124,082	19.6	131,251	20.7	206,229	32.6
Swimming	208,170	32.9	203,508	32.2	209,408	33.1	299,325	47.3
Game fishing	376,426	59.5	371,121	58.7	377,663	59.7	434,204	68.6
Rough fishing	412,545	65.2	408,186	64.5	413,415	65.4	462,704	73.1
Boating	451,749	71.4	447,297	70.7	452,575	71.5	491,249	77.7
No recreation	632,551	100.0	632,551	100.0	632,551	100.0	632,551	100.0

Table 3

Increase in Miles of Beneficial Uses under Three Scenarios

Beneficial Use	With CWA	With Zero Discharge	With NPS Loads Reduced by Half
Drinking[9]	5,324	1,845	76,823
Swimming	4,662	1,238	91,155
Game fishing	5,305	1,237	57,778
Rough fishing	4,359	870	50,159
Boating	4,453	825	39,500

Table 4

Estimated Range of Increase in Miles of Beneficial Use Under Varying Values for SDR and Decay Coefficients[a]

Beneficial Use	With CWA	With Zero Discharge
Drinking[10]	1,236 - 14,314	394 - 4,511
Swimming	1,790 - 11,828	468 - 2,937
Game fishing	5,305 - 14,380	1,237 - 2,937
Rough fishing	4,359 - 11,598	870 - 1,909
Boating	4,453 - 11,504	825 - 2,151

[a]SDR value = 0.05 to 0.01; Decay coefficient = 0.2 to 2.

Several possible improvements to the model have been identified. The importance of certain key modeling parameters, in particular SDR and decay coefficients, became apparent in analyzing the model results. Further efforts to calibrate the model have begun. Water quality monitoring data for several hundred NASQUAN stations have been obtained from the U.S. Geological Survey (USGS). These stations are linked to RF1, so automated calibration techniques can be developed. This additional calibration may enable valid estimation of absolute miles of rivers and streams supporting beneficial uses, and not just relative changes for each of the policy scenarios.

One advantage of using the limited set of parameters is that calibration and verification is a reasonable undertaking. Another advantage of the limited nature of the CWAEM is that priorities for

[9]See footnote 3.

[10]See footnote 3.

further refinements are clearly identifiable. More parameters and/or more complex kinetics can quickly create a model that would be extremely difficult to work with on such a large scale.

Currently, the model uses uniform coefficients from the entire country. The use of regional values should improve the results. Regional values make sense because of the varying impacts due to factors such as rainfall patterns and slope. The USGS monitoring data may very well enable regional calibration. In addition to regional analyses, seasonal analyses can be undertaken. RF1 contains low flows as well as monthly values, so the model can be set up for different months and/or low flow conditions.

Further improvements can be undertaken by enhancing the way NPS loads are incorporated. Currently, the urban and rural loads are combined and then added uniformly to the reaches. The development of techniques to add more selectively the urban NPS loads only to the reaches where urban areas exist could significantly improve the results and enhance the capabilities for evaluating alternative NPS control strategies.

The limited set of water quality criteria (BOD, TSS, and FC) that defines beneficial use support in our model leads to overestimates of the effects described in the policy scenarios if the omitted pollutants are limiting factors. It is not known how much the numbers would change by incorporating additional water quality parameters. There is no way of knowing how many miles currently classified by the model with a particular beneficial use would have the same beneficial use with other parameters considered. The question is, how much do beneficial use limitations coincide with other water quality parameters. For example, if a reach is limited to boating, would nutrients and toxicants also limit the water to boating?

The model results lead to some preliminary conclusions. First, the CWA has effected a relatively small percentage of the surface waters of the United States, but, several thousand river miles have achieved improvements in at least one of three pollutants (i.e., biochemical oxygen demand, total suspended solids, or fecal coliform). Furthermore, the effects are potentially significant because the waters improved are primarily in densely populated areas. Second, taking a national perspective, the majority of the improvements possible through point source control have already been achieved. Meeting the original CWA goal of "zero discharge" will have significantly less effect than the improvements achieved to date. However, this in no way implies that targeted controls of point source pollution are without merit. Finally, further significant improvements in water quality will require major reductions in nonpoint source pollution.

Directions for future research involve refinements to the model, to address issues such as the following:

1. Expand the list of pollutants to include loadings of toxics, nutrients, and other contaminants of regional or national importance for a more complete picture of beneficial use attainment under various policy scenarios;

2. Obtain an overview of which regions of the country are most adversely affected by which pollutants from which sources;

3. Assess the relative effectiveness of alternative policies to control pollution at the regional or watershed level; and,

4. Assess the economic costs and benefits of alternative policies to control pollution at the regional or watershed level.

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Recreation and Tourism Benefits From Water Quality Improvements: An Economist's Perspective[a]

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ABSTRACT

As the level of pollutants is reduced under legislation such as the Clean Water Act (CWA), benefits to users of water resources will arise. This paper focuses on the benefits in water-based recreation. We present the economist's view of such benefits, how they are defined and measured, and some examples of estimated benefits from water-based recreation. This perspective is probably different from the vantage point of just about everyone else. Regional planners and local officials cite increased tourism and the related expenditures of visitors to the region as "benefits" because the incoming dollars are revenue that may increase jobs and provide funds that may be used to enhance local services. In contrast, economists focus on a monetary measure of the enjoyment of recreation by the individual (known as the "consumer surplus") and think this is the important benefit from recreation. We explain both views below, critique the use of expenditures as a measure of the benefits from cleaner water, and summarize by providing some examples of benefits estimated in previous studies and estimated for a reduction in nonpoint source pollution.

1.0 INTRODUCTION

Water quality in surface and ground water sources is influenced by a host of pollutants and contaminants, including but not limited to: suspended solids, metals such as arsenic and lead, PCBs, and pesticides and chemicals from agricultural and other sources. As the level of these pollutants is reduced under legislation such as the Clean Water Act (CWA), benefits to users of these water sources will arise. This was shown to be the case with implementation of the amendments to the Federal Water Pollution Control Act of 1972 and 1977.[1] This paper focuses on the benefits in water-based recreation. Individuals use lakes, reservoirs, rivers, streams, and coastal waters for recreational fishing, motorized and non-motorized boating, swimming, sail-boarding (windsurfing), surfing, and use the banks and public access areas near water bodies for activities such as walking, picnicking, or just to look at the water. In an early study, the "most likely" estimate of the national benefits from pollution control was $13.9 billion (1979 dollars, Freeman), with recreation accounting for well over half of this. While some are skeptical of the results by subcategory,[1] there is no doubt that recreation is an important benefit from water quality improvement.

This paper presents the economist's view of such benefits, how they are defined and measured, and some examples of estimated benefits from water-based recreation. This perspective is probably different from the vantage point of just about everyone else. Regional planners and local officials cite increased tourism and the related expenditures of visitors to the region as "benefits" because the incoming dollars are revenue that may increase jobs and provide funds that may be used to enhance local services. In contrast, economists focus on a monetary measure of the enjoyment of recreation by the individual (known as the "consumer surplus") and think this constitutes one of the important benefits from

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[a]Views within are those of the authors only and do not necessarily represent the views and opinions of RCG/Hagler, Bailly, Inc.

recreation. We explain both views below, critique the use of expenditures as a measure of the benefits from cleaner water, and summarize by providing some examples of recreation benefits estimated in previous studies and benefits estimated for a reduction in nonpoint source pollution.

2.0 AN ECONOMIST'S PERSPECTIVE ON BENEFITS FROM ENVIRONMENTAL IMPROVEMENT

As a consequence of water quality improvements generated by the Clean Water Act (CWA), individuals may be attracted to a region to engage in water-based recreation. Reservoirs, lakes and streams often attract individuals not only from close by, but from throughout the country, and individuals already engaged in recreation in the area may increase the number of outings they take. Many state and local government officials focus on the likely expenditures of those individuals, or the revenue from tourists. For example, in one study, it is noted that boating-related expenditures in the U.S. grew from $7.5 billion to over $12 billion in 1984,[2] and it is implied that this growth is "good" for the economy. Another study states that "it is clear from [the] statistics that boating plays an important economic and social role."[3] This same study goes on to estimate that the total estimated spending of Delaware-registered boaters in 1985 is $116 million, and states that

> "...spending provided much useful information to gauge the impacts that recreational boating has on the Delaware economy."[3]

If one wishes to link water quality changes with expenditures, then what has to be done is to estimate the *additional* expenditures that would stem from some water quality improvement. Economists, however, often do not consider these expenditures to be the important benefits from recreation that depend on water quality. This is particularly true for *national* programs, such as pursued in accordance with the federal CWA.

To begin, economists typically recognize that the relevant impacts of a project depend upon the accounting stance taken for an analysis. The impacts are viewed as either benefits or costs, and the stance from which these benefits and costs can be recognized can be national, regional, state, or local. The goal from the economist's perspective is to maximize the "net" benefits (total benefits minus total costs) from a project, or at least to go ahead with a project only when the benefits exceed the costs.

A national accounting stance views benefits and costs as they accrue to the entire nation, while the recognition of benefits and costs from a region's perspective is obviously much different. In addition, benefits and costs are defined as either being "primary" or "secondary", with the latter being those impacts that are generated from activities indirectly related to the project.[b] A regional government or economic planning office may be quite interested in the expenditures of recreational anglers or boaters who visit a river or lake in the region (such as for food, transportation, lodging, entertainment), but these expenditures may be of no interest from a national accounting stance because as tourists move from region A to region B to recreate, region A loses revenue from the expenditures from this group—that is benefits in region B are offset by costs in region A. Thus, secondary impacts such as expenditures are rarely considered at all by economists interested in the net benefits of a national program to improve water quality. There is yet another important reason that an individual's expenditures are not used by economists to estimate the benefits from recreation.

It is sometimes thought that spending, or *expenditures* might be used to proxy the costs that are borne by recreators in conducting their outing, and that these costs might in turn be considered a lower bound estimate of the benefits that each individual derives from an outing. This logic underlies the travel cost model (discussed below), in that identification of costs is a step toward identification of benefits, but is

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[b]Such secondary impacts are in fact sometimes referred to as "indirect" impacts.

flawed. The reason is twofold, and the first reason is simply that costs are *not* benefits.[c] The value that an individual places on recreation has to do with the maximum willingness to pay (WTP) for it, and the actual cost the individual must pay for recreation may have little to do with this value.

The second problem with the argument that expenditures are a lower bound estimate of benefits is that the expenditures an individual makes are his or her choice. The individual decides how much food to purchase on an outing, whether to stay overnight and in what hotel, whether to rent a guide or a boat, etc. These costs are thus endogenous to the consumer.

2.1 Costs as Proxies for Prices

Economists are interested in modeling behavior in the face of exogenous costs because knowledge of these costs helps identify the "demand" for the good.[d] Prices of goods and services are exogenous to the consumer, in that the consumer cannot choose what price to pay, except in unusual cases where bargaining is practiced. Costs may be "fixed" in the sense that if the individual decides to participate, he or she must pay this cost or price. The *price* of a hotel room is indeed exogenous, but the decision to stay overnight is not. Similarly, a boater pays a fixed cost of storing his boat at a marina, but the decision to store his boat is his own. For modeling purposes, as in the travel cost model discussed below, expenditures are often averaged over an entire sample of recreators, and this "average" cost is assumed to be exogenous to the individual recreator. Thus, only in this use are expenditures an important source of information to the economist. What then *is* important to the economist in assessing the magnitude of benefits?

2.2 Consumer Surplus

The primary benefits from water quality improvements here are measured by the benefit to each person who derives enjoyment from recreation. As will be seen below, these benefits can be quite substantial. In formal terms, this benefit is called the "consumer surplus" from the water-based recreation. Put simply, consumer surplus (CS) is the net benefit to an individual when the price of a good falls (or the net loss in CS when the price of the good rises), or when the quality of the good improves (or is the net loss in CS when the quality of the good decreases). CS is also often deemed the "Net Economic Value" (NEV) of a resource or good.

In the recreation context, the good is a water resource such as a lake or a stream, and the quality of this lake may be portrayed using an environmental characteristic that is measurable and influences the enjoyment of the resource. Examples are the catch rate for species of fish, or some index of site quality. In economic theory, a simple, though not strictly correct, way of presenting the benefits from a good is by examining the area under a demand curve bounded by two prices or two quantity levels (see Figure 1).[e] In

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[c]Indeed, we noted above that net benefits are benefits minus costs.

[d]When a market exists, a relationship can be identified between the quantity demanded of a good and the market price (i.e. how many boxes of cereal are purchased per year/month at a price of $2.50 per box). A well-defined market does not usually exist for outdoor recreation sites, however, so economists appeal to exogenous costs to proxy those prices, and the basic subsequent approach to identifying the demand relationship is the same as when a market exists.

[e]Economists know that what actually needs to be examined is the area under what is called the "Hicksian" or "Hicks-compensated" demand curve, which is different from an "Ordinary" or "Marshallian" demand curve due to compensation or income effects. There is an ongoing discussion about the magnitude of the discrepancy between the benefits estimated using an ordinary versus the Hicks-compensated demand curve.[5,6] To avoid the debate, it may be best to estimate exact consumer surplus measures such as the compensating and equivalent variation, which is now commonly done in more sophisticated recreation demand studies.[7]

the figure the shift in the demand curve from D_o to D_1 is an increase in demand, and may be assumed due to an improvement in environmental quality. For example, the equilibrium price of a recreation trip is P_0, and suppose that water quality doubles, increasing the number of trips from Q_0 to Q_1. Then the triangle ABC shows the graphical approximation of consumer surplus (see footnote e). The next section provides a simple discussion of how such benefits are estimated.

Figure 1
Benefits From an Increase in Demand

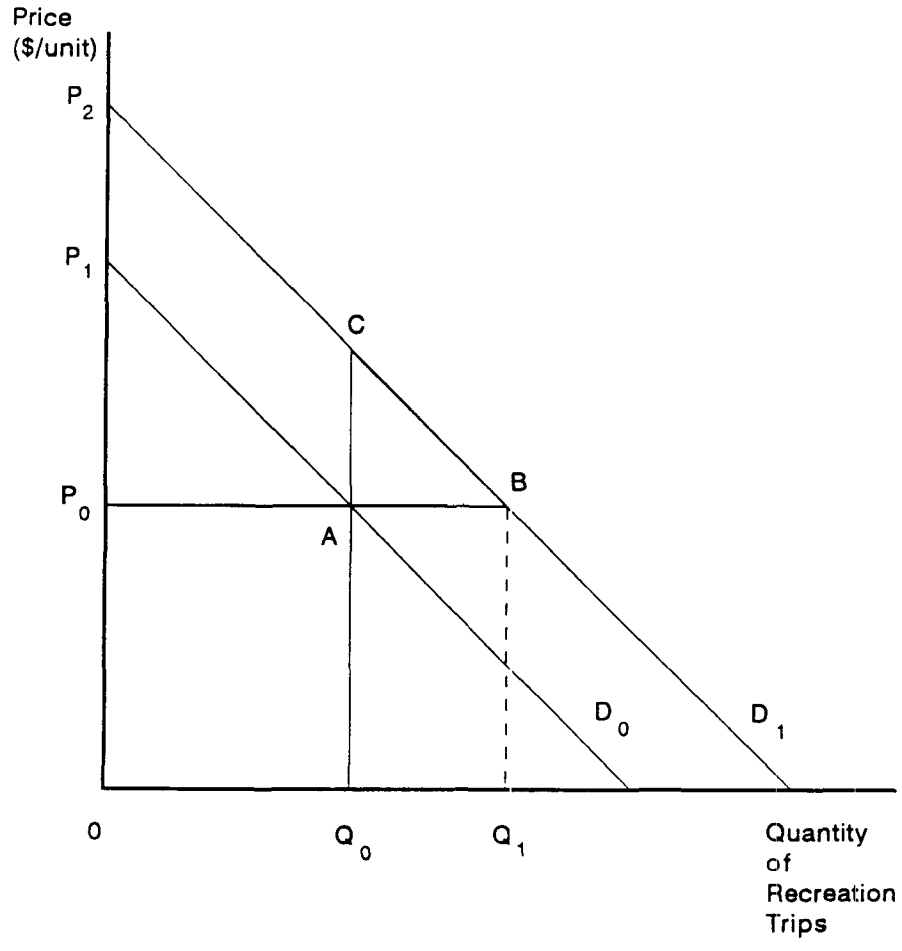

Figure 1

3.0 METHODS FOR ESTIMATING THE BENEFITS OF RECREATION

Water quality related benefits may be estimated by doing primary research on a set of individuals that use the resource. This type of research is expensive but quite common, and the literature is rich in examples of benefits estimated for recreational fishing and boating. In cases where primary research is not possible, benefits that have been previously estimated using primary research conducted for some resource might be "transferred" to another resource. The credibility of such a transfer depends not only on the comparability of the two resources, but also upon the ultimate purpose of the benefits estimation.[4] For example, it may be that the benefits from saltwater fishing estimated for anglers fishing off the Oregon coast

are transferable to saltwater fishing for anglers fishing off the Maine coast. The purpose of the benefits study for Maine anglers helps determine what level of "accuracy" in benefits needs to be obtained. A common view, however, is that a primary study is the best method of estimating benefits when resources are available.

3.1 Primary Methods

Benefits may stem from use or from nonuse of the water resource, but this paper focuses on recreational use.[f] Benefits from use may be estimated using a travel cost method (TCM), the contingent valuation method (CVM), or the hedonic price method (HPM). The benefits stemming from nonuse can thus far only be estimated using the CVM. A very short, and largely nontechnical discussion of each method follows. Virtually all methods below require conducting a survey of recreators.

3.1.1 Travel Cost Method

The TCM essentially uses the recreator's costs incurred in travel from an individual's home to a group of recreation sites to proxy the "price" that this person pays for use of the sites. Gathering information on all of the sites that the individual visits allows analysis of behavior with the possibility of substitution and complementarity between sites. Just as an individual may substitute a hotdog for a hamburger when the price of hamburgers increases and complement that hotdog with pickle relish, a recreator may substitute Chesapeake Bay for the Delaware Bay when water quality in the latter decreases, or complement a fishing trip to Lake Placid with a hiking trip to the Adirondack mountains when water quality in Lake Placid improves. Estimation of demand or behavior for trips to only one recreation site often rules out this possibility.

The relevant prices may include the often thought of "site-entry" fee, but also includes the out-of-pocket cost of getting to and from the sites (gas and wear and tear on an automobile), and some cost of time to the recreator. All of these costs are assumed exogenous to the consumer of recreation services. In order to ensure that this assumption holds, the costs reported by each individual are often averaged over the entire sample, or averaged from each origin point.[g] With data on these components and on environmental attributes that attract the recreator to the site, a relationship between the quantity demanded (trips to the site) and these variables may be formed. With such a relationship known, the consumer's surplus may be estimated. The data on the individual's behavior (destinations and trips to the recreation sites, number of hours engaged in recreation per day, place or residence, etc.), are usually obtained by conducting a mail, telephone, or on-site survey of recreators. Many of the new travel cost applications estimate the benefits for an individual and then aggregate benefits for a group of individuals, but older applications estimate benefits for populations from a zone or region.[9]

3.1.2 Hedonic Price Method

The hedonic price method often takes the form of a variation on the TCM.[10] In such a model, the quality attributes of a site (such as water quality) are used to explain the variation in how recreators value their use of a site. The idea stems from the fact that individuals can be observed to pay a

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[f]An example of nonuse value or benefit is the benefit of a recreation site to an individual from merely knowing that one's child may use the resource in the future. Though controversial, these nonuse values have been shown to be measurable and substantial.

[g]For example, all those fishing at Lake George and coming from New York City by automobile would face the same distance to drive and thus the same basic cost of operating a vehicle to get there and back. In addition, each individual has an opportunity cost to his or her time spent in travel to and from Lake George, and while at Lake George. Issues connected to valuation of time are complex, but inclusion of some time cost may substantially influence the estimation of benefits.[11]

different price for the same resource because some people travel much further to a recreation site than others. People may also be observed to travel much further than the closest recreation site to them to enjoy an activity. What explains this willingness to travel so much further than a person has to, or so much further than others visiting the same site? The thought is that people do this because of the environmental attributes sought after and the desire for a "different" or "better" recreation experience. Formally, the attributes are used to explain the variation in the WTP for recreation observed across a sample of individuals. Data are collected on observed behavior and preferences using some sort of survey technique.

3.1.3 Contingent Valuation Method

The CVM is an approach in which hypothetical markets are constructed and presented to individuals in a survey format, with the responses to questions used to infer prices and values for the goods and services being evaluated. For example, individuals may be asked about the recreator's WTP rather than do without the resource, or the WTP for an environmental improvement to determine the benefits of the resource when quality is improved.[h] These questions are asked in person, or using a telephone or mail survey questionnaire. The credibility of CVM results often depends on the credibility of the CVM survey instrument. The key issue may be, did the respondent really understand the question and believe in the scenario being presented when he or she answered the question?

The CVM technique and the use of surveys has improved over the years, but controversy still exists about the ability of the method to determine reliable non-use values[13] (the "Cambridge Symposium"[i]). There appears to be little controversy over the method's application to obtaining use values.

3.2 Secondary Methods: Benefits Transfer

The three primary methods described above are often quite expensive and time-consuming to implement for even a single site or area of interest. For a large number of sites which may be geographically dispersed, such as would be impacted by changes in the CWA, these primary research approaches are generally not feasible because of the costs. If a research budget does not allow implementation of one of these primary methods, then the researcher might appeal to the method of "benefits transfer" in order to develop some estimates of the magnitude of the potential benefits from a policy that leads to water quality improvement. Transferring involves taking the estimated benefits for one area or at one point in time, and using these benefits as approximations for the benefits for another area or at another point in time. An example is given in section 4.1 below.

4.0 EXAMPLES OF EXPENDITURES VERSUS BENEFITS

An example of the difference between the expenditures and the estimated consumers surplus for a group of recreators may drive home the points made above. Note, however, that we are recommending that expenditures *not* be used at all to make inferences about the benefits from recreational benefits associated with national CWA policies.

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[h]Questions may also be framed to elicit the individual's willingness to accept compensation for degradation of the resource.

[i]Research from the Cambridge Symposium[14] was largely funded by Exxon Corp. with the purpose of doing a "critical" assessment of CVM. The papers presented at the symposium have not been subjected to peer review so while controversial and thought-provoking, no conclusions about use and misuse of CVM should be drawn from them at this time.

4.1 Pace Study

Pace (1992)[15] estimates the change in net economic value (NEV) and the change in expenditures for the Middle Clark Fork River and the immediate region in Montana under a scenario to reproduce the effects of eliminating the Milltown Dam project.[j] Pace essentially conducts a benefits transfer and admits to many problems and assumptions made in his study; his results are used merely to demonstrate the difference between benefits and expenditures. The Dam and reservoir play a role in reducing spawning and recruitment of trout to the Middle Clark Fork River (MCF) fishery, and thus, elimination of the project most likely would enhance the fishery and lead to an increase in recreational fishing.

Pace[15] estimates the NEV and the change in expenditures for the river and for the region and these numbers are reported in Table 1. Presented there are both a "high" and a "low" estimate and the difference between the two depends on assumptions about likely changes in the trout density without the dam, the response of anglers to that change in trout density, the degree to which anglers substitute between fishing sites, and the degree to which resident and non-resident anglers fish on specific stretches of the rivers examined in the analysis. First, the table shows that the change in expenditures is larger than the NEV and thus the two cannot be identical. Note also that the actual NEV is quite substantial itself. It may be tempting to use the expenditures as an indication of the economic "benefits" from this scenario, but recall that these expenditures reflect costs, not value.

Table 1
Changes in Net Economic Values and Angler's Expenditures with Elimination of the Milltown Project[15]

	NEV		Expenditures	
	High	**Low**	**High**	**Low**
Middle Clark Fork	$75.2	$38.8	$208.0	$75.2
All Region	$101.8	$13.7	$211.0	$60.7

(in millions of dollars)

Second, note that comparing the two *rows* of Table 1 shows the effect of substitution among fishing sites in the event of a water quality improvement. At first, it seems that the NEV for the region (ALL) must always be higher than just for the river. But the "low" estimate for ALL is only $13.7 million, while it is $38.8 million just for the river. How can this be? This surprising result is explained by the role substitution plays in forming the high and low estimate. For the high estimate, weak substitution effects are assumed, while strong complementarity is assumed. For the low assumption, weak substitution is assumed, but even weaker complementarity is assumed, so the former effect outweighs the latter.

Specifically, under the "high" assumption when the Middle Clark Fork improves, the anglers only slightly switch to using it more and another river less, while at the same time use of a third river increases. Fishing in the region thus increases. Under the "low" assumption, when the Middle Clark Fork improves, other rivers are not used more, and there is some substitution away from river 2, thus inducing a loss in benefits for river 2. The total benefits generated by increased use of the Middle Clark Fork are not enough to make up for the loss in benefits from use of river 2. Though the change in expenditures also shows this trend, it does not do so nearly to the extent that the change in NEV does. In Pace's study, all of

[j]Pace[13] in turn draws heavily on the study by Duffield et al.[15,16]

these assumptions are just ones the author makes without any other information, but the point that use of expenditure data may be quite misleading is clear.

4.2 Other Recreation Benefits Studies

Benefit estimates are indeed large, however, as may be seen in Table 2. The few studies listed there show some results from applications of the primary methods above. Many, many other studies have been conducted and it would be impossible to include all of the interesting references to estimated recreation benefits in this paper. A fairly recent compilation of many recreation benefits studies may be found in Smith and Kaoru.[17] In Table 2, note that the WTP per trip or "choice occasion" may be quite small. The small numbers may reflect the small incremental water quality improvement, or may be confusing due to the technique used to estimate the WTP. For example, WTP measures in the random utility model (RUM) are often misinterpreted. Such WTP measures are estimated in a probabilistic model, and should not be interpreted as the actual WTP per trip *taken*. The models may have built into them the probability that the individual *will* take the trip (as in Jones and Sung's)[18], and thus the WTP needs to be adjusted by this probability.

5.0 CLEAN WATER ACT REAUTHORIZATION ISSUE: POTENTIAL RECREATION-RELATED BENEFITS FROM NONPOINT SOURCE CONTROLS

5.1 Overview of the Nonpoint Source Problem

Nonpoint sources (NPS) of water pollution are those activities (typically land use-related) that generate pollutant loadings that reach the nation's waters via runoff. For example, soil erosion from agricultural or silvicultural activities or urban development produces particles (sediment and associated nutrients, metals, and toxic organic chemical compounds) that can be transported by precipitation and runoff to a stream or lake.

NPS pollution often dominates total loadings of selected important pollutants. For example, Gianessi et al.[19] estimate that 99.9% of the sediment (TSS) loadings to the nation's waters are due to nonpoint sources, and more than 80% of the nutrients (measured as Total Phosphorus and Total Kjeldahl Nitrogen) are from NPS. These loadings have been associated with significant adverse impacts on water quality. For example, in EPA's Report to Congress, *1990 National Water Quality Inventory*,[20] summary information about data submitted in state 305(b) indicates that siltation and nutrient loadings from agricultural activities (including grazing) are the *leading* causes of water quality impairments in the nation's rivers and lakes.

Although NPS pollution has long been recognized as the leading contributor of selected pollutant loadings and has been clearly associated with widespread water quality impairments, these sources are not directly regulated under the CWA. Control of NPS pollution is primarily within the voluntary purview of individuals and firms engaged in land use activities that generate NPS loadings (e.g., farmers, builders, timber companies, etc.), although state and local codes and regulations often govern some NPS-generating activities (such as new construction). There also are several incentive-based and educational programs that try to induce greater participation in NPS control efforts (such as in agricultural sectors). In contrast, however, point source discharges are regulated directly under the CWA through the permit process—point source wastestreams are closely monitored and have discharges limited according to permits based on effluent limitation guidelines promulgated by EPA on the basis of Best Available Technology (or, where applicable, more stringent water quality criteria).

Having illustrated this difference, the policy maker or concerned local government official may be left wondering what numbers to use in order to estimate the likely benefits from water quality improvement. Expenditures are often easy to estimate, while CS or NEV measures are not readily available. One source of information stems from transferring the estimated benefits from one area to another, as

Table 2

Selected Benefits Estimates for Water-Based Recreation

Study Area/Authors/Date	Activity	Region	Type of Water Quality Improvement or Deterioration	Method of Analysis	Per person WTP or WTA	Total Estimated Benefits
Mid/South Atlantic; McConnell et. al., 1992	Marine Fishing	Atlantic Coast, south of Long Island	1 Fish increase in mean historic catch rate*	Travel Cost/ Nested Logit	$.52 per occasion July - Aug. 1988, (WTP)	$6.47 million (1988 dollars) Full sample - all states
Michigan; Jones and Sung, 1991	Michigan River Fishing (Warm)	Kalamazoo River	Cleanup of PCB contaminated sediments**	Travel Cost/ Nested Logit	$.29 (WTP) per season, 1984 dollars	$2,920.63 per season for 4,824 anglers***
Texas; Seller, Stoll, and Chavas, 1985	Lake Boating	Four Lakes in East Texas	Elimination of Boating at Lakes+	Contingent Valuation	$13.81 to $39.39 (WTP), 1980 dollars	No aggregate reported

*WTP were also calculated for avoiding loss of all access to Delaware sites.
**Cleanup consistent with elimination of fish contamination advisories on warmwater fisheries in two counties.
***$1.15 million when extrapolated to total population of licensed anglers in 1984.
+No quality improvement simulated, WTP is a maximum entry fee before stopping use of the lake.

mentioned above. Such transfers should not, however, be conducted without considerable care.[k] The next section discusses control of nonpoint source pollution and presents some estimates of *national* benefits which are estimated using the benefits transfer method.

When the CWA was last reauthorized, as the Water Quality Act of 1987, NPS pollution was given a higher profile through the inclusion of section 319, which requires state programs to determine the extent and impact of NPS pollution on water quality. As results of these mandated NPS data collection and reporting efforts have come in, analysis confirms that NPS pollution remains a significant water quality problem in the U.S. Therefore, an important issue for the upcoming CWA reauthorization discussions is whether an expanded federal role is warranted in the control of water pollution from nonpoint sources (NPS). One aspect of this discussion should be, what types and levels of benefits can the nation anticipate if NPS pollution is more aggressively controlled? Below, an overview is provided of the estimated potential recreation (and other) benefits associated with NPS controls in coastal waters.

5.2 Estimated Benefits of NPS Controls in Coastal Waters

Recently, rough estimates of the potential value of recreational (and other) benefits were derived, via a benefits transfer approach, for the control of NPS pollution to coastal waters. These benefits are associated with a guidance package developed by EPA, The Management Measures Guidance for Nonpoint Source Pollution, in accordance with the Coastal Zone Management Act Reauthorization Amendments of 1990.

The existing economics literature pertaining to the economic value of NPS pollution control programs, such as embodied in the Management Measures, has focused predominantly on topics not directly applicable to the Guidance (e.g., inland regional NPS control benefits, or the national damages of cropland soil erosion). However, these efforts have some applicability to the Guidance, although the Guidance differs because of its coastal waters focus, its applicability to more than cropland erosion problems, and the need to measure program benefits rather than damage levels. Nevertheless, as shown in Table 3, the consistency of the results transferred from other studies suggests the benefits of the Guidance may be appreciable, and that benefits may well exceed costs.

Table 3 presents summary results for recreation benefits from control of NPS pollution in coastal waters, some nonuse benefits estimates, and the bottom half shows some corroborating evidence. All estimates are converted to 1990 dollars. An aggregate benefits estimation approach has been developed from Mitchell and Carson's[21] research on water quality benefits. The household-based application of their willingness to pay (WTP) findings to coastal NPS controls yields benefit estimates in the range of $1.5 billion to $3.1 billion per year. The recreation-related portion of these benefits, as shown in the top line of Table 3, amounts to $0.8 to $1.5 billion per year.

Use of data from the US FWS 1985[22] survey of recreational angling also can be applied to develop benefits estimates. A saltwater angling effort-based interpretation of Mitchell-Carson indicates NPS control benefits of $2.0 billion in the coastal zone (more than half of which is recreation related). A comparable estimate of $1.3 to $2.7 billion is derived by valuing potential NPS-related improvements in coastal recreational fisheries.

In the bottom half of Table 3, note the aggregate *damage* research study by Clark et al.[23] This widely cited study suggests highly significant potential benefits, a significant portion of which (over 37%) are attributable to recreation.

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[k]A good portion of a March 1992 issue of Water Resources Research is devoted to benefits transfer, and the Association of Environmental and Resource Economists had a workshop devoted to the topic in the summer of 1992. A consensus may be emerging on how to use existing benefits numbers in transfers.

Table 3

Aggregate Benefit Estimates for NPS Controls in Coastal Waters

Annual Benefits Range*	Description/Comments	Source
Coastal NPS Benefit Estimates		
Recreation Benefits:		
$0.8 billion - $1.5 billion	NPS controls in coastal waters. Includes coastal households only.	Household WTP for Water Quality Improvements[13,22]
$1.1 billion	Benefits apportioned to controls in coastal waters by angling effort.	Recreational Angling-Based Allocation of National Benefits (based on US FWS (1989) and Mitchell-Carson (1991)).
$1.3 billion - $2.7 billion	Recreational angling benefits only, for NPS controls in coastal waters.	Value of Recreational and Angling in Salt and Great Lakes Water (based on US FWS (1989) and Walsh et al. (1988, 1990)).
Nonuse Benefits:		
$0.7 billion - $1.6 billion	NPS controls in coastal waters. Includes coastal households only.	Household WTP for Water Quality Improvements[13,22]
$0.9 billion	Nonuse benefits apportioned to NPS controls in coastal waters by angling effort.	Recreational Angling-Based Allocation of National Benefits (based on US FWS (1989) and Mitchell-Carson (1991)).
Further Corroborative Studies		
Use Benefits:		
$3.5 billion	Damages from cropland erosion only. Includes coastal and noncoastal areas.	Clark et al.[24]
$0.3 billion	CRP-related cropland erosion control benefits, limited to 9.1% of croplands in broad "coastal" regions, omitting several benefit categories.	Water Quality Benefits of CRP[26]
$0.9 billion	NPS controls in 201 county, seven state region. Benefits outweigh costs by factor of 3 or more.	Tennessee Valley NPS Controls[25,27]
$0.8 billion - $1.5 billion	NPS control benefits across 11 western states. Benefits outweigh costs by factor of 3 or more.	Federal Land NPS controls[26,28]
Nonuse Benefits:		
$0.4 billion - $0.7 billion	NPS coastal benefits across 11 western states.	Federal Land NPS controls[27,28]

*1990 dollars

Ribaudo's[24] estimated benefits pertain only to cropland erosion benefits for acreage retired under the Conservation Reserve Program. While the benefits estimated for coastal regions encompass inland waters, the benefits omit two important benefit categories and are limited by the CRP's enrollment focus on croplands in the nation's interior. Nonetheless, the coastal regions generated estimated benefits that amount to $0.3 billion annually for only 9.1% of the region's croplands.

Finally, two studies of regional NPS control scenarios indicate benefits of the same general order of magnitude as deduced from the studies described above. The benefits in the seven-state, 201-county Tennessee Valley region amount to $920 million annually (on-site plus water quality benefits, 1990 dollars). Likewise, the preliminary estimate of benefits of controlling NPS pollution on federal lands in the western states is estimated at $1.2 to $2.2 billion per year (of which between $600 million and $1.15 billion are attributable to recreation).

In sum, the aggregate benefit estimates described above are not particularly robust, nor directly applicable to the Guidance in some cases. Nonetheless, the consistency of the benefit estimates suggests that Guidance-related NPS control benefits could well be appreciable—potentially, in excess of $1 billion annually. These benefits are predominantly associated with enhanced recreation. These benefits also exceed the estimated costs of the adhering to the Guidance. Studies cited of other NPS control programs also suggest that benefits appear to exceed costs (or are, at least, commensurate with costs).

6.0 CONCLUSIONS

This paper has illustrated the difference between using expenditures and actual benefits measures grounded in economic theory for the purpose of estimating the gains to recreation from water quality improvement. As water quality improves, expenditures in the region may rise or fall. An individual may change his or her behavior in such a way that benefits from the improvement are measurable. Changes in expenditures might reveal something about the likely changes forthcoming in local economies if such estimates are accurate. For example, it is possible that another gas station might need to be built in order to service incoming tourists or recreators to the region.

This change in expenditure, however, has little or nothing to do with the benefits from recreation that are associated with the project. Such benefits are large, and often can swamp the cost of the water quality improvement itself. We close our discussion with a few final points.

1. Many economic models only provide estimates of benefits from simulations of enhanced catch rates[8] or from estimates of WTP rather than forego use of the site,[28] and thus the link between actual water quality improvement and these enhanced catch rates is missing.
2. Estimated benefits are often not directly comparable, in that some are estimated per person, some per "trip" or "day" of an activity, and some for a larger aggregate unit such as a state or county.
3. Some estimates are quite "preliminary" and are subject to revision or change[8] (McConnell et al. 1992).
4. Some aggregate estimates are extrapolated for the entire affected population, while others only are aggregated for a group of recreators. Table 2 indicates the group over which the total applies.

Finally, it is most important to stress that all benefits numbers are estimates. As such, they involve some error. In a primary study, this error stems from the fact that investigators cannot observe everything about individuals and recreation sites that there is to be known. This form of randomness is transmitted to the benefit estimate for an individual or group of individuals. Researchers are quite cognizant of this[29] and are more careful than they might have been in interpreting benefits estimates in the early years

of recreation-demand modeling. In transferring benefits from one site to another there is, of course, also some error. Determining how large such an error is requires knowledge of the similarity of the characteristics and prices of the recreation site(s) and the individuals in both the original study and the site for which an estimate is being sought (the policy site).

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The Costs of Marine Debris Washups On New York and New Jersey Beaches

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ABSTRACT

The New York Bight is perhaps one of the most used and abused coastal areas in the world as a consequence of urbanization and the disposal of the waste of some 20 million people who reside by its shores and surrounding bays and estuaries. A variety of sources contaminate these coastal waters. Many of the stresses of excess population and industrialization as measured by pollutant loadings and ecosystem impacts can be crudely quantified in terms of use impairments—use impairments that have measurable social and economic relevance. Beach closures caused by floatable marine debris are a category of impairment that have caused significant economic losses. We have examined beach closures and how the public has avoided beaches at New York and New Jersey ocean beaches following the major floatable washups of 1987 and 1988.

Our measures were loss of user days and total expenditures. The methodologies used are not standard nor totally quantifiable. However, during years of major washups, the losses to local economies for both states can be measured in billions of dollars. Corrective measures, while expensive, are necessary if area beaches are to continue to be a significant part of the tourist economies.

1.0 THE COSTS OF MARINE DEBRIS WASHUPS ON NEW YORK AND NEW JERSEY BEACHES

Introduction

Floatable wastes are waterborne materials and debris that are buoyant. These include debris (wood and beach litter such as cans, bottles, styrofoam cups, sheet plastic, balloons, straws, and paper products); sewage-related wastes (condoms, sanitary napkins, tampon applicators, diaper liners, grease balls, tar balls, and fecal material); fishing gear (nets, floats, traps, and lines); and medically related wastes (hypodermic needles, syringes, bandages, red bags, enema bottles).

Debris washups along the beaches of the New York Bight have been occurring for over a century. Cleanup operations have been costly to government and the tourist industry has suffered as well. In 1931, it was estimated to cost $10,000 per mile to remove refuse along New York's ocean beaches.[1] In 1976, when Long Island's south shore beaches were declared a Federal Disaster Area because of floatable wastes, the local economy was estimated to have lost $15 - $25 million. Beach cleanup may have cost more than $100,000.[2]

Following the 1987 and 1988 floatable washups in New York and New Jersey, the U.S. Environmental Protection Agency, Region II, as part of the New York Bight Restoration Plan, commissioned the Waste Management Institute to review the causes and impacts of the washups.[3] This paper reviews some of the costs associated with those washups in terms of loss of direct expenditures at beaches. Losses associated with reduced sales of fisheries products are not presented.

Areal Extent—In the period 1980-1988, there were on the order of 100 beach closures around the New York Bight (Figure 1) due to floatable wastes. Until 1989, the criteria for closing beaches because of floatable wastes were not consistent from beach to beach. Water quality (as measured by the coliform indicator) was generally not a factor in closing beaches during a floatable washup. Rather, closures depended on subjective criteria such as the look or smell of the material or on expectations of public perception—to avoid a possible public outcry. Most closures occurred for hours—rarely more than a day. More consistent beach-closure guidelines by local and state agencies are now in use.[4] Today, beach operators are more inclined to quickly and quietly clean up floatable debris and go about business. Negative press reporting on debris washups has been costly.

In New Jersey, beaches over a stretch of some 40 km were closed due to floatables on numerous occasions during May 1987. In August 1987, roughly 85 km of beaches were closed periodically in the same state (Figure 1). Few beaches in New Jersey were closed because of floatable wastes in 1988. In New York in 1976, sewage-related floatable wastes were responsible for closing some 90 km of beaches. There were 2 km of beaches closed in 1987, but in July 1988, 93 km of beaches were closed due to medically related and other floatable wastes (Figure 1).

Temporal Changes—From the late 1800s through the 1930s, garbage, paper, bottles, metal, and animal carcasses were discarded into New York Bight and New York harbor waters (e.g., Dead Horse Point in Jamaica Bay). Following the cessation of refuse dumping in 1934 and the gradual construction of sewage treatment plants throughout the region in the 1930s and 1940s, the floatables problem was probably less apparent for some period of time. During the 1960s and 1970s, styrofoam cups, disposable plastic diapers, plastic tampon applicators, and PET (polyethylene terephthalate) bottles increased the floatables load. Of course, some small quantity of medically related wastes found with the typical floatables focused international attention on area beaches in the late 1980s.

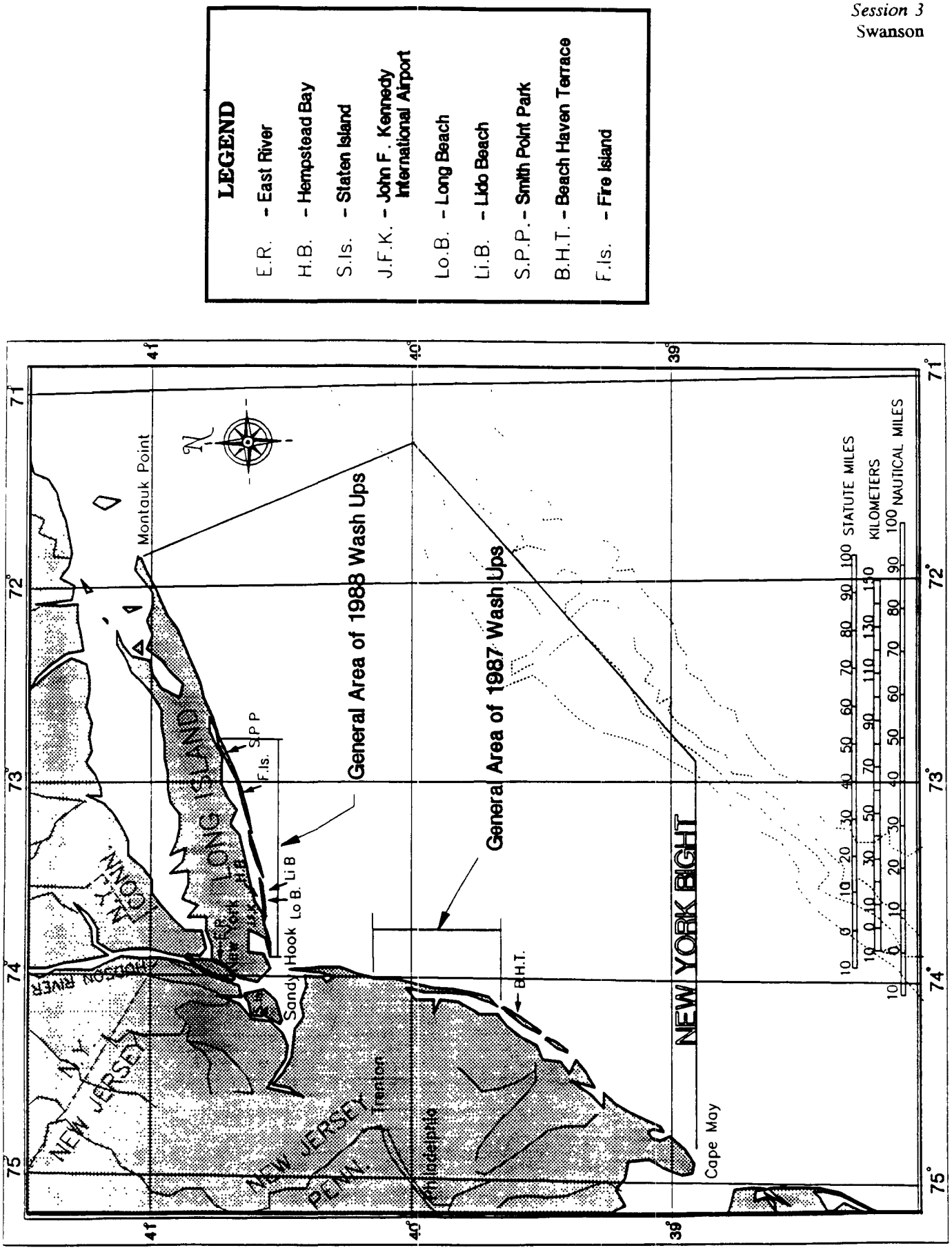
Causes of Washups—The sources for the majority of the floatable wastes are located along the periphery of the Hudson-Raritan Estuary, and many of these wastes are flushed out into the New York Bight during the spring freshet of the Hudson River.[5] The peak floatable waste input from the freshet is at or near the start of the beach season.

During the summer, rainfall often causes bypassing of sewage treatment plants. Floatable wastes are spewed to the receiving waters from combined sewer overflows (CSOs). CSOs are a major source of floatables to the region's coastal waters. Until recently, garbage and trash reached marine waters through improper solid waste handling in the metropolitan area. Storm sewers also contribute to the problem. Illegal disposal occurs but is probably a minor source.

Sea breezes may wash ashore debris accumulated along oceanic fronts and convergences and in Langmuir circulation cells. Long Island is particularly vulnerable to washups of floatable wastes because of the prevailing southerly summer winds in the area.[2,5]

Problems Associated with Washups—Floatable materials on beaches and in coastal waters are mainly an aesthetic problem for the public. There is a perception that contact with floatable material poses a major public health threat. There is no evidence to support that supposition. Public safety (injury from cuts, bruises, and punctures) is a more significant threat. The fear of exposure to AIDS made the medical wastes found in the floatable material a major concern in the 1987 and 1988 washups. These fears are unfounded. The chance of acquiring AIDS in this manner is close to zero.[6] Also, the risk of acquiring Hepatitis (B and non-A/non-B) from a needle that has washed ashore is extremely low.[7]

There are detrimental impacts on marine birds, turtles, fishes, and other marine animals from floatable wastes which may result in death: entanglement in plastic objects and in fishing line and ingestion of plastic objects that are mistaken by animals for prey food may occur. Some of the impacted marine animals have been designated as endangered or threatened species, underscoring the ecological significance of this impairment.


LEGEND
E.R. - East River
H.B. - Hempstead Bay
S.Is. - Staten Island
J.F.K. - John F. Kennedy International Airport
Lo.B. - Long Beach
Li.B. - Lido Beach
S.P.P. - Smith Point Park
B.H.T. - Beach Haven Terrace
F.Is. - Fire Island
General Area of 1988 Wash Ups
General Area of 1987 Wash Ups
NEW YORK BIGHT
LONG ISLAND
Montauk Point
Sandy Hook
Cape May
Trenton
Philadelphia
NEW JERSEY
PENN.
HUDSON RIVER
STATUTE MILES
KILOMETERS
NAUTICAL MILES

Economic and Social Impacts—Estimates of the economic consequences of beach impairments from floatables were based on beach use which can be measured in user days (a person going to a beach for all or part of a day). There is no single or comprehensive source from which these data can be derived.

The extent to which beach use decreased at New York beaches in 1988 as a result of floatable washups was approximated by extrapolating beach attendance at New York State Park beaches where attendance data are estimated. Loss in user days was approximated by assessing the attendance data from 1976 (60 million user days), the baseline attendance figure[a] (105 million), and attendance in peak years (150 million). Using these data, the reduction in beach use was estimated to have ranged between 30 and 90 million user days in New York State. Comparable figures for New Jersey were 6.7 to 37 million user days (based on an observed decline in beach attendance of 7.9% to 34% at beaches along the New Jersey shore in 1987-1988). Direct expenditures were estimated by adapting per-trip expenditures from other studies and adjusting them to 1987-1988.

A beach pollution event has three major economic impacts. First, there is a reduced level of expenditures on local beach activity, which has negative effects in many sectors of the economy. Second, there are impacts on employment. Third, the people who use the beaches suffer a lower quality of life because of diminished recreational opportunities. The measures of the first two impacts are apparent to the noneconomist. The third, measured by consumers' surplus, is not considered in this analysis.

Reductions in direct beach expenditures were multiplied by a factor of 2.5 to estimate loss in total expenditures—a result of the beach expenditures not being respent. For New York, the loss in total expenditures was estimated to be between $750 million and $1.8 billion for 1988 (using 1987 dollars). The New Jersey loss in total expenditures was estimated to be between $600 million and $3.6 billion. The reasons for the difference in the estimates of losses for the two states is not clear. However, it must be kept in mind that the character of the ocean beach areas of the two states is considerably different (it is much more commercial in New Jersey). Also, the manner of generating attendance figures is completely different. New Jersey, of course, experienced major floatable problems in 1987 so that frequenters of the New Jersey shore were reacting in 1988 to a problem over two summers.

In an independent analysis, R.L. Associates[8] reported a reduction in user days of 1.9 million in 1988 relative to 1987 along the New Jersey coast. They also reported a reduction of $700 million in expenditures in 1988 relative to 1987.

In a study for the Long Island Tourist and Convention Commission, Fey[9] estimated that the net loss of expenditures on Long Island in 1988 was $700 million. In this estimation, the Commission considered that the loss in beach-related expenditures of $1.4 billion was partially returned to other parts of the economy and that the Island had been experiencing a 5.6% growth rate in the tourist industry since 1978. The actual loss in expenditures in 1988 relative to 1987 was $900 million.

While it is difficult to be precise, it seems evident based on several different studies that losses in total expenditures in 1988 amounted to several billion dollars in New York and New Jersey. Losses in jobs (full and part-time) could be measured in the tens of thousands.

In an effort to reduce the impact of floatables, the U.S. Environmental Protection Agency (EPA) in cooperation with the U.S. Army Corps of Engineers (COE), the U.S. Coast Guard, the states of New York and New Jersey, and New York City implemented a short-term floatables action plan. The plan supplements the U.S. Army Corps of Engineers' program of skimming New York Harbor for debris that might pose a hazard to navigation. The effort, implemented in 1989 at an additional cost of $1 million,

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[a]Assumes no unusual events that would influence beach attendance, such as poor weather, floatable washups, gasoline restrictions, etc.

Table 1

Beach Closures and Significant Floatables Washups at Ocean Beaches of New York and New Jersey, 1989 through 1992

	1989		1990		1991		1992	
	NY	NJ	NY	NJ	NY	NJ	NY	NJ
Beach Closures		31 July: Ocean City (garbage) 18-20 August: Sandy Hook (general floatables)		25 July: Belmar, Monmouth Beach, Atlantic Beach, Allenhurst, Seven Presidents Oceanfront Park	31 August: Jacob Riis Park (crack vials, syringes)		6 June: Robert Moses State Park (oil)	
Significant Washups	24, 25 June: Atlantic Beach (grease balls) 2 July: Atlantic Beach (oil, grease, vials, syringes) 1 Sept: Atlantic Beach		23 June: Lido Beach, Jones Beach, Robert Moses State Park (general floatables) 27, 28 June: Fire Island, Jones Beach State Park, Gilgo Beach (general floatables)		17 July: Atlantic Beach (general floatables) 18, 19 July: 8 km along Robert Moses State Park (general floatables, syringes, needles) 14, 15, 17 August: Gilgo Beach, Long Beach (general floatables, syringes, crack vials) 6, 7 August: 10 km at Jones Beach State Park (general floatables)		20, 21 Atlantic Beach, Jones Beach, Babylon (general floatables, syringes, crack vials)	29 May: Monmouth Beach (general floatables) 2, 3 June: Belmar, Sandy Hook (wood, general floatables, garbage)

consists of reducing the mesh size of the existing nets in order to pick up much of the floating debris. Skimming operations and surveillance also occurs much more frequently than earlier.

2.0 BEACH CLOSURES AND WASHUPS 1989-1992

Since 1988, there have been relatively few beach closures along the ocean beaches of New York and New Jersey (Table 1). In fact, significant washups have occurred infrequently (Table 2). The decreased frequency of these events can be attributed to the fact that meteorological conditions that influence the quantity and distribution of floatable material have not favored landfall in either New York or New Jersey.[10-13] The short-term floatable action plan has also aided in capturing much of the material that did escape to marine waters. Also, beach operators have been cleaning the beaches early and more often reducing the likelihood of creating a media event. Covering garbage barges and policing marine transfer stations also reduced the floatable load in Hudson-Raritan Estuary.

People have returned to area beaches as is evident from 1988 and 1991 attendance figures from Jones Beach State Park on Long Island (Table 2). The changes in the monthly attendance figures are much more dramatic if they are normalized to reflect that June 1988 and June 1991 had four and five weekends respectively and July 1988 and July 1991 had five and four weekends respectively. A good weekday attendance figure at the Park is 50,000 and a good weekend day may have an attendance of between 150,000 and 180,000.

Table 2

Attendance Comparison for Jones Beach State Park 1988 and 1991

Month	1988 Attendance	1991 Attendance
June	1,258,000	1,569,000
July	1,318,000	1,720,000
August	862,000	1,531,000
TOTAL	3,438,000	4,820,000

NOTE: At Jones Beach, medical debris began washing ashore in significant quantities on Wednesday, July 6, 1988. The impact on attendance was felt immediately: with nearly identical weather on July 6 & 7, attendance on the 6th exceeded 50,000 while on the following day attendance was less than half that figure. Beach attendance was restored to pre-washup patterns by the summer of 1991.

(Joseph Lescinski, Superintendent, Jones Beach State Park, personal communication)

NOTE: 4 weekends in June 1988
5 weekends in June 1991

3.0 CONCLUSIONS

Despite the lack of a major floatable event over the last four summers, it is important to remember that floatable wastes are still washing ashore. The primary source of floatable waste in the New York/New Jersey metropolitan region, CSOs, still exists. Until there is a solution to the CSO problem, floatables will continue to contaminate the harbor and adjacent coastal waters and beaches.

New York City's long-term goal to contain and treat CSO discharges at a cost in excess of $1 billion over the next decade is a prudent investment. Other municipalities should do likewise. Capturing this debris prior to its being dispersed in the marine environment is far more effective and efficient than skimming waterways and cleaning beaches. A key element in capturing debris before it gets into the marine environment is that of reducing the quantity that gets into the CSO systems in the first place. Continued education of the public as to how to properly dispose of potential floatable debris is important and is being actively pursued. Equally important is the need to keep coastal city streets clean and free of potential floatable debris. Unfortunately, street cleaning is often one of the first programs cut in a budget crisis.

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Tuesday, October 20, 1992

Session 4: Commercial Fisheries

SESSION SUMMARY

MODERATOR: Tudor T. Davies

PRESENTERS:

Carlos Fetteroff—Paper Unavailable

Richard E. Marks—*Clean Water: The Seafood Connection*

Andrew A. Rosenberg—*U.S. Living Marine Resources: Current Status and Habitat Related Issues*

Ivar Strand—*The Contribution of Clean Water to Commercial Fisheries*

Clean Water: The Seafood Connection

Richard Marks
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ABSTRACT

People depend on the living resources of the oceans for a basic human need—food. For example, 90 million metric tons of fish and shellfish are being harvested annually on a global scale; 60% of the world's people receive more than 40% of their annual protein from fish; U.S. consumers pay in excess of $26 billion for fish and fish products each year. Regardless of the numbers, it suffices to say products from the sea constitute significant economic benefit, but more important is the benefit as food. People have a need to eat. Fish harvest, as opposed to production of animals or crops, does not contribute to water or air pollution. Therefore, sustaining food from the sea is an important goal, and a healthy environment is a necessity. Chemical contamination and eutrophication threaten the productivity and usability of the resources. Inconsistent standards and risk assessments do nothing to focus our research needs. Unregulated point discharge and nonpoint additions are jeopardizing our coastal zones and inland lakes. A healthy, productive ocean environment is essential not only for the world's fishing industries, but for society as a whole. Because the oceans are shared among many nations, efforts to protect marine ecosystems require concerted international attention.

Aquatic animals supply the world with 90 million tons of protein annually. In the U.S., more than $26 billion worth of fish and seafood are consumed each year. Clean water is the connection to this wholesome and abundant supply of seafood. However, this supply of food is increasingly threatened by the contamination of rivers, lakes, and vital coastal areas. Polluted water has devastating affects on our resources and our industry in three areas: (1) destruction of habitat and productivity; (2) subsequent loss of utilization; and (3) weakened consumer confidence. Additionally, pollution has no geographical boundary. It is a global problem which requires a concerted international effort. More effective water pollution control measures are needed to prevent further degradation of our resources, our food supply, and to reaffirm consumer confidence.

1.0 DESTRUCTION OF HABITAT

In recent years, overfishing has been implicated as the major cause for most fishery population declines. Ironically, excessive harvest, which is controllable, may be the least of our fishery problems. Anthropogenic factors such as destruction of coastal wetlands and pollution may prove to be among the most difficult challenges.

Maintaining healthy aquatic ecosystems entails more than controls and preventing pollution. A great many of our fishes and invertebrates spawn or utilize coastal areas as nurseries in the early, critical stages of life. For example, nearly 87% of the value and 82% by weight of U.S. finfish landings are species whose life history depends all or in part on near-coastal habitat.[2] Landings of estuarine-dependent species may run as high as 98% in the south Atlantic region alone.[3] To maintain sustainable fisheries we must minimize disturbance to productive habitat.[4]

Collectively, we have not been successful. The U.S. has already lost an estimated 50% of its coastal wetlands since the 1700s.[2] Specific regions have suffered coastal marsh and seagrass meadow losses equaling 90% or greater of their original coverage.[3]

Besides habitat loss/destruction, toxic and pathogen contamination and eutrophication are identified as other areas of concern.[2,4]

In 1991, the EPA reported that "Water quality impairment remains one of the most important environmental problems facing the U.S. In coastal areas, impaired water quality is evidenced in prohibitions on harvesting shellfish, beach closures, and biological productivity in coastal habitats (EPA, 1991)." Indeed, current EPA estimates indicate that for the 75% of estuarine areas assessed, 10% are threatened and 35% are impaired.[5]

In fact, back as early as the latter part of the 19th century, fishery resource surveys indicated that by the time of the Civil War, pollution had an impact on living marine resources. The escape of petroleum products reportedly affected the abundance and distribution of oysters, other shellfish, and finfish.[6] Additionally, there is evidence that by the end of the first quarter of the 20th century, shellfish and finfish were already affected by the release of petroleum products to the waters of lower New York Harbor.[6]

2.0 LOSS OF PRODUCTIVITY

Oceans cover approximately 71% of the earth's surface. A mere 7% of this total is considered coastal water and supports a large portion of all fishing activity.[7] In 1991, nearly 50% of U.S. commercial finfish and shellfish landings (by weight and value) were harvested within 3 miles of the shoreline.[8] Indeed, coastal habitats are among the most productive on the planet.

The correlation between water quality and productivity can be striking. For example, tens of thousands of Atlantic salmon were annually harvested from the Penobscot River until 80 years ago. By 1957, pollution had virtually eliminated the run. Cleanup was initiated in 1960, and by 1982, 914 fish were caught in the river.[4]

We can see evidence for a loss of productivity in a coastal species such as striped bass. Anadromous species spend an important and large part of their life history in coastal areas which are most heavily impacted by poor water quality. In 1973, harvest levels reached 14.7 million pounds. By 1983, this had dropped to 1.7 million pounds. Currently, a successful management plan has helped to initiate stock improvement, but with a lack of clean water, it remains questionable how far we can go.

Offshore fishery stocks of the mid-Atlantic region also depend on coastal habitat productivity. In addition to functioning as a nursery, coastal habitat provides piscivorous species with a forage base through an abbreviated foodchain involving plankton and menhaden, a primary forager on plant detritus and phytoplankton. These piscivorous species are then available to commercial and recreational anglers (Lewis and Peters, 1984).

Recently, poor water quality through excess nutrient input has been implicated in the loss of productivity and other serious concerns. Nutrients may stimulate toxic algal blooms which can kill fish outright, lead to hypoxia and eventual death, and shade marine grasses which may ultimately impact the recruitment of coastal-dependent species.[4] Several situations have resulted in public health concerns over seafood consumption.

Since 1987, there has been increased incidence of toxic algal blooms. In 1987 and 1988, a red tide, previously thought endemic to Florida, spread to North Carolina releasing a brevetoxin and shutting down shellfishing, resulting in a loss of $25 million. Also in 1987, in Prince Edward Island, Canada, three people died and more than 100 others got sick from eating mussels contaminated with domoic acid, a naturally occurring toxin causing amnesic shellfish poisoning. In fall 1991, pelicans eating anchovies offshore in California were found to be dying from domoic acid poisoning. Shellfish and crab fisheries were shut down from California to Washington due to high levels of domoic acid. Recently, the potentially lethal paralytic shellfish poison, saxitoxin, was found for the first time in the guts of dungeness crab from Alaska.[9]

In 1988, eutrophication was also determined to be initially responsible for the hypoxic conditions which resulted in the death of large numbers of flatfish in the Raritan River, New Jersey. A buildup of organic matter generated by the bloom created the hypoxic conditions.[2]

In North Carolina during 1991, documented fish mortality due to toxic dinoflagellate blooms killed in excess of 1.5 billion menhaden, flounder, and blue crabs (Howard Glasgow, NC State Botany Dept., personal communication). In the Chesapeake Bay, loss of native sea grasses and subsequent reductions in juvenile fish and shellfish populations may be tied to eutrification. Oyster populations have declined 96% from levels 100 years ago. Speculation also exists for the relationship between brown tide and the crash of the scallop fishery in the Peconic Bay system off Long Island, New York.

Some experts point to increased nutrient load as the culprit but the cause may be multi-faceted. We do not really know how biotoxins and chemical toxins are affecting the spawning behavior and survival of juvenile fishes. Now, as in the past, scientists are researching the subtle effects of toxic contaminants on finfish populations manifested in the decline of growth and reproduction.[10]

3.0 LOSS OF UTILIZATION

Chemical contaminants can affect the health of an organism as well as the quality of seafood products which may risk human health. Many of our inshore waters are so called "contaminated" yet we have little grasp of what that truly means. We don't know the source, extent of contamination, or its long-term effects.[4]

Oftentimes, fish are healthy but consumptive value is lost due to contamination. Examples exist from the latter part of the 19th century when some finfish could not be used for consumption because they tasted of coal oils resulting from the escape of petroleum products.[1]

In the 1970s, mercury levels completely shut down the pelagic swordfish fishery. The FDA set guidelines for methylmercury at a risk-averse 0.5 ppm. Before the FDA could adjust their contaminant standards to a more accurate 1.0 ppm, the industry collapsed.[11] Businesses were lost as consumer demand approached zero. Landings plummeted from 287 tons in 1970 to 35 tons in 1971. As in other cases like this, the fish were healthy and abundant, only consumers were scarce. We are seeing some of the same concerns today in tuna and sharks.

The loss of utilization is particularly worrisome regarding molluscan shellfish which inhabit coastal waters. Molluscan shellfish can pass diseases associated with human sewage if not purchased from respectable dealers working with product harvested in monitored waters. Unfortunately, fully one-half of the most productive shellfish growing areas may be closed for harvest 50% of the year (Kilgen, 1991). In 1980, the California oyster industry suffered a loss of $631,000 due to an outbreak of paralytic shellfish poisoning.[12] Here again, shellfish may be abundant in these waters, but the utilization has been lost to poor water quality.

4.0 CONSUMER CONFIDENCE

The loss of utilization leads directly to a weakening of consumer confidence. Fritter[4] stated that "It is most probable that all human foodstuffs are affected in some way with contaminants." In 1992, the FDA reported that the vast majority of seafood in this country is safe, clean, and free of contaminants (Commissioner David A. Kessler, FDA—addressing NFI Board of Directors, April 1992).

Unfortunately, and for no apparent reason, seafood has become the major target. A myriad of advisories has shaken the confidence of the consumer. In the recent past, PCB levels resulted in warnings on the consumption of striped bass in New York due to contamination by metals and pesticides. Warnings were issued to young children and pregnant or nursing mothers. Bluefish consumption was reduced to one-half pound fillet per week with the blood line removed. Sportfish advisories have and do exist in the Great

Lakes. Washington state has reported tumors on the livers of flatfish foraging on contaminated soils.[2] In 1991, the state of Minnesota issued mercury warnings for shark consumption.

Advisories create a serious economic problem. While consumers can still consume the product, the cost/benefit equation is ruined for the industry. The impact has a ripple effect through the industry, starting with the retailer and ending with the fisherman.

The troublesome die-offs of dolphins and humpback whales off the Atlantic coast in the late 1980's, beach closures, and rumors of hospital waste severely impacted the seafood industry. The correlation between the die-offs and water quality was questionable. However, numerous companies suffered in the aftermath.[1]

These incidents provide grist for the hysteria mill. Special interest groups are using the water quality issue to stir public fright. We hear cries that "fish are the sponges of their environment", and ridiculous claims such as "salmonella originating from salmon." The majority of these claims stem from the water quality issue, and negatively impact the industry regardless of their accuracy.

Should concerns about seafood contamination be raised? In Japan, people eat many times more fish than we do here in the U.S. Yet, they do not suffer from increased chronic illnesses. In fact, they live longer.

Another important point to consider is, compared to the production of other proteins, seafood production results in less impact to the environment. A lack of pesticides, fertilizers, runoff, and greenhouse gases makes seafood production that much more desirable. It would be difficult to replace the annually harvested 90 million metric tons of seafood with land-based protein production. The environmental impact would not be sustainable.

5.0 A GLOBAL ISSUE

Living marine resources are shared among the nations of the world. All nations should be encouraged to develop and maintain standardized, sustainable practices. For example, in 1988 the National Academy of Sciences predicted a potential 2-9°F increase in global temperature as a result of global emissions. This may impact food chains of the world's oceans via oceanographic changes (NAS, 1988). Although speculative, it supports the need for international agreements. The U.S. must assume the leadership role in these areas.

Advisories also impact international commerce and the 30 to 40% of our total harvest which is exported. PCB warnings for Great Lakes salmon were heard in Switzerland, a major importer of U.S. salmon products. The scare resulted in the Swiss refusal of any U.S. salmon, including wholesome West Coast-harvested species.

6.0 AREAS OF CONCERN

The reauthorization of the Clean Water Act provides Congress with an the opportunity to do something about the problems facing the U.S. and our food supply from contaminated water. There have been some improvements, particularly in the area of point source controls, but as I have shown, substantial problems still exist. Efforts must be made in the following areas if we are to maintain a safe, healthy supply of seafood.

Wetlands—Section 404 of the CWA is perhaps the most contentious. How can we satisfactorily care for our resources when the current Administration is admittedly fuzzy about what constitutes a wetland? Continuing to vacillate will not save our most productive areas.[14] The key to the development of sound wetland legislation is not to reinvent the definition but rather to utilize the existing body of knowledge to encompass wetland protection and economic growth. Developing region-sensitive

classification, streamlining the regulatory process, and addressing private ownership are important components. According to Copeland,[15] Section 404 issues cannot be permitted to overshadow other sections of the act.

Point Source—Positive steps have been taken under Section 403(c) to control discharge from point sources. The National Pollutant Discharge Elimination System (NPDES) requirement that all point discharges must not "unreasonably degrade the marine environment" must be maintained and strengthened.

The pretreatment of toxic material released through industrial discharge to municipal sewers remains a serious enforcement problem. The EPA estimates that double the volume of toxic wastewater is released to treatment plants than is directly discharged to surface water.[16] Ironically, the Water Quality Act of 1987 dramatically changed how the nation will finance construction and improvements of state wastewater treatment plants to conform with requirements of the act. The amendments of 1987 replaced federal funding with a State Revolving Fund (SRF) by which states will generate their own loan programs via federal seed monies. According to a recent GAO report (Hembra, 1992), SRFs are not sufficient to handle the problem of keeping treatment plants at an efficient level. Since 1972, Congress has provided $57 billion in wastewater construction assistance to achieve requirements for secondary treatment of municipal sewage. The EPA and the states estimate needs totalling an additional $83 billion.[16]

Unregulated combined sewer overflows (CSOs) are cause for serious concern. During periods of high precipitation, wastewater treatment plants that cannot handle the increased volume discharge effluent directly to surface water. Under the CWA, CSOs are defined as point sources yet they require less permitting restrictions compared to other point sources.[16]

Nonpoint Source—The EPA suggests that nonpoint pollution is responsible for 60% of water quality problems and that failure to curtail that will prevent the nation from reaching its water quality objectives.[15] Section 319 of the CWA is critical to improving water quality. Eutrification is a direct result of nonpoint input. The Chesapeake Bay receives 38% of its nitrogen and 53% of its phosphorous via landbased nonpoint sources. Atmospheric deposition accounts for 30% of the nutrient input to the Bay.[2]

Copeland[16] reports that budget constraints have frustrated the implementation of new programs and impeded state response. The FY 1992 funding for grants under Section 319 allocated 50% less monies to states for nonpoint programs than in FY 1991.

Contaminants—Toxins may affect marine organisms in ways science has yet to determine. Efforts have already started to shift toward less conventional pollutants and pathways, to persistent toxic substances and atmospheric deposition.[10] It is critical to push for zero-tolerance or "virtual elimination" of these substances. At this point, we are not sure what the potential impacts are of these substances on our environment or food supply.

Accordingly, we need to develop valid indicators or direct detection of contaminants in our food supply and to help develop microbial standards and guidelines. Currently, "practical methods for determining health risk from potential human fecal contamination in estuarine waters for shellfish and seafood, and indeed for all foods - does not exist (Kilgen, 1991)." We need valid indicators or direct detection to facilitate the development of microbial standards and guidelines (Kilgen, 1991). For example, during periods of heavy rainfall, runoff from animal or other nonhuman sources can carry high levels of indicator bacterial into shellfish beds resulting in closure despite the fact that no concrete public health risk has been established (Kilgren, 1991).

7.0 CONCLUSION

The 1972 amendments to the CWA made "fishable" water a specific national policy objective. This highlights the link between environmental quality and fisheries.[18] What is missing now is a clearly defined series of objectives and priorities. The seafood industry depends on water quality for its very

existence. We need to maintain an organized, long-term process that will protect our marine resources. Without viable habitat, there are no fish. Without fish, there is no seafood business.

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U.S. Living Marine Resources: Current Status and Habitat Related Issues

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ABSTRACT

The long-term potential yield of the living marine resources of the United States is 9.5 million metric tons worth nearly $7 billion in first-sale value. Recent annual yields have amounted to about 69% of this potential (6.6 million MT) worth around $5 billion. Of 200 fish or shellfish stocks in federal waters, 57 are over utilized; that is, there is more fishing effort operating than is needed to harvest the potential yield. In some of these fisheries, the stocks are depleted and yielding well below their potential, while others are economically inefficient or at high risk of depletion. Of the remaining stocks, 55 are fully utilized and 28 are under utilized. The status of 60 stocks can not be determined.

In nearshore state waters, of 36 stocks whose fisheries have been evaluated, 10 are over utilized, six are fully utilized, and 20 are of unknown status. Recent yields from nearshore resources are over 200,000 MT. The commercial part of this yield is worth over $375 million, and the recreational value is likely to be far higher.

Most of the nearshore resources and several important stocks in federal waters are impacted by water quality or habitat changes. In some cases, this may reduce the long-term potential yield from the fishery and adversely affect the important recreational value of the resource. In other cases, poor habitat for the resource base increases industry costs, reduces marketability, or can destabilize the fishery. Management of our living marine resources is improving in recent years, to take advantage of their potential economic value to the nation. This could be undermined by adverse impacts on fish and shellfish habitats through water quality or other pollution-related problems, particularly in nearshore regions.

1.0 INTRODUCTION

The National Marine Fisheries Service (NMFS), part of the National Oceanic and Atmospheric Administration in the U.S. Department of Commerce, published the first annual report on the living marine resources of the United States in 1991. The second annual report will appear before the end of 1992. These reports, entitled Our Living Oceans, describe the marine resources of the nation and categorizes them according to their current state of utilization.

In this paper, I summarize the information in Our Living Oceans concerning the status of U.S. living marine resources. This information is then considered in the light of environmental effects on fisheries in a general sense. The impact of habitat and water quality on fish productivity.

2.0 CURRENT STATUS

There are 236 stocks of fish and shellfish described in the 1992 edition of Our Living Oceans. Using the available scientific information and the best judgement of NMFS scientists the report lists the long-term potential yield, recent average yield, and status of utilization for each stock.

The long-term potential yield is the amount of fish or shellfish, in weight, that can be harvested sustainably from the resource under good management. If fishing mortality (i.e., the harvest rate)

was carefully controlled and adjusted to the productivity of the resource, then the long-term potential yield would be, on average, the most that could be taken from the stock without depleting it.

The long-term potential yield from U.S. living marine resources is estimated to be about 9.5 million metric tons. More than 40% of this potential is in the waters of Alaska (Figure 1a), while the other regions of the country (Coastal Pacific, Oceanic Pacific, the Southeast and the Northeast) each contribute between 10 and 20% of the total. Bottom dwelling fish make up 48% and pelagic species of fish and give 43% of the total long-term potential yield. The majority of the potential yield in weight results from three fisheries; Alaska groundfish such as walleye pollock, Pacific tunas, and Atlantic and Gulf Coast menhaden and butterfish. However, in value of the resources, not including recreational value, shellfish such as shrimp, scallops, and lobsters dominate. Regionally, the southeast, with its large shrimp fisheries, has the most valuable commercial resources (Figure 1b), closely followed the oceanic Pacific where valuable tuna stocks dominate the commercial landings.

The recent average yield is what is actually being harvested from each stock currently. If it is much more than the long-term potential, such high catches are unlikely to be sustainable and the stock will be depleted. If recent yields are much lower than the long-term potential, the stock is not now being heavily exploited or it is already depleted to a low level and needs to rebuild before higher sustainable yields will be available. The 1992 edition of Our Living Oceans also gives the current stock level, relative to the level that would support the long-term potential yield, to clarify stock status.

The status of utilization is, in the best judgement of NMFS scientists an indicator of level of use of the fishery resource. Stocks are classified as under utilized, fully utilized, over utilized, or unknown. Details are given in Our Living Oceans. Briefly, an over-utilized resource is being harvested faster or more heavily than is sustainable in the long term. This usually results from the application of too much fishing effort than needed to take the long-term potential catch. An over-utilized resource is often being depleted and yielding less than it could under a reduced rate of harvesting. In some cases, while the resource is still apparently producing good harvests, these catches are taken very inefficiently, using far more effort than required. Improved management, of whatever form, should increase yield or efficiency or both while protecting the resource from depletion.

A fully utilized resource is being harvested at near the long-term potential yield level. In some cases, recent yields are less than the long-term potential level because of cautious management in the face of uncertainties about the status of the resource or for socio-economic reasons. An under-utilized fishery resource is not currently being fished heavily enough to obtain the best long-term yield. This is usually due to poor market conditions for the products of a particular fishery or reduced availability and high harvesting costs for a species.

Recent yields from all marine fisheries have been about 69% of the nation's long-term potential yield. Some stocks have been depleted and are yielding less than they could if rebuilt. Of the stocks where assessments have been possible (164), the abundance of 42% were below the level needed to support the long-term potential yield. Other stocks are under utilized for the reasons given above. Of those assessed, the abundance of 17% were considered to be above the long-term potential yield level. These stocks could be fished down in the short term and then support better long-term yields in future. In many cases, improved management based on better scientific information is needed to obtain a greater portion of the potential fishery yield.

Nearly 30%, 67 U.S. fish and shellfish stocks, are over utilized (Figure 2a). An even greater proportion have an unknown potential and so their status of utilization is unknown. Only about a quarter are now known to be fully utilized. This indicates the need for improved management if the nation is to obtain the best yield from its resources.

Considering resource status by region (Figure 2b), most of the Alaska stocks are fully utilized, while the majority of the stocks in the Northeast are over utilized. In the Southeast and the Oceanic

Pacific, where there are many species of reef fishes and pelagics, the status of the majority of the resources is unknown, but over utilization is clearly a problem. The numbers indicate that there is room for improvement in all regions of the country.

3.0 HABITAT AND WATER QUALITY EFFECTS

The degradation of habitat and water quality may result in currently productive marine fisheries yielding less in the future. The amount of yield harvestable from a living resource must just balance production from growth and reproduction, discounted for natural (nonfishing) sources of mortality, in order for that yield to be sustainable (i.e., not deplete the stock in the long term). Poor habitat can directly result in higher nonfishing mortality of fish or shellfish, thereby reducing the portion of the stock available for sustainable harvest. More often, and at potentially much lower levels of contamination or other habitat degradation, the productivity of the stock can be reduced. Lower growth and reproductive rates lead directly to a lower sustainable yield. This is schematically depicted in Figure 3, where recruitment, the number of new born coming into the stock, is shown as a function of habitat and spawning stock size. As habitat deteriorates, the production of new fish or shellfish per adult decreases. This means less can be harvested while still leaving enough to maintain the resource base. If the habitat for a currently productive fishery degrades, the stock may not be able to withstand the pressure of fishing even if this harvesting effort remains unchanged. Stocks now listed as fully utilized could become over utilized in this manner.

Habitat and water quality changes may also impede the recovery of the many stocks currently below the abundance level which would support long-term potential yield. Again, changes in resource productivity are the underlying cause of this problem. For the 164 stocks which are sufficiently well known for a determination to be made, 42% are below the long-term potential yield abundance level. This includes many of the nearshore stocks, which are often the most affected by poor habitat. If these resource bases are to rebuild through improved management controls, then the quality of their habitat may play an important role.

4.0 EXAMPLES

Pacific Salmon

The fishery for salmon on the west coast of the United States is an important symbol for this region of the country. Around 11 million fish are caught each year by commercial and recreational fishermen with a direct (first sale) worth of over $150 million. This does not include the large indirect monetary and nonmonetary value of this resource. Stocks have declined in a number of rivers, often due to the loss of suitable spawning habitat or access to spawning sites. Chinook salmon in the Sacramento river are now listed as a threatened species under the Endangered Species Act. Sockeye salmon in the Snake River are listed as endangered. Coho salmon in the lower Columbia River are extinct. The productivity of other stocks, such as pink salmon or chum salmon, may be at risk of reduction if spawning habitat is not maintained.

Atlantic Anadromous Fish

Atlantic salmon, striped bass, shad, and river herring are not major fisheries in terms of the amount of landings obtained (about 4000 MT) from the stocks, but they are important as recreational fisheries and as indices of environmental conditions in rivers of the Northeast. Spawning habitat for all species is critically dependent on water quality. Salmon young can spend up to 3 years in freshwater before migrating to sea. Striped bass larvae and juveniles utilize fresh and brackish water habitats during their first year. There is evidence for both species that water quality may have major impacts on reproductive success.

Southeast Shellfish

The shellfish resources of the Southeastern U.S Atlantic coast and Gulf of Mexico are the most valuable commercial fisheries resource in the nation, worth some $450 million annually. Shrimp dominate the landings and the value, but lobster and crab also contribute. These species are dependent on nearshore habitats during their early life. Shrimp use marshes and estuaries as nursery grounds. The loss of these habitats, due to changing water flow such as through the Everglades to Florida Bay or filling and pollution, may have serious consequences for the Gulf shrimp fisheries in particular.

Nearshore Fisheries

Recent documented yields from nearshore fisheries have been about 225,000 MT worth nearly $375 million commercially. But, many of the landings of these fisheries for crab, oysters, clams, and scallops go unrecorded.

These stocks are the most vulnerable to water quality and habitat problems by their very nature, near to the shore. A large number of shellfish beds have been closed due to contamination. Many species utilize coastal wetlands as nursery grounds, but half of these wetlands have disappeared. A majority of these stocks are over utilized and at low abundance levels relative to the level that would give the best potential yield. In order to rebuild the stocks and maintain those fully utilized, their habitat needs to be maintained or improved.

5.0 CONCLUSIONS

The marine fisheries of the U.S. are a very valuable resource, but they could be even more valuable. If resource management is improved to bring us closer to obtaining the long-term potential yield from more of our resources, the nation may realize additional benefits of $1 to $2 billion annually in first-sale value of the landings. However, these benefits are multiplied in terms of employment and indirect effects for the nation. According to recent analyses of the economic impact of commercial fishing[2] each $1 million in harvester revenue has a total (direct, indirect, and induced) impact of 14:1 on the gross national product and generates nearly 350 person-years of employment. The recovery of depleted stocks and the maintenance of currently productive stocks is an important goal for the National Marine Fisheries Service given these large economic impacts.

The attainment of this goal of obtaining the best long-term potential yield from U.S. resources could be undermined by loss of habitat and poor water quality. This will not just be from the dramatic effects of closed areas and fish kills, but the more subtle impacts on productivity of our living marine resources.

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The Contribution of Clean Water to Commercial Fisheries

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ABSTRACT

A primary beneficiary of improved water quality in the United States may be the commercial fishing industry. The vast majority of commercially harvested fish depends on estuaries at some stage of their life history. Moreover, cleaner water improves consumers' actual and perceived quality of seafood. Generally, there is little definitive research that shows the value to the commercial fishing industry from improved water quality. Reasons for the research record are discussed and exceptional studies are noted. However, there are many reasons why improved water quality may not translate into gains from commercial fishing and these are also highlighted. Particularly important is the management of fisheries and, without its improvement, potential gains from improved water quality may dissipate.

1.0 INTRODUCTION

In reauthorizing the Clean Water Act, Congress may wish to consider the gains to the various sectors that are positively influenced by it. The Act is costly and a prudent manager would consider whether those costs are excessive in light of the benefits received[a]. The principal benefactors of cleaner water have been the users of the water—the public, the recreation industry, and the commercial fishing industry.

The historic 1972 amendments to the Water Quality Act have been in effect for about twenty years. Dramatic changes have been made in the way that industries, municipalities, and citizens can use the nation's waters. In 1988, the annual expense on water pollution abatement was estimated to be $27 billion (constant 1982 $).[1] A legitimate question might be "Have these expenditures improved the well-being of producers and consumers of fish?"

A superficial look at the trends in U.S. landings gives the impression of dramatic gains over the last twenty years, from annual landings of around 2.5 million metric tons (MMT) to annual landings around 5 MMT. With an average price of around $800/ton, it would appear that we had a $20 billion increase in fishery production. This value along with contribution to consumers and the recreation industry would make the $27 billion cost reasonable. Closer examination of this doubling in output, however, gives no credence to causality between passage of the amendments and enhanced fishery production.

The outward expansion of the U.S. fishery management jurisdiction in 1976 extended our control of fishing to 200 miles of the coast. Many previously overfished stocks were brought under U.S. jurisdiction. The result, after years of eliminating foreign harvest, was to increase offshore annual production

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[a]Some argue that clean water transcends this logic and that the gains are not relevant. Most economists do not subscribe to this position, although they usually admit that the benefit-cost logic is only a portion of the information necessary for a complete policy analysis.

(in the zone 3 to 200 miles from the coast) from about 0.25 MMT of harvest to about 2.6 MMT (see Figure 1). The inshore component of the annual landings, the resources likely to be most dependent on the quality of the estuarine waters[b], rose only from 1.27 MMT to 1.75 MMT. Moreover, the real (1982 $) annual value of inshore production has risen only by $140,000 (see Figure 2).

There are obviously many reasons why these figures do not tell the entire story[c]. After all, there is reason to believe that there would be no commercial fishing industry if the trends in water quality of the 1960s had continued. The next section contains an explanation of the chain of events that links improved water quality with improved well-being of fish producers and consumers. In going through the chain of events, I draw out existing literature which demonstrates the linkage and also note the potential reasons that the linkage is difficult to demonstrate and may not even exist in some cases. My experience draws mostly from research on the Chesapeake Bay and thus, so does much of the cited literature.

2.0 AN OVERVIEW

To begin, consider an overview of the process that transforms legislation into gains. Figure 3 presents a crude schematic of the events that might have followed the passage of the 1972 Amendments. In Section 1 of the diagram, restrictions (denoted by I) change the level and/or quality of the effluent flow. Other factors (labeled intervening effects and designated with a *) can change or mask the influence of changed effluent flow. Understanding and accounting for them is critical to estimating gains. Both physical and economic effects factors are important in this level. The second section contains the relationship between the changed effluent flow and the stocks of fish. By and large, this is a physical process and my discussion of it is limited. Finally, improved water quality and enhanced stocks are translated into gains to fish producers and consumers. This is primarily an economic effect and more discussion will be made of it.

An important element that is often overlooked is shown by the arrow going directly from the water quality box to the producer/consumer box. These effects arise because cleaner water represents an actual or perceived improvement in the quality of the fish. Willingness to pay for the fish is increased and prices rise. Consumers are better off because they perceive themselves as obtaining a higher quality product and producers are better off because of the higher prices.

3.0 STUDIES OF STOCK-POLLUTION RELATIONSHIPS

Essential to understanding the gains from reauthorization are studies which have examined the effect of pollutants on fish stocks. The conceptual modeling aspects of detecting changes in fish stocks resulting from changes in pollutants are reviewed in Vaughan et al.[3] Cross et. al.[4] have shown effects using simulation models. The primary issue that we are addressing, however, is the actual evidence of improved water quality on fish stocks.

The number of studies which show how parameters of water quality influence stocks of fish are few. Although I am no expert in this area, the best and most comprehensive works to my knowledge are by Summers, et al.[5] and by Prager and MacCall.[6] Summers et al. study the history of pollutants and fish stocks in five major northeastern estuaries (Hudson River/Ruritan Bay, Potomac River, Delaware River/Bay, Connecticut River, and Narragansett Bay) for the period 1880 to 1980, whereas Prager and MacCall study Pacific coastal pelagics for the period 1946 to 1981.

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[b]The focus on inland waters arises from conclusions drawn by Summers et. al.[4]". . . obvious relationships between historic stock abundance and gross indicators of pollutants are best seen for estuarine resident fisheries and shell fisheries." (p. 206).

[c]Not the least is the fact that landings are a poor measure of fish stocks and gross dockside revenues are a poor measure of well-being in the fishery. For a thorough discussion of appropriate measures of well-being in a commercial fishery, see Thurman and Easley.[5]

Figure 1: U.S. Commercial Landings
By Water Area, 1974-1991 [13]

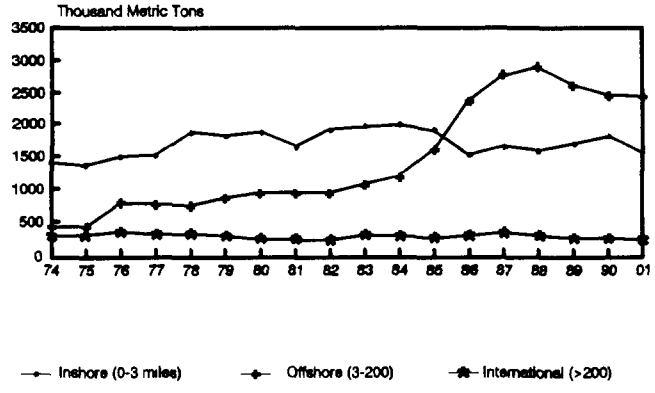
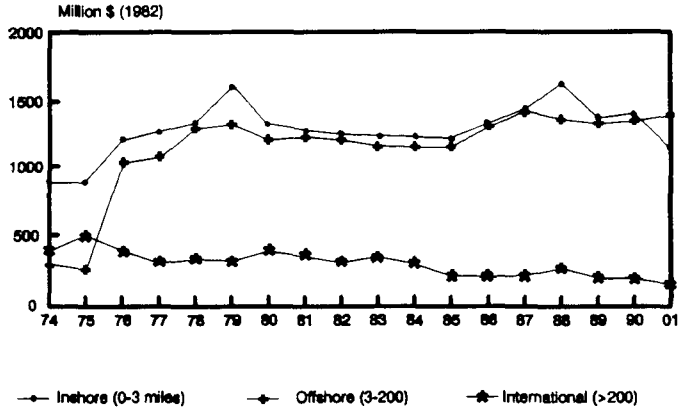


Figure 2: Value of U.S. Commercial Landings
By Water Area, 1974-1991 [13]



Summers et al. found 68 significant stock-pollutant relationships. Twenty-six of the 68 were "trend" macropollutants without much variation from year to year and hence questionable from an omitted variable standpoint. However, the remaining 42 were linked with dissolved oxygen and/or dredging activity, both of which vary greatly from year to year. They conclude:

> "...results do indicate that the methodology does establish defensible links among stock histories, natural environmental variation, and macropollutant trends that permit the generation of hypothesis pinpointing those stocks that are most likely to be affected by particular variates. " (p. 206)

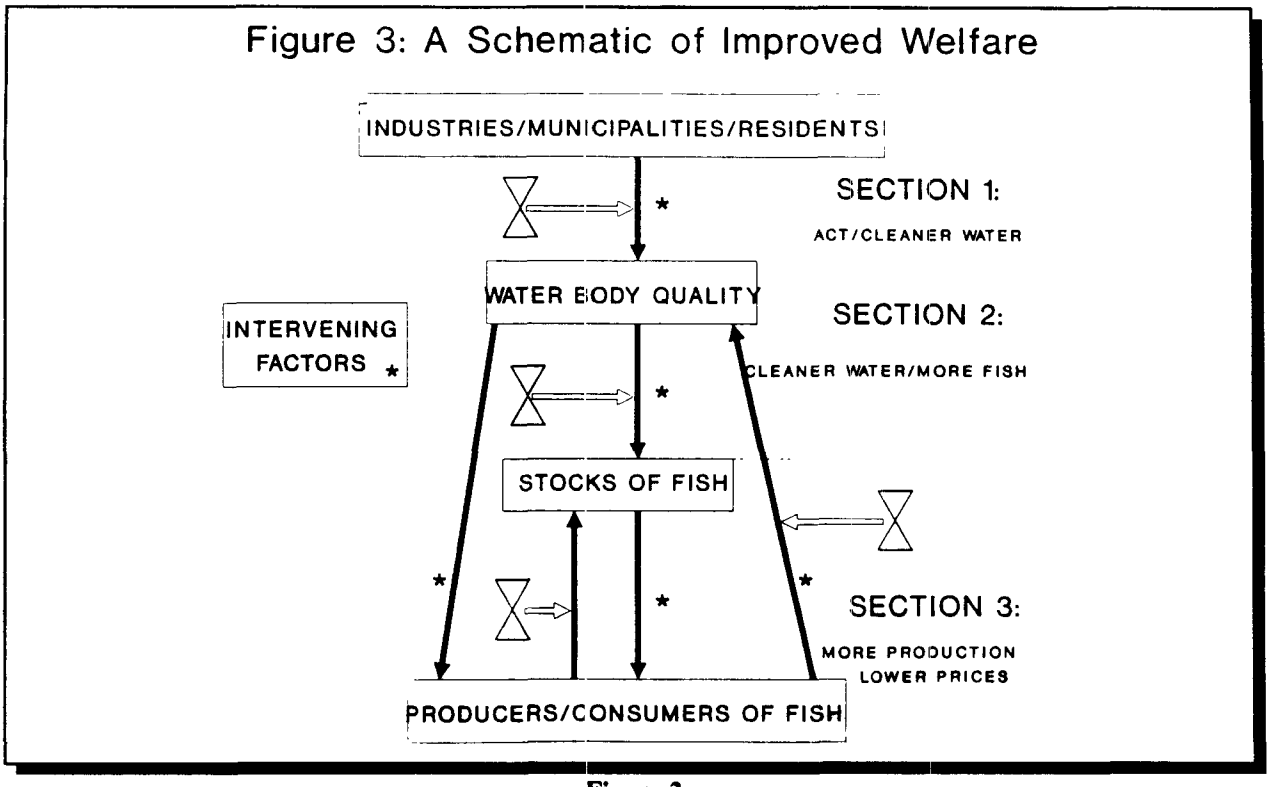


Figure 2

Prager and MacCall studied the effect of climate and contaminant loadings on the reproductive success of three coastal pelagic species (northern anchovy, Pacific sardine, and chub mackerel) on the West Coast. Their results "for Pacific sardine suggest that contaminant stress, at a time of severe overfishing, contributed to the decline and collapse of this stock." (p. 22). Thus, there is reasonable evidence, at least in the Northeast and West Coast, that the stocks of some species are negatively influenced by poor water quality and presumably, higher water quality will enhance fish stocks.[d]

4.0 PROBLEMS IN OBTAINING NEGATIVE STOCK-POLLUTION RELATIONSHIPS

If this information is essential to assessing the impending legislation, why are there so few studies documenting the effects? One obvious reason is the difficulty in accomplishing them. Long-time series of contamination and of fish stock variables are necessary. Moreover, the system's "noise" and general problem of correlation among included and omitted variables make the results of the analysis tenuous.

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[d]Another less comprehensive analysis shows sequential effects among nutrients, submerged aquatic vegetation, and striped bass recruitment.[7]

Rather than dwell on the statistical and data limitations, let me suggest other more provocative reasons. Most people assume that reauthorization of the Clean Water Act will translate into improved water quality and enhanced fish stocks. While this is perhaps true, it is important to note that it may not. Let me raise three situations in my experience that cast doubt on the assumption.

First, water quality is a multidimensional concept. Improvement in water quality to a manager of a municipal wastewater treatment plant (WWTP) may mean reduced bacteria, even with greater chlorine concentrations in the effluent. Whereas the reduced bacteria enhances beach use, may improve human health, and perhaps perceptions of the quality of fish, the increased chlorine concentrations may have effects on the successful spawn of marine life. Maryland's fishing industry, for example, has been concerned about the lethal and sub-lethal effects of chlorine on various Bay organisms.[9]

There are also reasons to believe that subsidizing abatement processes does not necessarily lead to enhanced water quality.[10] The general argument is that, although the effluent per unit of output may be reduced, subsidies increase the total output. The net effect can be reduced water quality. Success in controlling nitrogen concentration in the Chesapeake Bay through subsidization of Best Management Practices (BMPs) has been particularly unimpressive.[11] Whether this is a case example awaits study but it is clear that the "stick" approach of prohibiting the use of detergent phosphates has led to dramatic improvements in Chesapeake Bay phosphorus concentrations, whereas the "carrot" approach has not improved nitrogen concentrations.

Believe it or not, some desirable species appear to be dependent on the industrial and municipal effluent. The recruitment of striped bass in the Potomac River apparently is positively related to sewage nutrients pumped from various WWTP along the Potomac. To quote Tsai et. al.[12]

> "We hypothesize further that the improvements in sewage treatment processes since the early 1970s have greatly lowered sewage nutrient loading, lowered fertility in the spawning and nursery regions, and contributed to the recent decline of striped bass in the Potomac Estuary. (p 1.)"

While questions may remain concerning the analysis on which the conclusion was based, the point is that sewage does provide nutrients and, in moderation, they can be beneficial to marine organisms. It is the excessive release of them that causes problems.

Thus, one cannot state with certainty that legislation which is designed to improve water quality and fish stocks will have the intended effect. Each of the above cases may deserve research attention but the type of analysis differs greatly from an assessment of pollutants on stocks.

5.0 WATER QUALITY AND FISHERIES MANAGEMENT

Fisheries management is another factor which cannot be ignored when examining these relationships. Poor fisheries management can negate all gains from improved water quality and may hurt the commercial sector (see McConnell and Strand,[13] for the conceptual basis of this argument). As illustration, consider a oyster bed in an area designated as contaminated. It has been serving as a broodstock for the oysters in noncontaminated areas for years. Water quality improves, causing the water area around it to be opened for oyster harvest. Without good management, they may be eliminated from the broodstock causing declines in future oyster populations. This is particularly relevant, considering that numerous U.S. fisheries stocks have been cited as severely overharvested and that the Magnuson Fisheries Conservation and Management Act is also in the process of reauthorization.

The point is that fisheries management and water quality management are complementary and there is potential for tremendous gains to arise from the reauthorization of the two Acts if linkages between the two are explored. It may require tougher fisheries management legislation to get higher water quality standards.

6.0 CONCLUSIONS

My initial review of the evidence for gains to commercial fisheries was more alarming than it should be. To observe only $140,000 per year in increased value of commercial harvest after twenty years of legislation does give one pause for reflection. However, the figure of $140,000 is meaningless for several reasons. Most obviously, the actions taken in the 1972 Amendments may have been necessary simply to preserve an annual $1 billion gross receipts from commercial fishing.

The fact that there are very few studies available which document the relationship between pollutants and fish stocks may be more alarming. Again, however, there several important documents that do find statistical relationships between fish stocks/spawning success and pollutants. This research is done over the period of declining water quality and is reasonably convincing.

The fact that only a few studies exist may be a serious concern, depending on why there are not more. Are agencies simply ignoring the problem and not devoting resources to it? If so, perhaps more effort should be made. If they exist because of lack of data, we need to assess whether the data are worth collecting, recognizing that it will likely be a long time before the analysis will be complete.

Finally, if it is because the effects are not present, then we may need to assess our policies. Perhaps the most important set of policies we need to consider are those associated with nonpoint pollution from agriculture and those associated with fisheries management. The former relate to whether scarce funding is going into projects with little net effect on the water quality. Best management practices must be revealed to have a positive effect on the nation's waters. At the same time, improvements in fisheries management are necessary if we are to receive all of the benefits from the improved waters.

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Tuesday, October 20, 1992

Session 5: Export Opportunities in Water Technologies and Services

SESSION SUMMARY

MODERATOR: Daniel C. Esty

PRESENTERS:

Liliana Morales—Paper Unavailable

William T. Lorenz—*Export Opportunities in Water Technologies and Services*

Alfred Slatin—*Exporting Our Best Ideas: How the U.S. Can Capitalize on the Global Market for Innovative Waste Treatment Technologies*

Export Opportunities in Water Technologies and Services

William T. Lorenz
William T. Lorenz & Co.

1.0 INTRODUCTION

It is estimated that the global market for environmental products and services exceeds $200 billion, and is growing at 7% per year. OECD countries account for about 85% of the spending. Table 1 presents the macro spending on the environment in most of the regions of interest, and the breakdown between public and private spending in each of these regions. The question of who pays for environmental activities is interesting. As a country moves from the role of being a LDC to a NIC, and then to a mature industrial nation, the percentage of government spending declines. This is a move away from the *society pays* concept to the fully developed *polluter pays* concept that we have in the U.S. One factor that tends to moderate this move is the state-owned enterprise in many of the regions that we examined. Definition becomes critical. The expenditure may be made in the industrial sector, but the industry may be state-owned. Woven into the fabric of new and proposed environmental legislation around the world is a shift to the polluter pays concept. There are always government expenditures due to public infrastructure requirements, but even these expenditures decline as a percentage of overall spending over time. Privatization and contract operations are the primary reasons. Industrial countries appear to have spent in the range of 0.8 to 1.7% of GNP on the environment. In the 1970s, the U.K. followed by the U.S., devoted the largest shares of GNP to pollution control. But the GNP share of environmental expenditures in the U.K. declined sharply in the 1980s, and in the U.S. only stabilized in the mid-1980s after declining for more than five years.

Table 1

Environmental Expenditures		**Percent Spending by Sector**	
Region	**Spending ($Billions)**	**Public**	**Private**
United States	112.7	30-40	60-70
Canada	10.0	40-50	50-60
Mexico	2.1	60-70	30-40
Europe and U.K.*	51.6	50-60	40-50
Pacific Rim	3.5	70-80	20-30
Australia/New Zealand	2.9	50-60	40-50
*Note: * - Includes Eastern Europe but excludes USSR*			

2.0 UNITED STATES

Population (1990) = 248.7 million; GNP (1989) = $5.2 trillion

Average annual U.S. environmental expenditures as a percentage of GNP, 1981 through 1990, were 1.4%. Table 2 is estimated 1990-1995 environmental spending in the U.S. including capital and O&M spending. This table is based upon legislated driving forces, and is as good a macro picture of the market as any that we have seen. There has been some slowing in certain markets. The recent relegation of

the environment to fourth place in a priorities list of the American people is a function of the recession and the rhetoric from the 1992 election campaign. In a slow economy, environmental spending suffers.

Table 2

ANNUAL POLLUTION CONTROL COSTS (billions of dollars)						
	1990	**1991**	**1992**	**1993**	**1994**	**1995**
AIR	33.8	35.2	36.8	38.2	39.9	41.6
Stationary	*24.4*	*25.4*	*26.4*	*27.4*	*28.5*	*30.0*
Mobile	*9.1*	*9.6*	*10.0*	*10.4*	*11.0*	*11.3*
Undesignated	*0.3*	*0.3*	*0.3*	*0.3*	*0.4*	*0.4*
RADIATION	0.7	0.8	0.8	1.0	1.1	1.2
WASTEWATER	42.5	44.5	45.8	48.1	51.2	55.3
Point Source	*41.1*	*42.7*	*43.6*	*45.3*	*47.6*	*50.0*
Non-Point	*1.4*	*1.8*	*2.2*	*2.7*	*3.6*	*5.3*
WATER	4.2	4.5	4.8	5.1	5.5	5.9
RCRA	28.3	31.1	33.4	37.0	40.6	42.8
Solid Waste	*19.8*	*20.3*	*20.4*	*30.9*	*22.8*	*23.9*
Hazardous	*6.6*	*8.3*	*9.9*	*12.4*	*13.5*	*14.2*
UST	*1.9*	*2.5*	*3.1*	*3.8*	*4.3*	*4.8*
SUPERFUND	1.6	2.1	2.7	3.1	3.3	2.9
TOXIC SUBSTANCES	0.7	0.8	0.9	1.0	1.1	1.2
PESTICIDES	0.9	1.0	1.1	1.3	1.4	1.5
TOTAL COSTS	112.7	120.0	126.3	134.9	144.0	152.6
Source: William T. Lorenz & Co. and U.S. EPA data						

Solid wastes represent a fairly stable opportunity for goods and service suppliers. Recycling markets will grow at more than 10% through 1995. Waste-to-energy markets will grow at less than 10% through 1995. Spending in the U.S. for solid waste management amounts to more than $20 billion annually, versus about $2 billion in Canada. There is a trend in both countries toward recycling which will increase as disposal options become dearer. Hazardous waste cleanup costs could eventually total over $200 billion. Only about 50 of the EPA's 1,150 priority sites have been cleaned up so far.

The annual demand for air pollution control equipment in 1992 is projected to be $25 million for mechanical collectors, $35 million for solvent recovery, $40 million for wet scrubbers, $160 million for FGD, $100 million for ESPs, $135 million for oxidation systems, and $195 million for fabric filters. Equipment is a very small percentage of total air pollution control spending. Acid rain legislation could lead to $80 billion worth of scrubber systems and related expenditures. Expenditures on air pollution control for

mobile sources totaled $12 billion in North American in 1990. A further $27 billion was spent on stationary sources.

Figure 2 pictures the breakdown of environmental spending in the U.S. in 1990. (Hazardous waste spending is included in the solid waste category.) Municipal wastewater treatment capital expenditures were $2.8 billion in 1990, with four times that amount spent for O&M of existing systems. Engineering ($240 million), equipment ($370 million), instruments ($65 million), construction ($1.7 billion), and materials ($90 million) were the components in the 1990 municipal capital expenditures. Figure 1 presents the breakdown of total 1990 environmental expenditures, $112.7 billion, by product or service. Electric utility and industrial facilities also had sizable capital spending in 1990 for wastewater treatment with $5 billion. Potable water treatment facilities require about $5 billion annually. The government expects municipal wastewater capital spending of $60 billion by the year 2000 in order to meet the requirements of the Clean Water Act. We do not expect that level of spending, but do anticipate that over $30 billion may be spent.

3.0 CANADA

Population (1990) = 26.5 million; GDP (1989) = $513.6 billion

Average annual environmental expenditures as a percentage of GNP, 1981 through 1990, were 1.2%. The market, not including services, totaled approximately $1.4 billion in 1990. The market is about $5 billion annually (see Table 3). The estimates in Table 3 include only tradable products and services, not non-purchased services (primarily O&M) which represent at least an equal amount annually. We estimate the total spending is more like $10 billion. The growth is 5 to 7% per year. Canada, a member of OECD, is often perceived abroad as being a leader in environmental matters. The Department of the Environment was created in 1971 and every province has a Ministry of Environment. The Canadian Environmental Protection Act (CEPA) was introduced in 1988. The Government's substantive response to worldwide interest in sustainable development was the release of the Green Plan in 1990. By the year 2000, the government plans to have stabilized emissions of carbon dioxide and other greenhouse gases and to have virtually eliminated toxic discharges. In the same timeframe, the Green Plan aims to reduce emissions that cause smog in problem areas by 40%, and solid waste by 50%. CEPA provides for better enforcement and tougher punishment of polluters. Environmental legislation is also placing increasing emphasis on strong enforcement and compliance provisions. Individual provinces and municipalities are also directing their attention to stricter environmental controls. Ontario seems to be in a leading role. The management of hazardous wastes in Canada is the responsibility of both the Federal Government and the provinces. The Green Plan is fully funded. The government has committed $2.6 billion in new funds to federal environmental expenditures over the next six years, adding to existing federal expenditures of $1.2 billion. Green Plan funds will be spent as follows:

- Clean air, water, and land - $740 million
- Sustaining resources - $305 million
- Special spaces and species - $152 million
- Arctic strategy - $87 million
- Global environmental problems - $500 million
- Environmental regulation and information - $435 million
- Environmental assessment and stewardship - $240 million
- Emergency preparedness - $150 million

Annual environmental spending on tradable products and services breaks down, by media or law, as follows:

- Air - 14%
- Water - 50%
- Solid waste - 21%
- Hazardous waste - 2%
- Conservation - 10%
- Other (noise, laboratory, and monitoring) - 3%

FIGURE 1
1990 U.S. ENVIRONMENTAL MARKET VOLUME BY PRODUCT/SERVICE

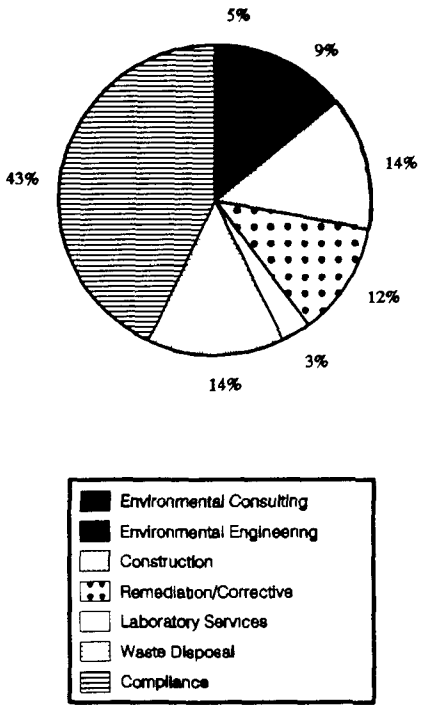

FIGURE 2

1990 U.S. ENVIRONMENTAL SPENDING

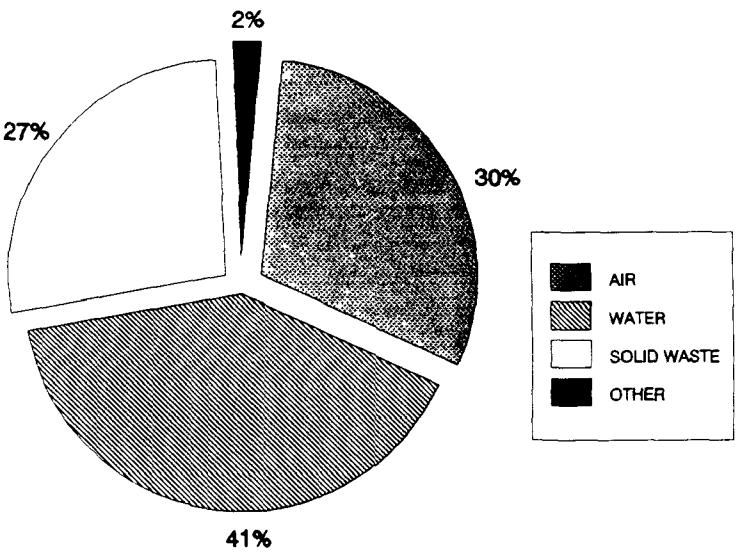

Table 3

Market Segment	1990 $Millions
Municipalities	2,000
Industrial	1,970
Utilities	280
Federal and provincial	160
Other	610
Total	5,020
Source: I.S.&T. Canada, March 1991	

Municipalities are the largest potential customers. Municipal expenditures on water, wastewater, and solid waste control, and private industrial expenditures designed to meet new regulations, will fuel much of the increase in Canadian environmental activity. For example, the costs of complying with new regulations controlling pulp mill effluent are estimated to be $3.5 billion. Technical capacity and cost-effectiveness are the key buying criteria. The Canadian environmental industry is expanding rapidly, but there appears to be room for increased penetration of the market by foreign suppliers. Only 40 to 50% of the demand is filled by Canadian companies. The balance is supplied by foreign firms, 70 to 80% of which come from the U.S.

4.0 MEXICO

Population (1990) = 87.9 million; GDP (1989) = $187.0 billion

Mexico's economy grew 3.9% in 1990 and 4.8% in the first half of 1991. Between 1990 and 1995, the Mexican government plans to spend $2.5 billion to fight pollution. The government plans to spend at least $100 million on its pollution control program in Mexico City alone through 1992. Mexico City is considered one of the most contaminated cities in the world. Spending for pollution control *equipment* was $189 millon in 1987 and $248 million in 1990. Equipment represents 10 to 15% of total environmental expenditures in a developing or newly industrialized country when a substantial portion is imported, which is usually the case. The market is expected to grow at an average rate of 15% per year. In 1990, the estimated pollution control equipment market of $248 million broke down as follows:

- Air - $78 million
- Land - $83 million
- Water - $87 million

Market demand has grown due to the liberalization of trade policy, economic conditions, and the willingness of the federal government and the private sector to protect the environment. Many rivers in Mexico are being contaminated because of effluent discharge and untreated residual waters. Eighty percent of Mexico's major residual water problem discharges are concentrated in 20 of Mexico's 270 rivers. The Secretariat for Urban Development and Ecology (SEDUE) is directing the installation of treatment plants in only the most polluted of these 20 rivers. The government developed a tough Ecological Law which went into effect in 1988. This law regulates:

- Auto and industry air pollutants;
- Municipal, agricultural, and industrial wastewater;

- Municipal and industrial toxic waste; and
- Noise pollution.

The law demands significantly increased use of equipment and services to detect and reduce pollution. One of the examples of the willingness of the government to solve the pollution problem is SEDUE's 1990-1994 National Program to Protect the Environment presented in 1990. The highest priority projects will be funded. Five watersheds have been given a high priority:

- Lerma-Santiago
- Panuco
- San Juan
- Balsas
- Blanco

Specific programs designed for each one will include:

- Sanitation;
- Appropriate hydraulic usage;
- Control of wastewater discharges;
- Construction and operation of treatment plants; and
- Restoration of damaged surrounding areas.

In order to preserve water resources, the systematic control of water quality will be undertaken. Treatment of estuary and marine waters will be carried out in areas of petroleum production. The national monitoring network capability will be increased. Sixty percent of the products and services are purchased by government agencies and 40% by private industry. The federal government, however, wants municipalities to take care of wastewater problems. The current position of U.S. suppliers looks promising because of the quality of U.S products and services and the proximity of the two countries. There are domestic manufacturers and consulting firms. The Comision Nacional del Agua is the public agency responsible for water.

5.0 EUROPE AND THE U.K.

5.1 Overview

The European Community (EC), with 320 million people, includes Belgium, Denmark, France, Ireland, Italy, Luxembourg, the Netherlands, Germany, Greece, Portugal, Spain, and the United Kingdom. In 1990, environmental protection spending by EC countries was over $50 billion. It is expected that EC spending for environmental protection will increase from about 1% of GNP in the 1980s, to 2 or 3% of GNP in the mid-1990s. The combination of Western and Eastern Europe will create a bloc of 25 nations and some 480 million people which could eventually outstrip the economies of the U.S. and Japan. Figure 3 presents Eastern Europe populations. Marked contrasts exist among Europe's three regions. Denmark, Luxembourg, the Netherlands, and West Germany are the most progressive EC members. Germany, France, and the U.K. are much like the U.S. In Southern Europe, fewer regulations have been enacted and enforcement of these laws has been weak. This has led many European companies to relocate to the South seeking to reduce costs. Eastern European countries have polluting industries, but lack healthy economies and environmental laws. For the few laws that do exist, enforcement is practically nonexistent. Norway, Sweden, and Switzerland have the toughest laws and most advanced regulatory systems outside the EC.

5.2 Eastern Europe

Population (1989) = 113 million; GNP (1989) = $650 billion

The bill for cleaning up Eastern Europe will be huge, perhaps as much as $1 trillion. Cleanup costs for East Germany alone could exceed $330 billion. Poland could spend $20 billion on its

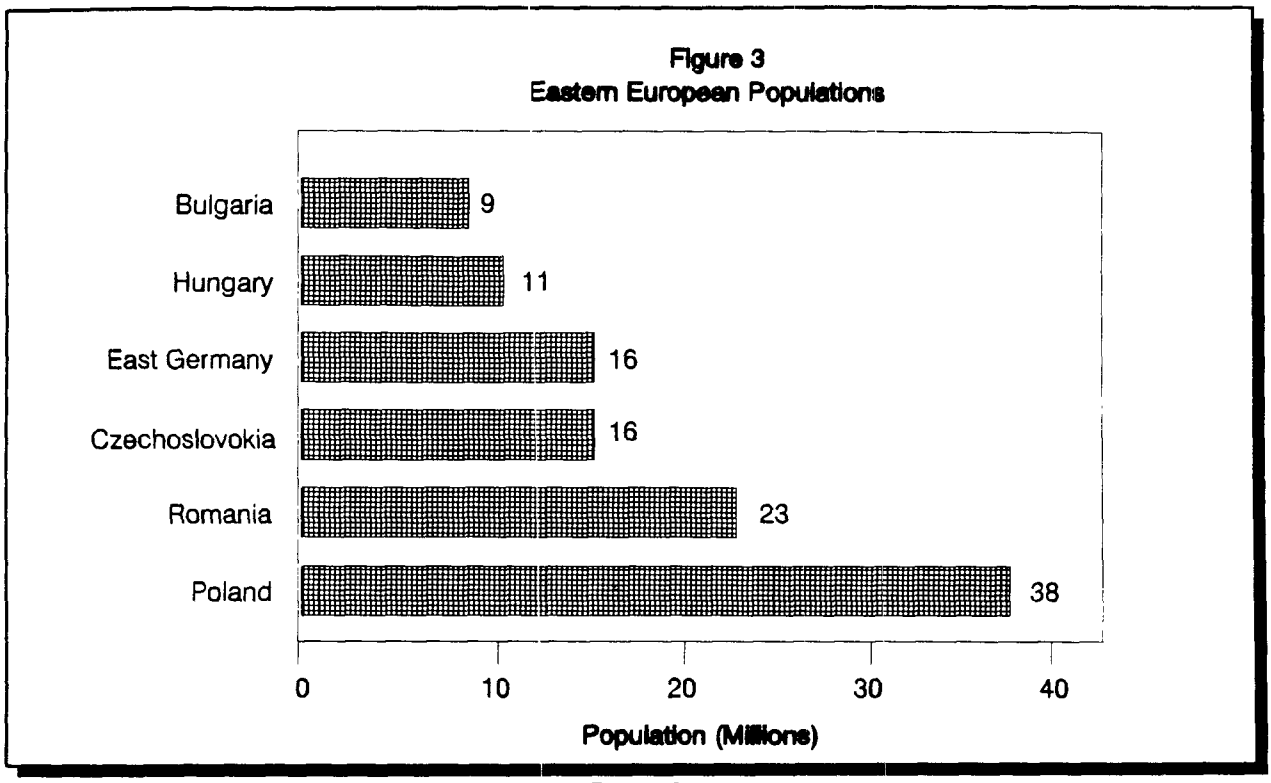

Figure 3

environment over the next decade. The market in Eastern Europe, excluding the USSR, amounted to $1.6 billion in 1990 and an estimated $2.1 billion in 1991. This is expected to increase to $10 billion by the mid-1990s. The total Eastern European and USSR market was $4.7 billion in 1990. The West German government estimated that it will take up to $200 billion to bring Eastern European industry up to Western environmental standards. This estimate does not include the large sum that will be needed to reduce pollution levels in soils and surface ground waters.

The largest market sector is water pollution control, and represents 60 to 70% of the total. Water pollution control spending should increase from $1.4 billion in 1991, to over $5 billion in 1995. Most of the spending will be for treatment facilities. The most rapid growth, however, is in the waste management sector, which may almost double in five years. East Germany accounts for more than 40% of the total, but this is expected to change over the next five years, as other makers grow more rapidly. All makers will experience dramatic growth by Western standards, particularly the more developed countries of Czechoslovakia, Hungary, and Poland. The economic situation in the USSR is too uncertain to allow any objective market forecasts, but the market was estimated to be about $3 billion in 1990, with water pollution control representing the largest segment.

Growth in this market will be driven by the enforcement of stringent legislation and regulation by governmental and international agencies, by privatization programs in industry, by the need for clean technology, and by international aid programs. The immediate priority will be reducing air pollution, which is also affecting Western Europe. Next will come cleanups of contaminated water and soil. However, these efforts are not likely to begin until the necessary environmental laws are enacted and new institutions created or existing ones empowered to make certain these laws are enforced. There are several sources from which money may become available:

- Loans from developed countries;

- Loans and donations from Western European countries that are threatened by pollution originating in Eastern Europe;
- Loans and aid from world organizations such as the World Bank and United Nations; and
- Debt for nature swaps.

Eastern European suppliers are concentrated in the areas of water treatment and purifying equipment and electrostatic air filters. Very few local companies are engaged in the supply of pollution control goods and services, and these have limited expertise and specialization. There are opportunities for Western companies to bring capital, modern technology and experience to the market.

5.3 Southern Europe

In this group of countries fall Italy, Spain, Greece, Portugal, and Yugoslavia. All but Yugoslavia are members of the EC. Italy and Spain have the fastest growing economies and probably the worst environmental problems in the EC. Yugoslavia, Greece, and Portugal are like the countries of Eastern Europe. The main characteristics shared by these five countries are that they are environmentally underregulated and enforcement of existing laws is lax.

5.3.1 Italy

Population (1990) = 57.7 million; GDP (1989) = $803.3 billion

In 1990, environmental protection spending by Italy was over $6 billion. Average annual environmental expenditures as a percentage of GNP, 1981 through 1990, were 0.65%. The government regards the hazardous waste problem as extremely serious and emergency legislation is backed up with funding of over $500 million to set up treatment measures on a regional basis throughout the country, but concentrated mainly in the industrial north. Roughly half of Italy's wastewater treatment plants are not working and cities such as Milan, Palermo, and Florence have little or no wastewater treatment at all. Its adoption of West Germany's air regulations in 1990 is a sign that Italy intends to catch up to other EC members. The investments that will be required of the country's public and private sectors are enormous. A billion-dollar project is underway to treat the municipal wastewater of greater Milan. The Italian government owns a larger share of industry than other EC governments. Therefore, the public sector buys the major share of environmental goods and services. The government is using its considerable influence on local industry to promote environmental effort. Under billion-dollar agreements with Enimont and Fiat, the companies will build treatment plants, install air pollution control devices, and make other efforts to implement Italy's environmental program to become role models. In 1990, there were over 3,000 companies involved in the environmental services industry with revenues approaching $4 billion.

5.3.2 Spain

Population (1990) = 39.3 million; GNP (1989) = $398.7 billion

In 1990, environmental protection spending by Spain was over $2 billion. The country will have to spend billions of dollars to achieve an acceptable level of environmental standards, but the Olympics in 1992 provide incentive. Some multinational companies that operate in Spain have acknowledged the stricter times that will come as the country moves toward EC standards. These companies are designing pollution control and waste management systems according to the stricter standards to which they have grown accustomed elsewhere.

5.4 Western Europe

Green parties have become a political force all over Western Europe. The Single European Act (SEA) has the following objectives:

- To preserve, protect, and improve the quality of the environment;
- To contribute to protecting human health; and
- To ensure a prudent and rational utilization of natural resources.

The underlying principles of EC action are that preventative action should be taken, that environmental damage should be rectified at the source, and that the polluter should pay. Environmental protection requirements are to be a component of other EC policies. The current (fourth) action program runs from 1987 to 1992 and covers a wide range of activity to combat pollution and protect the environment. In 1987, the Council of Ministers suggested priorities for action, including:

- The reduction at the source of pollution and nuisance in various areas;
- The control of chemical substances and preparation;
- The prevention of industrial accidents;
- Measures on the elevation and best use of biotechnology with regard to the environment;
- The protection of Europe's natural heritage; and
- The encouragement of agricultural practices which are environmentally beneficial.

Western European countries will spend $200 billion to clean up sites within their own borders. The EC environmental protection market exceeded $50 billion in 1990, with 21% for air pollution control, 48% for water quality, 27% for solid and hazardous waste management, and the balance for noise and other. Table 4 presents the 1990 environmental expenditures by the large EC spenders. Approximately $15 billion will be spent on a Mediterranean pollution abatement program in the 1990s, with $60 billion long term, to be co-financed by the European Investment Bank and the World Bank. In the EC, national

Table 4

Country	1990 $Millions
West Germany	18,688
France	9,856
United Kingdom	8,832
Italy	6,016
The Netherlands	2,560
Belgium	1,664
Source: European Commission, 1991	

programs to ensure compliance with EC directives have been announced. For example, Spain is spending $1.3 billion and the U.K. $2 billion to curb air pollution. In Denmark, the government is spending $3.2 billion to eliminate nitrogen and phosphorous from wastewater. There is increasing emphasis on the O&M and modernization of existing installations rather than on new complexes. New markets will not emerge alongside already existing ones. They will replace them, at least in part. Some European markets that are well ahead in adopting and complying with environmental protection standards have reached a peak. They contributed to the environmental services industry's growth in the 1980s, but in the 1990s will undergo a downward trend. One such market is stack gas emission control for large plants in Germany.

Cooperation agreements have been set up with U.S., Japanese, and non-EC European firms. Mergers are also occurring. In Denmark, the third largest industrial group, Danisco, now controls several companies in the environmental services sector, including DDS and Niro Atomizer. In the U.K., a vertical integration of the water industry has been initiated. In Germany, vertical integration and diversification are underway. Europeans look to U.S. consultants for internationally recognized experience in environmental protection. The strategies of the leading European firms differ, depending on each country's selling points. Broadly speaking, German firms tend to support the harmonization of environmental standards in order to ensure markets in the rest of the EC for their advanced technology. French firms, with their experience in O&M of infrastructure and installations, are seeking to adapt their strategies to the opportunities offered by privatization. The U.K. is particularly dynamic in the area of services. The Netherlands is making a considerable effort in research and innovation. Denmark, very advanced in some areas but without large groups, is striving to advance in the area of innovation and the regrouping of its firms. The chief concern in Spain and Italy appears to be that of opening up to foreign technologies and expertise, while at the same time preserving a certain autonomy in their firms.

5.4.1 Belgium

Population (1990) = 9.9 million; GDP (1989) = $136.0 billion

In 1990, environmental protection spending by Belgium was over $1.6 billion. Belgium was the first country to vote Greens into national office in 1981. Belgium is divided into three regions. While a central parliament retains certain traditional authority, environmental protection is among the powers delegated to the regions. The Flemish Public Waste Agency (OVAM) was created by a decree on the management of waste enacted in 1981. The agency has the authority to plan, regulate, and establish facilities for the management of solid and hazardous waste for the Flemish Region of Belgium. OVAM operates under the administrative control of the Minister of the Environment.

5.4.2 Denmark

Population (1990) = 5.1 million; GDP (1989) = $73.7 billion

In 1990, environmental protection spending by Denmark was over $1.1 billion. Denmark is subdivided into 16 counties, each having an environmental agency. Denmark has established a complete system and set of procedures for the management of hazardous waste including a central treatment system (Kommunekemi). The administration of the Danish system is organized in a decentralized way. The Kommunekemi facility is a publicly owned and operated facility. In 1990, there were about 400 companies involved in the environmental services industry. Like most other European countries, one of Denmark's major thrusts has been research in the field of recycling and waste source reduction.

5.4.3 France

Population (1990) = 56.4 million; GDP (1989) = $819.6 billion

In 1990, environmental protection spending by France was over $9.8 billion. Average annual environmental expenditures as a percentage of GNP, 1981 through 1990, were 0.85%. The new national environmental plan will increase the nation's environmental budget to almost 2% of the GNP. In France, only 35% of the sewage in the southern regions of the country is treated. Sewage systems in major cities are due for revamps. Current concerns about these conditions could double the French market for sewage

systems in 5 to 10 years. France is recognized as a European leader in industrial risk assessment and emergency planning. A sweeping environmental plan introduced in 1990 may go a long way toward catching up the country with its neighbors. It will also consolidate all of the environmental regulatory and enforcement activities of various national, departmental, and local agencies under an Environmental Institute. There are six basin authorities responsible for water management and pollution control. The basin authorities generate significant income through the assessment of fees for drinking water and water pollution discharges. Specific goals for the year 2000 include:

- Reducing air pollution by 30%;
- Increasing wastewater and water treatment to 67% of all discharges;
- Stabilizing carbon dioxide emissions; and
- Recycling 50% of all primary industrial materials.

The Ministry has a 1991 budget of $230 million, up from $160 million in 1990. In order to help fund their new plan, the Ministry has proposed substantial taxes based on the polluter-pays principle. There are a wide variety of waste collection and transport firms. The Generale des Eaux, Lyonnaise des Eaux, and SAUR distribute water to 18 million, 8 million, and 4.8 million people, respectively. A fourth company is SOGEA, a subsidiary of Saint Gobain-Pont a Mousson, which serves a population of 2.7 million. These companies are also significant in wastewater treatment and solid waste management.

5.4.4 The Netherlands

Population (1990) = 14.9 million; GDP (1989) = $205.9 billion

In 1990, environmental protection spending by the Netherlands was over $2.5 billion. Average annual environmental expenditures as a percentage of GNP, 1981 through 1990, were 1.4%. The government wants to spend up to 3.5% of GNP to reduce pollution. The Netherlands saw the need in 1989 to elect Greens to parliament. The socialist Labor party, however, has an excellent record on environmental affairs. A very ambitious, long-term National Environment Plan was adopted by the Netherlands in 1989. By 2010, the plan is intended to reverse the country's environmental degradation problems. The plan contains some 200 pollution fighting measures, and its eventual goal is to reduce all types of emissions by 70 to 90%. The cost of the plan was to rise to $3.4 billion by 1994, of which at least half would be paid for by higher taxes on pollution industries. A further $1 billion would come from higher indirect taxes, and the remainder through savings in the budget. The overall level of expenditure on the environment was estimated to rise to $7.5 billion on an annual basis. An important development in the Netherlands is that all major companies will be required to demonstrate to the government that they are in compliance with the new policies. Other significant new initiatives include:

- The creation of a single permit for all of a company's environmental emissions rather than a collection of separate permits that apply to various environmental media;
- Stricter incineration standards; and
- A government seal of environmental approval for consumer goods.

Plans also include removal of 7,000 toxic waste dumps. The U.S. is third behind domestic and West German suppliers of environmental products.

5.4.5 West Germany

Population (1990) = 62.5 million; GDP (1989) = $945.7 billion

On October 3, 1990, East Germany acceded to West Germany and ceased to exist as a separate nation. This discussion, however, considers West Germany as a separate state. In 1990, environmental protection spending by West Germany was over $14 billion, up from only $5 billion in 1981.

Average annual environmental expenditures as a percentage of GNP, 1981 through 1990, were 1.2%. It has marginally risen over the last few years, and data suggest it now stands at more than 1.5% of GNP. West Germany represents the largest market in Europe, accounting for one-third of EC expenditures for environmental protection in 1990, and about 7% of global spending. The average annual growth rate in market segments ranged from 8 to 14% between 1981 and 1990. The country's political parties are debating how to form an ecologically oriented economy that emphasizes sustainable development. Eco-taxes are one proposal being discussed. Tough environmental laws effective on January 1, 1991, require most companies to name top managers who are responsible for complying with environmental laws and for presenting compliance plans for the companies to the government.

West Germany has had a water management law in place for more than 20 years. A law is being debated that would extend this principle to cover air and soil contamination. Comprehensive new hazardous waste regulations have been introduced that require generators to show proof that their wastes cannot be recycled before disposal is permitted. Stiffer law enforcement is helping to bring about the shift in thinking. The number of charges filed is already between 25,000 and 30,000 per year, and the total is increasing from 20 to 30% annually. The country has successfully completed an FGD program for all major combustion facilities and is embarking on a program for flue gas denitrification. Another environmental policy initiative is a proposed tax on industry that is designed to finance cleanup of old waste sites. In 1990, there were about 4,000 companies involved in the environmental services industry.

5.5 The United Kingdom

Population (1990) = 57.4 million; GDP (1989) = $818.0 billion

In 1990, environmental protection spending by the U.K. was over $8.8 billion. Average annual environmental expenditures as a percentage of GNP, 1981 through 1990, were 0.74%. Expenditures for water, electricity, and roads will total $33 billion between 1989 and 1994. The investment in water is designed to comply with both EC and national directives. For 1992, the market for water pollution control equipment is estimated at:

- $706 million, or 49%, from water supply companies;
- $677 million, or 47%, from industry and commerce; and
- $57 million, or 4%, from residential, agriculture, and leisure.

The U.K. discharges significant quantities of untreated sewage into the North Sea. Landfill capacity is rapidly declining while U.K. industry's annual output of hazardous wastes is 4 to 5 million metric tons. Surface and ground water in much of central England is polluted with nitrates. The U.K. has been Europe's largest environmental polluter on a total volume basis. EC legislation is forcing the U.K. to strengthen its commitment to environmental improvement. The government is supporting a 25-year plan to reduce water pollution. In 1990, the total market for air pollution control equipment in the U.K. was estimated to be $770 million. Growth is projected at approximately 9% per year. EC pressure will stimulate the market. The standards for air pollution control in the U.K. must be brought in line with those of the EC by 1992. Specific areas with require attention include:

- The discharge of gases from high sulfur coal;
- The release of CFCs and gases; and
- Vehicle exhaust pollution.

The percentage of total demand for air pollution control from each of the major industries is as follows:

- Electric power - 32%
- Chemicals - 19%
- Steel and metallurgical - 16%

- Mining - 5%
- Other industries - 28%

Municipal sewage treatment works are controlled by the privatized water companies. They operate such works under the National Rivers Authority consents, which stipulate quantity of effluent which may be discharged and the quality standards which need to be met. The water companies will spend $4 billion by 1992 on these needs. Discharges by industrial concerns directly into the river are controlled by the same consents. Discharges by industry into sewers come under the authority of the water companies. In addition, a new water pollution law, the Green Bill, the nation's first major environmental statute since 1974, was introduced in 1990. Official bodies have increased scrutiny of effluents discharged from chemical, industrial, and energy generation sectors.

The nation's solid and hazardous waste management businesses are also to be privatized, and the EC is likely to monitor these developments closely because it does not consider privatization a progressive environmental step. Large industrial companies are now spending considerable sums on water purification and pollution control consultancy services and equipment. Over the past few years, the total amount spent annually has averaged about $1 billion. In 1990, there were about 1,500 companies involved in the environmental services industry. U.S. environmental consulting firms have a significant advantage in this market. Industry observers identify the U.S. as a strong competitor with Japan and Germany in supplying the market.

6.0 PACIFIC RIM

6.1 Overview

The Pacific Rim is the world's largest business area. U.S. firms are beginning to take advantage of the opportunities that Asia and especially the Association of Southeast Asian Nations (ASEAN) offer. ASEAN includes six countries (Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Brunei). Industry estimates suggest that the bill for environmental projects in Asia could run as high as $200 billion over the next decade. The ASEAN market consists of over 305 million people with the world's fastest growing economies. The total market for environmental control equipment and services in ASEAN is estimated at more than $1.5 billion in 1991. In 1992, environmental spending will again be up substantially. Asia has inherited some of the world's worst environmental problems, but there is a rising sense of urgency that something must be done to halt and prevent further environmental damage. Regional and global policies on the environment will be forthcoming at the UNCED meeting in Brazil in 1992, eventually resulting in industries having to observe strict environmental standards as an integral part of their business. This will lead to another increase in demand for environmental products and services. The U.S. Department of Commerce has recently emphasized the opportunities in Malaysia, Taiwan, and Thailand.

Indonesia's regulatory environment is rapidly changing, as is that in Thailand where spectacular economic development is placing a significant burden on the environment. The national plans of China, Indonesia, and Thailand have safe drinking water as among their major socioeconomic objectives. One study estimated that $20 billion to $30 billion would be required annually to provide safe drinking water to all people on earth. New industry is putting a tremendous strain on what was already an overloaded waste management system. Recognizing this, private and government demand for solutions to ecological and waste management problems has never been stronger. Traditional laissez faire attitudes on environmental issues are gradually giving way under international pressure and regional concern to action now before the catastrophic mistakes of the West are repeated in Asia. The region's governments are actively implementing increasingly tougher legislation to control the pollution and emissions of industry, while the private sector is rapidly waking up to its role in safeguarding the future of the planet.

Ministerial support for environmental protection in Asia reached a milestone in 1990 at the Conference on Environmentally Sound and Sustainable Development when ministers of Economic and Social Commission for Asia and the Pacific member countries declared a Regional Strategy for achieving

environmental goals. Indonesia, Malaysia, Thailand, and Singapore continue to implement tougher legislation. Projects designed to provide adequate water and sewage treatment are being researched and started through ASEAN. High on the list of priorities are the projects to provide adequate water and sewage treatment plants for the swelling inner city areas of the region. The task is enormous. In central Jakarta, only 28% of all households have publicly supplied water. Developments in solid waste management have been on the increase in the region, with many countries finding new and innovative ways of recycling waste. Worldwide education and training expenditures for the water and sanitation area will amount to $20 billion annually by the year 2000. Consulting, remote sensing, monitoring, R&D, and other service industries will also grow rapidly. Financing for Pacific Rim projects has been considerably eased by loans for the Asian Development Bank, the World Bank, and other funding agencies.

6.2 Hong Kong

Population (1990) = 5.8 million; GDP (1990) = $57.0 billion

Hong Kong officials announced a $2.6 billion cleanup plan. Sewage systems and a switch to low sulfur fuels will absorb the largest share of this figure. Total environmental outlays by the Hong Kong government may easily double before 1997. As far as the immediate outlook is concerned, the Environmental Protection Department started 1991 with $970 million worth of approved projects on the books. The legislative council has been asked to significantly strengthen the current standards for water and air quality, noise control, and waste disposal. According to the government's civil engineering services department, of the $130 million plus that will be spent annually on environment projects for the next 10 years, consultants will receive 14.5% of the total business. In 1990, plans required consultancy work on five sewage master plans, including a proposal to construct sewage outfalls of 35 kilometers in length. There is also engineering/design work to be done on the control of effluents in Tolo Harbour. Four distinct markets for environmental equipment and services exist in Hong Kong:

- Large-scale governmental projects (e.g., waste management, treatment, and disposal) on a design-build-operate basis;
- Equipment and engineering/design for the private industrial sector;
- Instrumentation for the public and private sectors; and
- Technical consulting and design services.

The Hong Kong Government issued a benchmark White Paper on Pollution Control in 1989. The document outlines a comprehensive 10-year plan to remedy the problems of Victoria Harbour, Southside beaches, and the rest of the territory. Of the total expenditures planned, 60% has been earmarked for the construction of sewage and drainage facilities and most of the remaining 40% is allocated for landfills and waste transfer stations. The government announced a $16.5 billion infrastructure program that will require the use of modern environmental technology. Because U.K. engineering firms are both more numerous and more active than their U.S. counterparts, the U.K. has a 2-to-1 lead over the U.S. in supplying products and services for Hong Kong projects. U.S. technology enjoys a good reputation in the territory.

6.3 Korea

Population (1990) = 43.0 million; GNP (1989) = $200.0 billion

Korea will spend $750 million over the next five years on pollution control equipment, and annual expenditures are expected to increase by $100 million per year beyond this five-year horizon. The Environmental Master Plan delineated priorities for pollution control for air, water, and solid waste through the 1990s. By 1991, the implementation of the highest priority measures required a total capital investment of $6.2 million and for O&M, $2.7 billion. Korea's rapid industrialization has brought about severe pollution problems especially in the large urban centers and industrial areas. The Korean Government is now cracking down on polluters by strengthening environmental legislation and increasing its spending at an unprecedented

rate. At present, the most serious problem in Korea is water pollution caused by local manufacturing industries. Korea has considered construction of 15 waste-to-energy plants at $100 million each. There are not 500 registered firms in Korea that manufacture or install environmental systems and facilities. Two Korean companies manufacture pollution control equipment and facilities under technology transfer agreements with foreign companies.

6.4 Singapore

Population (1990) = 2.7 million; GDP (1989) = $27.5 billion

No city in Asia is as clean or as health conscious. Singapore handles waste through its Ministry of Environment (ENV) which controls all aspects of public cleanliness. The National Council on the Environment is Singapore's first non-governmental organization, formed in 1990, as a public voice on environmental issues. Singapore is leading the fight against industrial emissions with legislation already in place to ensure effective emission control at the source. All new factories with high pollution potential are required to install control measures before they begin to operate, while existing factories have to retrofit pollution control equipment. A ban on open-air burning of industrial waste has reduced smoke and dust fallout. Chemical companies are required to meet three criteria before their processes are allowed:

- Waste must be adequately treated and disposed of;
- Chemicals must be handled and stored safely; and
- There must be suitable land for the plant.

Unlike some cities, Singapore rigorously enforces the regulations it promulgates. The compact size of the island makes it easier to monitor factories and industry. In Singapore, some industrial effluents are pretreated and placed in public sewers. Sludge is disposed of in dump sites. The feasibility of recycling some hazardous wastes will be studied in the future. Singapore has 3,700 manufacturing establishments with employment of 340,000. Singapore's manufacturing output grew almost 70% between 1986 and 1989. ENV and Mitsubishi Corporation of Japan have signed a Memorandum of Understanding that prepares the ground for Mitsubishi to collaborate closely with ENV in technology development and training in environmental engineering and management projects in Singapore and the region. Also, both parties will work on the study, design, and commissioning of environmental projects such as the construction of incineration plants outside Singapore.

6.5 Taiwan

Population (1990) = 20.5 million; GNP (1989) $121.4 billion

Taiwan is becoming a very active environmental market with recent legislation leading to a $35-billion plan to clean up the islands by the year 2000. According to figures released by the Taiwan Environmental Protection Agency, total environmental protection spending in the country now stands at $1.2 billion annually or 0.9% of the GNP. By 1992, that figure will reach $4 billion. Spending on environmental products and services may total more than $40 billion between 1988 and the year 2000. Public expenditures made for national environmental improvement projects are growing at impressive rates. It is predicted that total environmental investment will increase at a rate of 25% per annum. By 1994, Taiwan's pollution control expenditures will account for about 2.0% of its GNP. Most is spent by public agencies and state-run firms, while the remainder is spent by the private industrial sector. Public purchases, with a projected annual growth rate of 25 to 30%, will continue to lead the sales. Stricter enforcement of regulations are also creating a tremendous industrial demand for pollution control systems. In the later 1980s, the government announced the following major pollution control projects:

- Water pollution control - $1.6 billion to be spent over six years on modernizing sanitary sewage systems, dry weather flow interceptors and ocean outfalls;

- Air pollution control - $2.9 billion to be spent over six years on air pollution control and air quality monitoring;

- Solid waste disposal - $913 million to be spent on 15 major projects for solid waste disposal and shore fill reclamation projects; and

- Hazardous waste control - $62 million to be spent on high-pressure incinerators and waste treatment centers.

Taiwan has discussed the construction of more than 20 waste-to-energy facilities, each of which would cost more than $100 million. In addition, the government will raise not less than $3.3 billion from government expenditures to improve pollution control and prevention. In the coming years, both state-owned and private sector industries will be called upon to tackle the extensive problems of environmental pollution. Private factories have drastically increased their spending on pollution control since 1989, when fines for pollution were increased dramatically.

6.6 Thailand

Population (1990) = 55.1 million; GNP (1989) = $64.5 billion

Estimates suggest that Bangkok Authorities will need to spend at least $14 billion to upgrade the city's sewage system to present requirements. Ecological and environmental problems stem from the application of science and technology. In the future, the country will attempt to strike a balance between sustaining development and maintaining, improving, and repairing the environment. Environmental pollution problems which Thailand is facing are air, water, and noise pollution, solid waste, and toxic substances. Water pollution is considered to be the major pollution problem in Thailand.

Under the sixth (1986-1991) and seventh (1992-1996) five-year National Economic and Social Development Plans, the government has expressed clearly its concern over the environmental problems and its intention to enforce the law more seriously and support more environmental campaign projects at all levels. The Board of Investment, in granting promotional privilege to new investments, requires that projects must not in any way damage the country's environment. Thailand regulates industrial wastewater under the Improvement and Conservation of the Natural Environmental Quality Act of 1978. However, actual control of water pollution is carried out by the Ministry of Industry which sets standards, licenses discharges, and enforces regulations.

Bangkok is converting from ground water sources to piped water systems to mitigate ground water subsidence problems. The master plan of the Bangkok Metropolitan Administration (BMA) for the construction of wastewater treatment plants has been drafted to identify and recommend areas where wastewater treatment plants need to be built and to ensure the public of the authority's commitment to solving the problems. Twelve major plants are proposed with a total capacity of 1.7 million cubic meters per day and a cost of $640 million. Three industrial hazardous waste treatment centers have been planned. The number of factories in Thailand has increased from 85,000 in 1986 to almost 100,000 in 1991. In 1991, the World Bank and Denmark each advanced $700,000 to Thailand for two wastewater treatment plants. The loans were for consulting and design fees for both projects. An additional $200,000 was also advanced by the Thai Industrial Works Department. The World Bank has also advanced $30 million to the Thai government so it can increase the efficiency of industrial plants and reduce pollution. TPI, a joint venture of TAMS and Malcolm Pirnie of the U.S., prepared a master plan for management of Bangkok's solid waste for the BMA. Recycling and composting were important parts of the plan.

7.0 AUSTRALIA

Population (1990) = 16.9 million; GNP (1989) = $240.8 billion

Australia spends under 1% of its annual GNP on environmental matters. The 1990 expenditures were estimated to be $2.1 billion. Dramatic increases in the 1990s will result from major infrastructure spending related to the environment. The major industries in Australia are mining, industrial, and transportation equipment and food processing. Australia has undergone considerable industrial development in the past two decades. Once the richest nations in the world in per capita GNP, it is no

longer even in the top ten. The Labor party is seeking to privatize some state-owned industries. Industrial activity in Australia is characterized by a high concentration of hazardous waste-producing industries in Sydney and Melbourne. There was the development of the 1986 National Guidelines for the Management of Hazardous Wastes. Some of the key principles are:

- The polluter-pays principle should apply;
- Generators and TSDs should be regulated;
- The classification system for hazardous wastes should be applied nationally;
- The manifest system should be implemented;
- Specific technical and environmental guidelines should be developed as site-selection criteria for hazardous waste facilities;
- A national high-temperature incinerator should be built;
- A national system for the exchange of industrial waste should be established; and
- Australian and overseas R&D on hazardous waste management should be monitored.

After the publication of the guidelines in 1986, the six Australian states developed a single nationally coordinated approach to hazardous wastes. Over 20 million tons of hazardous waste are generated annually. In the late 1980s, Australia was still exporting a small amount of its hazardous wastes. Air pollution control is in the developing stage and expenditures are somewhat limited. Over 10 million tons of solid waste are generated annually, and these solid wastes are primarily managed through landfilling. Massive expenditures are underway in Sydney and other major cities (Canberra, Melbourne, and Brisbane) to build and upgrade sewage systems. The spending in Sydney may turn out to be the world's largest water quality expenditure. French (Bouygues, Generale, and Lyonnaise), U.K. (Acer Consultants), and U.S. (James M. Montgomery & Co. and others) firms are involved.

8.0 NEW ZEALAND

Population (1990) = 3.3 million; GDP (1989) = $39.1 million

Annual environmental expenditures average almost 2% of the country's GDP. The 1990 expenditures in New Zealand approached $800 million. New Zealand is one of the first nations to create a comprehensive welfare state. Most mines, forests, transportation facilities, power plants, and communication facilities are publicly owned. Anti-nuclear feeling is very high in this ANZUS nation. New Zealand's economy is dominated by livestock raising. Over 300,000 tons of hazardous waste are generated annually. Air pollution control is in place and expenditures are small. Over 2 million tons of solid waste are generated annually, and the solid wastes are primarily managed through landfilling. Over 88% of the population is served by wastewater treatment plants, a higher percentage than in the U.S. (80%), and exceeded only by top-tier European countries (e.g., Denmark, Germany, the Netherlands, and Switzerland). Expenditures are underway in Wellington and Auckland to upgrade water and sewage systems. The spending is not large by U.S. standards. U.K. and U.S. firms are involved in a minor way.

Exporting Our Best Ideas: How the U.S. Can Capitalize on the Global Market for Innovative Waste Treatment Technologies

Alfred Slatin
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Zimpro Passavant Environmental Systems, Inc.

ABSTRACT

The worldwide market for water pollution control equipment is enormous, but the most profitable opportunities for U.S. suppliers may lie in exporting innovative, non-conventional technologies. These are technologies designed to solve specialized waste treatment problems, where higher degrees of treatment are required, and where competition from local suppliers is not prohibitive.

In the United Kingdom and European Community alone, it is estimated that as much as $1.2 billion per year will be spent on innovative technologies by the end of this decade.

Barriers to exporting innovative U.S. technologies are not unlike the barriers that block the adoption of innovative technology within our own country: conservative design favors conventional technology, even though this choice is obviously less effective and potentially more costly.

The U.S. EPA can help facilitate the global acceptance of innovative U.S. technologies. EPA is well-respected around the world as a regulatory body, and should promote its innovative technology programs (such as SITE) as global models.

Specifically, EPA might consider helping foreign countries establish data bases on innovative technologies, and entering into pilot testing projects with foreign entities as methods of nurturing the adoption of U.S. technologies abroad.

The payoff for U.S. firms can be significant. Zimpro Passavant Environmental Systems, Inc., a Wisconsin company whose proprietary wet air oxidation and PACT® systems are member technologies in the SITE program, is generating nearly 50% of its revenues from overseas sales. Keys to success have been cooperation agreements with qualified local firms, commitment to full technical support, and above all—patience.

1.0 INTRODUCTION: THE VIEW FROM HERE

In approaching export of American technology in the environmental area, my first thought is that no nation, or for that matter, no population of human beings is terribly concerned about the environment as long as poverty, starvation, and infant mortality from disease are epidemic in their society. Priority action on pollution will not occur until the basic needs of survival are met. I think we can clearly see this in the countries with emerging economies. I don't think it's any exaggeration to cite the rapid growth of environmental interest in Japan as its economy developed, then in Taiwan and now in Malaysia. Perhaps the best example is India; now that this country is producing sufficient food to maintain its population, it is investing in environmental projects. So we may properly say the greatest stimulus to export of American technology will be economic assistance to emerging countries: loans, aids, technical assistance, tariff policies.

It's probably also accurate to say that more advanced economies that are still in a dramatic growth phase, such as Mexico, will become very ardent defenders of their water quality once the situation has reached crisis dimensions, but may not be inclined to act without outside stimuli before a crisis is reached.

On the other hand, the experience of our country and more recently, Europe, shows that more mature economies will move to remedy current practices and to rectify past environmental sins before a crisis is reached, but still at rates that are slower than the most concerned group of citizenry will want. A fiscal component, whether it be Keynesian economics or budget control will act either as a damper or stimulus to the rate of spending.

In this connection, it's interesting to think of the trend that seems to have been led in Europe by the United Kingdom, toward privatization of publicly owned water and wastewater treatment facilities. In the U.K., to stimulate investment, the new water companies have obtained significant tax concessions plus an important incentive in that targeted investment will allow them to raise their rates to a higher level than the increase due to inflation. These are incentives which warrant a great deal of scrutiny within the United States as the movement toward privatization, directed by the President's initiative, move forward. Legislation here could initiate similar actions in export markets, which would help in export sales since public agencies frequently are under special pressure to buy domestic products, while privatized operations have a profit or loss target and performance criteria are paramount in their decision making.

Clearly, the United States has maintained a significant lead in the advancement of water quality since the early 1970s, and our technologies have therefore a preeminent place in the market. What we do not have—and this conference has been called to help create—are strong programs to enable American companies to rapidly reach export markets while that competitive advantage is still valid.

2.0 CURRENT AND FUTURE STATUS OF MARKETS

There is a lot of information to support the contention that the worldwide market opportunities for U.S. companies are huge, but they are not necessarily readily accessible. The vast majority of projects reaching the construction stage employ internationally available conventional treatment technologies and rely heavily on existing civil engineering practices. It is difficult to see U.S. companies competing successfully for these contracts given the low (and sometimes negative) margins that currently exist in a highly competitive environment, where some of our international competitors can also offer government-supported financial incentives.

Of greater attraction should be those projects which seek to solve problems which are not amenable to conventional technology. These might fall into several categories, among them:

1. Where conventional technologies cannot achieve the desired technical performance, such as destruction of intractable/toxic organics. Examples are chemical plants, pharmaceutical producers, refineries.

2. Where the cost or land requirements of conventional solutions are too great; for example, upgrading POTWs.

3. Where there is public resistance to "conventional solutions," as in the incineration of sludges.

The market for innovative technologies, while of course not as large as the total market, remains attractive for U.S. firms. For example, in the United Kingdom and the European Community alone, it is estimated that some $93 billion will be spent on wastewater treatment in this decade (1991-2000). And of that, the share invested in innovative technologies is expected to increase from 2% (or $180 million) in 1991, to 8 to 15% a year (or $640 million to $1.2 billion) by the end of the decade. Further, these numbers do not include the market for in-house waste treatment or merchant (commercial) treatment of hazardous waste. Our estimates are that this segment itself could account for an additional $10-15 billion per year in capital expenditures.

3.0 THE CHALLENGE

We know from our own experience that it is difficult to get a customer to accept an innovative solution. The degree of conservatism within consulting engineers, the utilities, and other customers will often result in the retention of conventional solutions albeit with both cost and performance penalties. (It's the "no one ever got fired for buying an activated sludge plant" syndrome).

Realistically then, we should be looking for mechanisms whereby the U.S. EPA can promote U.S. technology exports at minimal cost by tackling the blocks which hinder the adoption of innovative technology and by highlighting (and endorsing) the U.S. capability in this area.

To this end, EPA can do and should do much to promote innovative, but commercially proven technologies. EPA can and does help distribute information about U.S. technologies, such as wet air oxidation, and can help sell them by promoting our government's financial assistance such as loan credits, and by encouraging the use of these technologies through demonstrations.

The Japanese have a substantial MITI fund to enhance overseas marketing efforts and provide financing with the proviso that the financed plants must use Japanese equipment. Significant programs along those lines would mean a great deal to American companies, and I rush to add, to the American economy, if the money is in fact spent with United States producers, using our labor and material. Programs could undoubtedly be in the form of loan guarantees, or other indirect use of credit, particularly in the former Soviet block or in nations whose economies may have reached the point where pollution control is clearly necessary, but where the economy is not yet wealthy enough to assure normal credit avenues for the projects. (Denmark, much smaller than we, has successfully promoted its technology through government participation as far away as Malaysia).

EPA could facilitate the inclusion of environmental requirements in free trade agreements. This might require close cooperation with the U.S. Department of Commerce, but tighter liaison here might be a good idea in view of the efforts U.S. DOC has undertaken to promote U.S. waste treatment technology overseas.

But the solution to the acceptance problems I alluded to earlier may lie in the concept of BDAT or its foreign counterparts (BATNEEC in the United Kingdom). These classifications are extremely powerful. They say that for a specific problem, an optimum technical solution can be defined, and what is more, the regulators will act as a potent force in promoting that solution.

The theory is fine, but in practice most environmental regulators around the world (even in developed countries) are woefully equipped to recognize specific examples and applications of BDAT. Contrast this to the U.S. where, for all its problems, the EPA has already developed the detailed protocols for determining BDAT and has considerable experience in managing programs such as SITE and VISITT. We should also recognize that most regulatory agencies (although they may not care to admit it) look to the U.S. EPA for inspiration, as was demonstrated by the close collaboration on Mexican regulation. EPA should enhance its role of world leadership.

4.0 DATABASE

What regulators and technology users require is a "consumers guide to BDAT". It could take the form of a database with the ability to match problems with solutions which have been rigorously and objectively proven and giving detailed and up-to-date information on costs and performance.

Such a database would need to be a collaborative venture between participating environmental agencies and might be managed by a suitable private venture. Entry to the database would necessitate conformity with strict guidelines. Many of the technologies would be the result of supervised pilot trials (as in the SITE program). These trials could be conducted on a bilateral or multi-lateral basis. For

example a UK-based trial would be recognized and supervised by observers from U.S. EPA, UK HMIP, and perhaps regulators from the European Community and Japan. Under these circumstances, grant-aid may be available from national funds to meet some of the costs.

The existence of such a database and its use by regulators and engineers would transform the sales prospects for good technology and help clear away some of the "tire-kickers." It would also assist in defining the limitations of conventional technology. As such, it would be of inestimable value to U.S. technology suppliers. I say this because even without a great deal of government assistance, U.S. firms are successfully marketing innovative treatment technologies overseas—adding to the U.S. economy and job base as they go.

5.0 TECHNOLOGY DEMONSTRATIONS

Beyond development of a database, the U.S. EPA could facilitate the application of innovative American treatment technologies by supporting demonstration of these technologies at overseas sites. For example, U.S. companies could work with offshore partners to include innovative U.S. processes in wastewater treatment pilot plants.

In such projects, innovative technologies would first be identified by the participating companies for inclusion in the pilot plant. Local regulatory agencies would be heavily involved in assessing the performance of the pilot plant, thereby assuring active and positive collaboration with regulators—a situation that would encourage, rather than discourage, the use of innovative technologies.

Regulatory agency involvement would be encouraged in other ways, as well. The existence of a showpiece wastewater treatment facility would benefit the host country by serving as an example to other nations with similar wastewater treatment problems. The U.S. EPA and the host country regulatory authority might jointly recognize the pilot project, and apply BDAT protocols. U.S. government assistance could be provided in the form of suitably qualified personnel who would act as observers or advisers.

Finally, U.S. and other governments might also be willing to contribute to the costs of developing the pilot treatment plant database, devising database software and perhaps the running costs. The database could then be provided free of charge to others (similar to VISITT).

Pilot-plant projects such as this would be an excellent way for U.S. companies to showcase innovative technologies, define suitable wastewaters for treatment, and win international acceptance of the technologies, particularly among key regulatory audiences. These projects would become important "launching pads" for U.S. exports and would be of significant benefit to American firms who are aiming at international markets.

6.0 THE ZIMPRO PASSAVANT EXPERIENCE

Our company, Zimpro Passavant Environmental Systems, Inc., is an example. As Table 1 illustrates, we have expanded our international business over the past seven years such that more than 40% of our anticipated revenues for 1992 will come from exports. A healthy portion of our business came from overseas markets in 1989 and 1991, as well. And, as can be seen in Table 2, our activity includes Canada, as well as Europe, the Middle East, and particularly in the last five years, the Far East—specifically Taiwan.

How are we doing this? Through carefully constructed relationships with appropriate regional "partner" companies, supported by an all-out commitment to technical support in the field, and with a great deal of patience!

While we have had a very rewarding license arrangement with a Japanese company for some 18 years, and have had a similar licensing agreement with a Indian company, we do not currently seek licenses for our technology. We now prefer what we call "cooperation agreements" whereby we are

represented in one way or another in the importing country by technically qualified firms, but where the critical components of our technology are controlled by us. That is to say, we will do the detailed process engineering and we will supply key equipment, operator training, and startup assistance; and in most cases, the cooperating company will supply civil engineering, the general site supervision or contracting such as buildings, foundations and structures, and provide the interconnecting piping.

Table 1

Zimpro Passavant Export Revenue

Year	Export Revenue (000's)
1986	$4,511
1987	2,594
1988	6,145
1989	14,056
1990	4,068
1991	14,092
1992 (est.)	15,900

Table 2

Zimpro Passavant Exports ($000's) by Country

Countries	1986	1987	1988	1989	1990	1991	1992 (Est.)
Canada	4,228	1,812	4,167	3,049	746	2,511	2,573
Taiwan			1,529	8,212	1,760	6,119	11,082
Belgium				845			
United Kingdom						4,688	1,942
Korea				662			
Egypt		742		685			

Depending upon costs or other special considerations such as tariffs, local preference, and delivery, we will either purchase other components in the importing country or supply them from the United States. This seems to be an effective method of protecting the interests of all parties and so far has worked very effectively. In passing, at this point it's probably appropriate to say that we are concerned that some of the regulations being written within the Common Market not take the form whereby they excessively discourage the supply of U.S. components.

As an American company, what do we have to sell? For Zimpro Passavant, this is a particularly appropriate question since the name of the company is derived both from the origin of Zimpro,

that is F.J. Zimmermann, who developed the wet air oxidation process and Passavant Werke of Aarbergen, Germany, whose American subsidiary merged with Zimpro in 1987. Obviously we have found considerable value in some European technology and I, therefore, must again stress that there are many companies throughout the world who produce wastewater treatment equipment. The strength of American exports must be in proprietary, unique products or products designed to meet a new need which is not yet resolved throughout the world.

Let me give you several examples, based on our experience. In Portsmouth, New Hampshire, we have supplied a unusual configuration of our proprietary Hydro-Clear[R] filter which is being used after primary treatment to remove most of the remaining BOD and suspended solids from municipal sewage prior to ocean discharge. The effluent from this plant will meet the standards for ocean discharge at 40 mg/l of suspended solids and close to zero coliform at a fraction of the cost and at a fraction of the land use of a conventional full primary and secondary treatment plant. In Great Britain alone, there are an estimated 700 ocean outfalls which could utilize this technology; and throughout the world there are a number of locations where the cost and size of a full-blown treatment plant prior to ocean discharge would be prohibitive. This simple concept could greatly reduce the bacterial and physical contamination of direct ocean discharge.

We also have been successful in such countries as Korea, Japan, and Canada with our proprietary PACT® wastewater treatment system, which enhances biological treatment with powdered activated carbon. When wastewater is contaminated with compounds that are either toxic to treatment bacteria or are resistant to biological degradation, this technology can produce a very high quality effluent. We are just now beginning marketing efforts in Mexico and the Common Market. This system is producing effluent that meets a permit level of 10 mg/l BOD, 10 mg/l suspended solids and 1 mg/l phosphorus on one particular discharge which, until the introduction of this system, created a dead and highly odoriferous river. PACT® was part of the EPA innovative technology program.

When this system is coupled with our carbon regeneration system, utilizing wet air oxidation, we not only regenerate the carbon, but we turn secondary sludge to an inert ash, without producing dioxins or nitrogen oxides.

This leads me to our third innovative technology—wet air oxidation. A recent installation of Zimpro wet air oxidation technology at Sterling Organics in the U.K. is eliminating a problem with an ocean discharge. At Yorkshire Water, one of the new British water companies, wet air oxidation is the cornerstone of a new installation that will treat wastewaters too severely contaminated for treatment in Yorkshire Water's sewage treatment plants. Wet air oxidation in other configurations is being used in Taiwan by Chinese Petroleum Corp., in Belgium by Finaneste, and elsewhere throughout the world in petrochemical plants where a caustic wash water is utilized to adsorb sulfides and mercaptans from the production of chemical feedstocks. These materials cannot be biologically treated and are serious contaminants. When they go through wet air oxidation, they are converted to sulfates which precipitate out. The residual compounds in the wastewater are largely converted to acetic acid (vinegar) which is highly biodegradable, producing an effluent which is wholly compatible with environmental considerations.

We are currently embarking on efforts to introduce our wet air oxidation technology to the treatment of mixed waste which is both organically contaminated and radioactive. We are collaborating with international firms in the nuclear engineering field to achieve this end. We anticipate substantial international interest in this development.

Thanks to our affiliation with the Black Clawson company, we are embarked on a program of expansion of our technology into the pulp and paper industry, specifically as a process for the waste sludge produced through the deinking processes when wastepaper is recycled for reuse.

7.0 CONCLUSION

We are not trying to sell refrigerators to Eskimos. We do not attempt to simply compete with local producers, nor do we see any point in trying to match highly sophisticated systems to simple problems. We do see a great deal of merit throughout the world in using American technology to cope with complex problems, based on the experience of our roughly 40 years in wastewater treatment. I think there is a great deal to be learned from this successful approach. Our own export volume was negligible seven years ago, but today is a very large percentage of our sales. Frankly, we could do even better with our government's interest and support, not only through the programs I suggested earlier, but by federal support in whatever form it takes for private sector research initiatives. These could be tax abatement or direct funding to stimulate research and development by equipment suppliers. Such programs in the past have tended to limit proprietary developments by insisting that patents arising from the work be licensable. The key to commercial development is to make developmental effort profitable. We can't get very enthusiastic if the fruits of our efforts are universally available.

Luncheon Address by Keynote Speaker

Donald H. DeMeuse
President and Chairman/Chief Executive Officer
Fort Howard Corporation

It's a privilege to be here, and I want to show my appreciation with some straight talk.

There was a time when I would picture the 35,000 pages that comprise federal environmental regulations as 35,000 thousand-dollar bills leaving my company's coffers never to be seen again. Now this farm boy is smart enough to know that many of those regulations have helped to protect our environment. I'm also convinced that just as many of them provide a nebulous environmental return to society, and just as many were mandated with general disregard for the impact on companies like my own.

And that's been the rub between industry and regulators, and industry and environmental groups for longer than I care to remember. Environmentalists and regulators would stand on their respective street corners and shout across to industry, "Pay!" Industry would shout back, "For what?"

Well, I'm happy to share my observation that there is less shouting going on and the groups appear to be heading to a common neutral corner. The combative and confrontational style marking the 70s and 80s is beginning to give way to a more cooperative approach. I emphasize "beginning."

What is prompting this sea of change? One factor might be that the three groups actually seem to agree on something. What they agree on is the goal of cleaning our water and improving our environment. Most also agree that, given limited resources, making significant progress on environmental matters in the future demands that we recognize economic- and market-based realities. There is also consensus that we must do a better job of establishing environmental priorities to determine where those finite resources can do the most good.

Here's what the environmentalists say on this matter. And I quote Fred Krupp of the Environmental Defense Fund: "If we are to succeed in saving our planet—and we are degrading it at an accelerating rate—we must have solutions which reconcile environmental imperatives with economic needs."

From the regulatory agencies, I quote from EPA Administrator Bill Reilly, as quoted in *Fortune Magazine*: "Environmental spending cries out for discipline and rationality, for something to put things in a reasonable hierarchy."

To quote someone from industry, me . . . ditto! The challenge at hand is to reconcile the environment and the economy. To find ways so that protection of technology can work synergistically with increases in production. To foster what some are calling an eco-industrial revolution. My personal view is that this weighty challenge can be met if the innovation of American companies is allowed to flourish.

There's much more to be said on this subject, and I'll come back to it in a moment.

While I have your attention during the next several minutes, I want to develop two general areas. First, and I've already set the stage for this, are my views on the broad economic impact of regulation and compliance pressures on industry and how we can achieve a win-win situation where environmental improvement coincides with economic growth. Secondly, I'll share some specific comments on draft revisions to the Clean Water Act and how the revisions can be reworked to reflect economic considerations.

Just how do we begin to meet both the environmental and the economic needs of this nation? Well, for every complex problem, there is a simple, straightforward, and usually wrong answer. That's true in this case as well.

But we can begin by recognizing that there are not infinite resources to respond to ever more costly compliance regulations. Industry's deep pockets are getting threadbare. In 1990, U.S. businesses and industry spent an estimated $116 billion on environmental compliance. By 2000, that piece of the economic pie will grow to $200 billion. Last year the paper industry by itself spent more than $1 billion. That is an enormous levy on the national product.

To the extent capital resources are required for environmental compliance, they are unavailable for investing in new jobs, production capacity, and new technology. I might add that industry represents a large portion of the nation's tax base. And if you extend the economic flow chart to its end, you realize that diminishing industry's cash stream ultimately diminishes the taxes it pays, increasing deficit spending and the economic baggage that it brings with it.

Some still do not appreciate the massive expenditures that are being made on the environment. This misconception may occur because environmental spending is not immediately apparent because most of the expenditures are borne by the private sector and therefore, the costs are hidden. I agree with Paul Portney, Vice President of Resources for the Future who said, and I quote, "We should see the same public debate on environmental expenditures that we see on defense spending."

Indeed, in a study conducted by Jorgenson and Wilcoxen, they estimate that in the absence of the 1970s and 1980s environmental policies, real GNP would be about 2.6% higher than its current level—a figure that translates to about half of the combined federal, state, and local expenditures on education. Other respected studies show much higher figures.

Obviously, the answer is not in eliminating all environmental regulation. At the same time, in the area of regulation, more is not necessarily better. Better is better.

The Science Advisory Board described very well just what "better" means. I quote, "Although EPA's budget priorities are determined to a large extent by the different environmental laws that the agency implements, it should use whatever discretion it has to focus budget resources at those environmental problems that pose the most risk."

The parallel in industry is undertaking those projects that have the best financial return on investment. The process involves setting priorities and targeting your resources. That's the most formidable challenge for Congress and the EPA from my point of view, identifying the biggest environmental bang for the taxpayer and shareholder buck.

This fact has not been lost on EPA Administrator Reilly. I quote him here: "Until recently, we have made little effort to assess our overall environmental quality objectives, to target our laws and scarce resources to reduce the greatest risks to human health and natural systems. Now I think we've got to."

Mr. Reilly went on to say that there are simply more anxieties than we can possibly create laws to alleviate and far more risks than resources to eliminate them. And he candidly said that the environmental debate has long suffered from too little science.

I'm reluctant to be the one to break the news, but even if Mr. Reilly or his successor is successful in doing what he hopes to do, he and the agency won't be off the hook. You'll remain at the mercy of a strong emotional and political temptation to add more and more environmental mandates on many fronts.

The difficulty of holding the media and other pressures at bay while you make difficult decisions can't be overestimated. I don't need to remind you that the media routinely create an image of risk out of proportion with the problems. Editors don't want issues that are ambiguous, but most environmental issues are by nature ambiguous.

It's easy for me to stand up here and urge the EPA to work harder to determine your environmental return on investment. Obviously, EPA's commitment to achieving this goal at all levels of the agency is crucial. The truth of the matter, however, is that you are only as good as your scientific toolbox.

While the use of risk assessment as a tool may be far from perfect, thoughtfully done, it is key to determining whether or not a problem exists and whether or not resources need to be utilized to address the problem. We must simply commit to using this tool and the information it provides.

It is also important that EPA move more quickly to utilize direct evidence of causation as it becomes available as opposed to computer model default assumptions, an action recommended by the SAB.

Using realistic, as well as EPA's worst-case assumptions, would present a more informative and fair picture of the risk to real individuals. Advocates on both sides can argue for more or less stringent regulations, but the public interest is not served if participants in that debate are misled regarding the range of risk to which real persons are exposed.

Risk assessment requires a large number of assumptions and inferences. Consider just one assumption that any human exposure to carcinogens, no matter how small, is harmful and eventually will cause some increase in the incidence of cancer in the population.

Many scientists are now questioning this assumption based on new evidence. Arsenic, for example, causes cancer at very high doses, but evidence has indicated that it is an essential nutrient at very low levels. Thus, eliminating all public exposure to arsenic would actually harm public health.

Compared to other nations and even other U.S. regulatory agencies, the EPA's risk methodologies are too conservative and many overstate the risk. Industry knows painfully well that risk assessment drives cost. Overly restrictive regulations, born of unrealistic risk assessment, can be extremely costly with little environmental benefit. The resulting use of scarce resources with little environmental benefit is not in anyone's interest, whether you are with EPA, business, or an environmental organization.

The disparity between federal regulatory agencies in applying risk assessment standards is perplexing. A contaminant level that the FDA believes represents no risk can be enough to drive regulatory policy at the EPA. It can also drive unfounded public anxiety.

In my company, we have a total quality management process. As part of that process, we work on a challenge called "DIRTFT," which stands for "Do It Right The First Time." Today, I challenge the EPA to get with the quality process and integrate DIRTFT into everything you do.

A White House plan has been developed, and is now on hold, to revamp federal health risk assessment practices by imposing consistent practices across all federal agencies. It is my understanding that this plan moves in the right direction by, among other things, requiring that a range of risk be provided in risk assessment based on both average exposure as well as worst case exposure. I hope a reasonable and consistent plan across all federal agencies can be finalized.

One individual who we're associated with through our involvement in the National Recycling Coalition and the Recycling Advisory Council, and who has close contact with leading environmental groups, had an interesting suggestion. He proposed that an independent third party, such as the National Academy of Science, be charged with establishing realistic risk assessment formulas. This would be particularly useful

in the development of ecological risk assessment, an area which is even further behind health risk assessment in terms of consistency of approach or rationality.

Such a group, at least in theory, would have the necessary financial resources and be in a position to apply the best possible science to this processes. As a neutral and respected third party, this group might be able to pull the extreme positions close to the center. I, for one, believe the idea deserves more discussion.

Whatever the case, I believe it is critical that industry and government form a new partnership between us if we want to maintain our competitive position in this world.

Isn't it ironic that in one respect, technology is making our job harder. One of the greatest dangers of the 90s is our scientific capacity to discover ever diminishing levels of contamination. This may, if we're not careful, lead to investing greater resources on smaller and smaller levels of pollution with little real return in actual risk reduction.

Allow me to restate the fundamental tenet we started with: To make significant progress on environmental matters demands that we recognize economic realities and maximize marketplace opportunities. It's interesting to note that if you turn this tenet upside down, it's still true. To make significant progress on economic matters requires that we recognize environmental realities.

I believe my company is representative of general industry in this area. Environmental considerations are of major significance in all aspects of our business planning, from capital expansion projects, to product introductions, to employee recycling efforts.

To your credit, this environmental orientation has also gone beyond industry. For example, the World Bank and the Department of Defense are now making efforts to better integrate environmental considerations into their activities. It seems apparent that with the environmental stewardship mentality now prevailing in this country, this ecological strategic thinking will continue to grow.

But let's switch back to economic considerations. It is imperative, for the sake of U.S. industrial competitiveness, that the EPA not forsake economic considerations in its policies and planning. Both regulatory analysis, which compares optional ways to achieve desired goals, as well as thorough and honest cost/benefit analyses can help guide policy makers. As a nation, we can't afford environmental laws or resolutions that have not addressed the subject of costs or benefits during their development.

There is a growing school of thought that the EPA can actually boost U.S. competitiveness through environmental policies that emphasize performance standards, market incentives, and innovation. The rationale behind the thinking is that today's environmental problems stem from a lifestyle that relies heavily on diverse products and processes that defy traditional regulation.

Fred Krupp seems to support that thinking. In a recent speech, Krupp said, "In many cases we have reached the point of diminishing returns in the use of rigid mandates for specific anti-pollution technologies, which is the way many regulations have been. We cannot regulate our way out of every environmental problem—we have to innovate our way out—and that innovation has to come from the marketplace."

In his landmark study called Project '88, Harvard Professor Dr. Robert Stavins described ways in which everyday economic decisions of individuals, businesses, and the government might work effectively for the environment. One of his examples dealt with the development of tradeable permit systems for nonpoint source pollution—the nation's No. 1 water pollution issue. In Denver, Colorado, environmental groups, industry, and local and state governments worked together to create an innovative permit trading plan for nonpoint source pollution in the Dillon Reservoir, the major source of water for the city. The plan

not only saved money, but provided a greater likelihood of achieving environmental improvements. The same type of program is now being developed for other Colorado sites.

While I'm on this subject, I might mention that Colorado is an exception as far as individual states aggressively coming to grips with nonpoint source pollution. Most states are wallowing without clear direction. Perhaps more federal dollars should be shifted from industrial point source efforts to nonpoint source areas where opportunities for environmental gains are significantly greater.

I suggest that one way to fuel the type of environmental innovation shown in Colorado is to involve affected U.S. companies in agency management strategies. The communication my own industry has experienced with Bill Reilly is unprecedented. It helps to explain the strong voluntary support from the paper industry for the agency's 33/50 program. But the time is ripe to take that positive interaction to the next level. If the EPA can foster a meaningful dialogue with the stakeholders earlier in its processes, it can be more effective in setting priorities and establishing cost-effective solutions as early as possible.

This will require leaving behind what some EPA critics call the agency's "command and control" mentality, and it may require leaving behind mandated control technologies in favor of simply establishing target standards based on the best possible science. Set the target, not the tool. Industry will respond with innovation thanks to an innate aversion to costs.

And when you tell us what needs to be done, above all use sound science. In this day and age, it's time we got a little bit enlightened. It's simply not feasible to achieve a "zero discharge." With today's scientific technology, we can measure a little bit of everything everywhere, so to talk about zero discharge is absurd.

That's what the EPA can do. But, as they say, it takes two to tango.

An outreach effort on behalf of the nation's environmental agency has to be matched with a general commitment to corporate environmentalism. At Fort Howard, we believe corporate environmentalism is made up of five ingredients: First, we make environmental concerns part of everyday business decisions, not something extra. Second, we've assigned a high-level group of managers from several professions to meet regularly and closely monitor environmental issues emanating from the company. Third, we aggressively pursue dialogue with environmentalists, both in our plant communities and at the national level. Fourth, we do things because they are right, not because someone forced us. Fifth, we are not afraid to be leaders in what we do.

This is not corporate ecobabble. The widespread shift toward corporate environmentalism goes beyond Fort Howard, and it's not altogether altruistic. Our markets have changed. A combination of baby boomers having children and a significant part of the population moving into its senior years mean an enormous percentage of the population is taking the attitude of stewardship.

Our own experience in communicating with consumers backs this up. The largest percentage of individuals who write to us or call our 800 numbers have inquiries that are environmentally related. They want to know about our bleaching operations, our use of post-consumer wastepaper, and other complex issues. Not too many years ago, most of our consumer contacts were from folks who wanted to know where they could find our napkins with the cute blue geese on them.

Concern for the physical environment, its purity, safety, and inviolability has become one of the most deeply ingrained emotional and moral issues of our day.

It is against this background that congressional staff and policy makers are considering Clean Water Act Reauthorization. In inviting me to make some comments this morning, I was specifically asked to mention the economic ramifications of the Clean Water Act.

The next Congress will consider reauthorization of the Clean Water Act. Already we have seen a Senate staff draft, and I emphasize staff draft, which presents a number of major concerns to those who seek balance in environmental law. If adopted, this draft could have these possible effects:

- It would totally prohibit the discharge of hundreds of substances based on arbitrary thresholds, without an assessment of the environmental impact of such discharges or the impact of implementing such a ban.

- It could "require" changes in production processes, products, or raw materials, an unprecedented action that could give the federal government control over industry's ability to manage and effect our competitiveness without offsetting environmental benefits.

- If adopted, the draft would no longer allow EPA to use Best Conventional Technology (BCT) for conventional pollutants (BOD, pH, TSS). This is despite the fact that no consideration has been given to the social, environmental, or economic impacts that may occur if such pollutants are regulated under a new, more stringent standard.

- It would create an antidegradation provision that would sharply curtail modifications or expansions at existing industrial facilities, and development of new facilities. This is regardless of the nature or amount of the proposed pollutant discharge, its overall effect on the designated use, or the availability of countervailing decreases in other pollutants.

- Under the draft, states would be required within three years (with the possibility of a three-year extension) to designate all of their waters for "fishable/swimmable" designation. This is true even though the states may find that the less restrictive navigational, agricultural, or industrial uses are the only uses attainable consistent with the state's social and economic well being or that fishable/swimmable uses may never be attainable due to naturally occurring or unalterable manmade physical, biological, or chemical conditions.

- And it would arbitrarily provide "bonus points" toward Superfund designation for areas of concern in the Great Lakes. This would help ensure that these sites become Superfund sites even though they would not otherwise score high enough to warrant such designation. It, of course, makes absolutely no sense to put sites on the Superfund list that do not qualify on their own merits.

I would note that, according to EPA, less than 15% of the remaining water quality problems can be attributed to industrial (point source) dischargers, yet almost all of the provisions in S 1081 focus on this area and will divert government and industry resources away from the major remaining water problems.

Well, fortunately this is only a staff draft. However, it points to the fact that there are many provisions that are being tossed about, at least by a few, which, if adopted, would result in large expenditures and decreased flexibility with little offsetting environmental benefit.

It is my belief that only minor changes need to be made to the current comprehensive Clean Water Act and that a full and complete evaluation of the current statutory authorities and the potential impact of any major new provisions should be made before proceeding.

The 1987 Amendments significantly strengthened the statute. Additions included stringent new toxics and water quality standard provisions, new provisions regarding technology-based effluent guidelines, the anti-backsliding provision prohibiting less stringent discharge limitations in revised permits,

and more. EPA and the states are implementing each of these programs. Compliance is underway and continued improvements in water quality are occurring. Major changes to the Act simply are not necessary.

In the regulatory area, too, there are areas of concern. While the final guidance has not been issued in proposed form, one issue that immediately comes to mind is the Great Lakes Initiative or GLI. I should tell you that even if you are not involved in the Great Lakes, you should be interested. Many in EPA have indicated their plans to use the GLI as a model for other areas of the country. Accordingly, if appropriate methodologies, sound science, and other principles we have discussed today are not utilized in the development of water regulation of the Great Lakes, the error will be translated to other areas of the country in the coming months and years. Let's look at some of the concerns:

One concern deals with the proposed methodology for determining a chemical's ability to concentrate in an organism (known as bioaccumulation factors or BAFs), a methodology that could result in the bioaccumulation factors being overstated by a factor of up to 1,000. Such an approach could result in an unwarranted explosion in the number of regulated substances for no environmentally sound reason. Obviously, this is an example where sound science should be brought to bear.

Also, under the pending GLI, only the most stringent value for a substance will be developed to protect many varied ecosystems in the entire Great Lakes. Thus, if a value for a pollutant is developed to protect a sensitive fish or animal in New York State, the value will also be applicable in all other ecosystems on the Great Lakes potentially thousands of miles away where the species may not even exist and conditions may be entirely different. This approach abandons local flexibility and will result in overly restrictive controls for many areas.

Stunningly, it might even be possible for a discharger under the pending GLI to have to expend astronomical sums of money for negligible environmental benefits because a credit may not be allowed even for pollutants coming into a company's intake as a result of background pollutants already in the stream. Forcing companies to treat background levels only to put the water right back into the stream particularly highlights the failing of policy makers to focus our finite resources where they can do the most good. Again, higher costs with little benefit will be the result.

The GLI will also allow the establishment of stringent permit values based on far less reliable data sets (known as Tier II values) than in the past . . an approach to which the Science Advisory Board has urged modifications. This approach is made more untenable by the fact that inadequate time is allowed for the completion of studies to refute the questionable water quality values. This is because the GLI proposes to require compliance within three years with these permit values if no new data is developed. In addition, if the values are subsequently found through research to be overly stringent, the anti-backsliding provision in the Clean Water Act could prevent any relaxation.

In other words, stringent regulations would be established based on weak and incomplete science. However, reverse adjustment may not be allowed even if such a recommended change was based on more comprehensive scientific findings.

Finally, under the GLI, a stringent antidegradation proposal would, without a full antidegradation review, preclude increases in plants currently operating at less than full capacity and even below allowable permit limits. As you might expect, this is not an unusual situation for many facilities given the current recession. In addition, under this proposal, the flexibility of plant operators to alter production processes or obtain new or slightly different raw materials is limited, even if their permit limits are met.

As currently written, municipal POTWs will also face major problems. For example, any new industrial or commercial hook ups to municipal plants could increase emissions for some substances over current levels triggering an antidegradation review.

I urge EPA to carefully review the concerns I have noted using the principles we have discussed today because to do otherwise risks unnecessarily high costs for minimal environmental benefits. It is also my hope that, given the massive nature of this effort and its potential impact, a full regulatory review and cost/benefit analysis will be done and policy modifications made where appropriate prior to publication of the proposal in the Federal Register. The SAB findings should also be carefully weighed.

Both the GLI and the Clean Water Act represent opportunities to take advantage of the new environmentalism I've talked about today. A new environmentalism that is shaping up to be global in character, to be more cooperative than confrontational, and with business at the center. Our challenge is to aggressively move into a new era when practical and economically sensible policies, combined with good science, will provide more effective and efficient environmental protection and natural resource management. Environmental protection and sound business management are mutually achievable objectives.

Indeed, in my view, there is the basis for a win-win approach for environmental agencies, environmentalists, industry, and the public at large. The key points include:

- A commitment to the goal of a clean and safe environment and a genuine effort to work toward that goal at all levels.

- A recognition by all parties that our resources are finite and must therefore be targeted to the areas of greatest environmental return. Projects with high costs and little environmental benefit should be scrapped.

- A greater commitment to the use of sound science and responsible risk assessment methodologies to better help us honestly determine where the priority concerns lie and where resources need to be placed to do the most good.

- A commitment to allowing the most feasible and cost-efficient approaches to achieving the environmental goal.

No one can argue if funds are spent in a cost-effective manner on environmental programs that result in significant improvements to our environment. What should offend all of us, and I am including environmental activists here as well, is the expenditure of our finite resources on environmental programs that result in high costs for negligible benefits. No one benefits . . . least of all the environment when scarce resources are misallocated.

I like the way Bill Reilly describes it. He refers to it as allying the green of environmental protection with the green of profits to form a new environmentalism in this country.

But we are at a point where the road ahead forks and we must decide which direction to take in the name of the environment.

The now infamous Woody Allen described our predicament in his own inimitable way. He said, "More than any time in history, mankind faces a crossroads. One path leads to despair and utter hopelessness, the other to total extinction. Let us pray we have the wisdom to choose correctly."

My personal view is not nearly so bleak as Mr. Allen's. But we have a lot riding on our ultimate path. After all, we all live downstream from something, and we all want to leave the same legacy for our children. Our goal should be to leave the next generation with a stronger economy, a cleaner environment, and a sense of mission to protect both.

Thank you very much.

Tuesday, October 20, 1992

Session 6: Pollution Prevention in Water-Intensive Industries

SESSION SUMMARY

MODERATOR: Wendell (Ray) Cunningham

PRESENTERS:

Charles D. Malloch—*Pollution Prevention in Water-Intensive Industries: One Chemical Company's Views*

W. Jeffrey Pardue—*Balancing Economics and the Environment: The Case for Retaining Section 316(a) of the Clean Water Act*

Deborah Sparks—*Environmental Opportunities Missed: Can The Clean Water Act Make a Difference in the Future?*

Dennis R. Sasseville—*Voluntary Pollution Prevention Initiatives Will Shape U.S. Industry's Regulatory Relationships and Economic Future*

Pollution Prevention In Water-Intensive Industries: One Chemical Company's Views

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ABSTRACT

Water resources can be viewed as a positive, important need as well as a significant concern for the chemical manufacturing industry. Industrial uses of water require varying levels of purity and availability necessitating an appropriate supply of this resource. The "flip side" of the coin directs that "used up" water resources be returned to, but not adversely impact, the environment. The chemical industry will continue to have water resource needs and must also continue to find new economical and socially responsible means of meeting its water quality obligations. Pollution prevention and minimization of use are but two tools toward this end. Statutory changes to the Clean Water Act as well as regulatory redirection by EPA may be necessary to encourage, motivate, and provide incentives to maximize pollution prevention opportunities.

1.0 INTRODUCTION

This paper was prepared at the invitation of the U.S. Environmental Protection Agency as an element for its "Clean Water and the American Economy" Conference on October 20, 1992. While the paper specifically addresses the author's company and its approaches to pollution prevention issues, it also discusses some publicly expressed views of the Chemical Manufacturers Association (CMA) which represents the chemical industry. CMA references will be noted with all other points attributed to Monsanto Company.

2.0 MONSANTO WATER RESOURCE ISSUES

2.1 Industrial Water Uses and Supply

Monsanto operates over thirty manufacturing facilities within the United States. These plants require water resources of widely varying degrees of purity for use either directly or indirectly in support of manufacturing operations. Uses include process needs for water meeting drinking water purity in the manufacture of food and pharmaceutical products, as well as indirect uses for cooling, pollution control, and other support operations. Without water resource availability at appropriate purity levels or at the quantities needed, many of Monsanto's production processes could not be sustained.

Monsanto's water resources come from a wide variety of sources. For drinking water purity (or equivalent), the most common source is from municipal water suppliers followed by water wells and from rivers, both subjected to varying levels of treatment. Water for indirect process uses and for cooling needs is generally obtained from local rivers or other water bodies. Without an appropriate water resource, Monsanto operations could not be sustained.

2.2 Wastewater Treatment

Monsanto's U.S. plants treat wastewater to levels consistent with internal Monsanto standards which equal, or exceed, those requirements mandated by the Clean Water Act (CWA). Monsanto has approximately 21 NPDES permits covering 17 significant wastewater treatment operations at 17 plants.

These treatment facilities utilize technologies recognized as current state of the art, such as biological oxidation, activated carbon, and secondary biological treatment.

Monsanto also operates treatment units to pretreat wastewater before its transfer to municipal wastewater treatment plants, (i.e., publicly owned treatment works (POTW)), in municipalities in which we operate. Again, Monsanto conforms to its own guidelines or the EPA's pretreatment regulations or state and local requirements, whichever is stricter. These treatment facilities employ somewhat different technologies than discussed above, such as pH neutralization, activated carbon adsorption, and steam stripping.

Monsanto spent $365 million in 1991 on combined multi-media capital, operation/maintenance and remediation costs to meet its environmental, safety, and health obligations.

3.0 MONSANTO'S ENVIRONMENTAL STEWARDSHIP

For a number of years, Monsanto's corporate environmental stewardship philosophy has embraced an ethic of "doing the right thing". This ethic governs both our internal commitment to set the best course of action for the company as well as striving to meet public expectations. The rising level of public awareness on environmental issues has heightened their expectations in terms of expected corporate responses.

Over the last 20 years, a number of significant national or worldwide events have occurred, each contributing to the changing attitudes of the communities in which we are located. Instead of welcoming new manufacturers, communities and their environmental groups today often protest new facilities and ask sophisticated questions concerning new operations. They want companies to not only meet the law, but to go well beyond the law in environmental protection. In at least one case, Monsanto has had to rethink plans for a new facility as a result of the attitude in the community in which we intended to locate. This attitude change is real and will likely continue to be strengthened.

At Monsanto, CEO Dick Mahoney, has said, "Our right to operate and the ability to reach our goals will be available to us only as long as we come closer and closer to public expectations." Monsanto has been striving to meet these expectations by allowing the public to see us acting, and performing, in good faith on environmental issues. We want to earn a level of trust that causes the public to give us the benefit of doubt, to allow us the right to operate, to give us credit for our efforts. Meeting public expectations is not easy, but it is essential if we are to succeed as a company.

One major driving force, among many, was enactment of Title III, the Community Right-to-Know Act of 1986, which required all manufacturers, for the first time, to annually report emissions and releases of some 320 chemicals. These reports are given to federal and state regulators who in turn make them available to the public. We also make our reports directly available to the public.

It should be noted that the federal law only requires manufacturers to report; nothing else was required. No clean-ups, no reduction of waste or releases, nothing but the reporting of releases and off-site transfers. Yet this law, as no other, has inaugurated a revolution in industry and may ultimately result in more waste reduction than all the other environmental laws combined.

Several examples of the Monsanto stewardship both before and since the 1986 enactment of the Right-to-Know legislation include the following:

1. A milestone for Monsanto in the pollution prevention arena was reached in 1981 with the formation of a waste minimization program focusing on hazardous waste. Put yourself back into 1981. The Resource Conservation and Recovery Act (RCRA) was just "kicking in," imposing significant new cost burdens on hazardous wastes. Monsanto and others in industry were also coming to grips in the early

1980s with a realization that prior disposal of hazardous wastes had left a legacy of problems. The Superfund law had been put into place to address those problems, at significant expense to waste generators.

Our progress on hazardous waste minimization was encouraging when we tallied the results in 1987 noting that waste generation had been reduced by 50% from 1982 levels. We thought that was good progress, and it was. But we also noted that reductions from process improvements were starting to run dry. Significant further progress was going to require some fundamental work on processes, necessitating commitment of significantly higher funds to R&D.

2. Outside the company, public concerns began to focus on multimedia releases. These included releases to air, water, and land, and were not just associated with hazardous waste. There were increasing concerns on the part of the public that releases to one media were not remedied by simply scrubbing them to, or burying them in, another media. As a result, we redirected our corporate efforts to pollution prevention, and Monsanto's executive leadership stepped in to catalyze that redirection.

   In June of 1988, our CEO, Dick Mahoney, looked at the Title III data and said that the numbers were not acceptable, not to him, not to Monsanto, and certainly not to the public. On July 1 of that year, Monsanto announced its Title III numbers to the public together with Mr. Mahoney's commitment, and the corporate commitment, that we would reduce Monsanto's Title III air emissions, worldwide, by 90% by the end of 1992. We would then work towards the ultimate goal of zero effect.

   By the end of 1991, we had reduced our air emissions by over 66% and will reach the 90% goal by the end of 1992. Many projects are being installed to finish this commitment, and when we report the calendar year 1993 releases, they will show a greater than 90% reduction of the 1987 reported base.

3. Also back in 1988, the Chemical Group of Monsanto, by far the largest unit within the corporation, established a multimedia goal of reducing 70% of targeted releases by the end of 1995. We are currently working to update this multimedia program to broaden its scope and make it even more responsive to public expectations. Later in 1992, we expect to announce this expanded initiative.

   Most recently, the Pollution Prevention Act of 1990 requires all companies reporting releases under Title III to expand their reports to now quantify the amount of chemicals in waste streams *prior to* recovery or treatment. In other words, chemicals which are recycled, used for energy recovery, or destroyed before being released to the environment or transferred off site for further processing are now reported for the first time.

   Public reaction to the first set of numbers for calendar year 1991 under this new reporting scheme has yet to be assessed, but within EPA and in public interest groups, there appears to be an increasing emphasis on source reduction as a means to reduce waste. Monsanto is fully supportive of source reduction as being the best route to achieving pollution prevention since it pays both environmental and financial dividends. *However*, we believe industry should also be given full credit for recycle, energy recovery and treatment where they are the best technological and

economic solutions available. Pollution prevention approaches are a way of life at Monsanto and are strong driving forces in its environmental stewardship programs.

4.0 POLLUTION PREVENTION IN A WATER RESOURCE CONTEXT

The U.S. is reaching a significant crossroads as it moves from traditional command and control treatment approaches for solving wastewater problems to seeking pollution prevention/market incentive approaches to achieve additional reductions in an economical and beneficial manner. Over the last several years, both the U.S. EPA and the regulated industrial community have begun to seek voluntary actions as a supplement to existing command and control regulations to achieve environmental improvements. Remaining environmental problems, particularly in the wastewater area, will require more complex and diffuse solutions, many of which will be more site specific in their nature than ever before.

EPA Administrator Reilly, in his testimony before the House Public Works Committee on January 20, 1991, noted that "many of our old ways of doing business are simply not appropriate to address the complex and varied problems that lie ahead. Increasingly, we will have to craft solutions to complex problems on a geographic-specific basis, and we will have to find new ways to implement nontraditional solutions. Traditional national regulatory approaches are not effective for every problem. The extent and complexity of these future risks require the flexibility to use a much broader array of tools, to promote grassroots involvement, voluntary approaches, economic incentives, negotiations, and education to supplement and enhance existing traditional regulatory approaches." Mr. Reilly was testifying on Clean Water Act reauthorization at the time.

CMA noted in its testimony on May 14, 1991 before the House Public Works Committee's Subcommittee on Water Resources that Mr. Reilly "suggests a willingness to look beyond traditional" command and control techniques to help solve remaining environmental problems. He "suggests the potential for more innovative approaches in combination with existing regulatory approaches." CMA also went on to suggest that Congress "needs to encourage innovative approaches" in the next round of environmental legislation. Further, CMA supported that "voluntary, crossmedia programs to address pollution prevention are an appropriate complement to existing regulatory controls." Finally, CMA believes that "to get more reductions, quicker, and without the accompanying shell game of moving the pollution around from one media to another, industry needs encouragement and flexibility, not more regulation."

While there are some current Clean Water Act statutory restraints as well as EPA regulatory impediments, Monsanto has been able to institute some wastewater pollution prevention activities which do support the CMA, and Monsanto corporate beliefs that such reductions outside the command and control format is an appropriate approach for the future.

Several examples within Monsanto help illustrate this point. Monsanto's West Virginia plant modified one of its production units and updated the operating procedures in that department, resulting in elimination of 116,000 pounds of aniline and 114,000 pounds of acetone from its wastewater. Also, a Monsanto plant in Ohio modernized equipment in two departments and increased purity of a raw material to eliminate releases of almost 300,000 pounds of Title III-listed chemicals and 12,000 pounds of non-Title III chemicals. Included in this reduction were 77,000 pounds of styrene formerly released in the plant's wastewater and 10,000 pounds of styrene formerly emitted to the air as a result of evaporation from the wastewater. Modernization projects such as carried out by these two plants not only reduced releases to the air and water, but also reduced production downtime, improved yields, and increased consistency in product quality.

Process control instrumentation upgrades and equipment improvements were made at a Massachusetts plant in the fall of 1990 which reduced the amount of butanol being sent off site to the regional POTW by close to 100,000 pounds per year. The most significant improvement was the replacement of an in-line density meter with a nuclear density meter which more accurately measured change from

aqueous phase to organic phase in the line draining to the process sewer. This change reduced not only the amount of butanol released to the sewer, but also the amount of butanol used in production.

At a Monsanto plant in Illinois, a new technology was licensed to replace major process steps in the production of a chemical used in mothballs. The old process was a "wet process" while the new process is a "dry process". The result has been the virtual elimination of all water discharges, as well as a substantial reduction of air emissions.

These are four examples within Monsanto of pollution prevention activities, each of which took time to implement, but each of which were consistent with the corporate commitment to reduce environmental releases.

5.0 CLEAN WATER ACT STATUTORY AND EPA REGULATORY CHANGES TO PROMOTE POLLUTION PREVENTION

The U.S. Clean Water Act and its implementing agency, EPA-issued regulations should be modified to encourage pollution prevention and market incentives to further water quality improvements. While it can be said that the EPA effluent limitation guidelines programs promulgated over the last two decades are based on a treatment technology-driven approach, such approaches have also encouraged some reductions of pollutant loads through in-plant source reduction activities. Within Monsanto, we do not look solely at end-of-pipe treatment scenarios to achieve our effluent limitations, we also look back into the processes generating the wastewaters to determine if there are more economical ways to achieve the same reductions. Several of the examples noted above speak to this approach.

Monsanto (and CMA in its May 14, 1991 testimony noted previously) support voluntary pollution prevention programs using a hierarchy of approaches: source reduction, followed by recycle/reuse activities, lastly treatment. CMA's testimony notes further that "pollution prevention efforts should be voluntary to allow creative development of the infinite variations in methods of achieving prevention of pollution. Source reductions should be *encouraged*, not mandated, because EPA lacks sufficient expertise on industrial manufacturing processes to be able to judge whether source reduction is feasible in particular circumstances. Pollution prevention should be crossmedia in order not to shift pollution from one media to another. If Congress wants to encourage *more* voluntary pollution prevention under the CWA, it should consider adopting incentives for additional pollutant reductions. Market incentives also might encourage more voluntary pollution prevention efforts."

CMA, in its May 14, 1991 testimony, also "supports the use of certain types of positive market incentives such as tax credits, accelerated depreciation schedules, streamlined permitting and monitoring requirements and tradeable credits to achieve this goal. CMA can support *positive* market incentives, while effluent fees and taxes are inappropriate because they apply across-the-board unfairly, without consideration of efforts a facility may have already made to reduce discharges. Facilities that may be unable to reduce discharges any further as a result of earlier reductions would be penalized. Further, these taxes and fees would raise the cost of U.S.-based production and harm the international competitiveness of U.S. manufacturing. Reduced competitiveness of U.S. manufacturers increases imports, and results in the loss of manufacturing jobs."

While the above lays out a generic framework and concept that should be embraced in any statutory or regulatory changes, some specific CWA revisions may be needed. The following thoughts embrace several such possible revisions which some industry trade groups and Monsanto believe may help promote pollution prevention activities.

1. Antibacksliding requirements of CWA Section 402(o) and EPA's regulations severely restrict the circumstances under which permit limits may be made less stringent in the future. This may discourage dischargers from employing innovative

technologies or making process changes which might not perform as well as anticipated. EPA should consider revising its antibacksliding regulations to provide needed flexibility in future permit modifications or renewals. To encourage pollution prevention, the statute may also need to be modified to remove unnecessary restrictions on changes to permit limitations (e.g., changes to water quality-based effluent limitations to reflect revised waste load allocations).

2. Antidegradation may be another disincentive to pollution prevention as embraced in EPA's policy. Antidegradation can place severe restrictions on increases in a discharge in order to protect existing uses of water bodies. This in turn could discourage voluntary reductions because they could result in lowering permit limits that later preclude increased production which could have been accomplished within the old, higher permit limits. While some modifications to the CWA may be needed, EPA may wish to clarify its antidegradation policy to provide some flexibility in its application concerning NPDES permit renewals to encourage pollution prevention activities.

3. When CWA Section 301(k) was added by the 1987 amendments, it seemed to represent an opportunity for a company to seek out innovative means to modify its processes to reduce the generation of wastewater pollutants. However, as Monsanto reviewed this provision further, it seemed to act more as a disincentive, than an incentive, to pollution prevention. Seeking out ways to modify or replace processes takes more time than just adding normal end-of-the-pipe treatment. This section has a major flaw in its restriction limiting the time extension to develop innovative technology to March 31, 1991, a date now passed. A second major flaw with the innovative technology section is it is only available if the particular innovative system "has the potential for industry-wide application". Sharing such information will be a disincentive due to the competitive nature of our businesses and does not recognize the site-specific nature of such technologies. If EPA has the desire to encourage innovative solutions to encourage pollution prevention, and if CWA Section 301(k) is to be used, then the Act needs to be revised to address both of these concerns and add implementation flexibility.

The above are only a few examples of possible legislative/regulatory changes possible, but taken in concert with the generic points raised at the beginning of this section could serve as encouragement and incentive to pollution prevention-source reduction activities. Experiences gained to date by Monsanto with the voluntary-early reduction program under the Clean Air Act Amendments of 1990 would indicate that excessive "dotting of the i's and crossing of the t's" in any such voluntary programs will also serve as a disincentive. If the true intent is to achieve water quality improvements, at reasonable costs, and within the confines of a competitive, market-based atmosphere, then the mindset of Congress and EPA needs to be in concert towards making appropriate provisions to encourage these approaches.

Balancing Economics and the Environment The Case for Retaining Section 316(a) of the Clean Water Act

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ABSTRACT

The electric utility industry uses significant quantities of water in the process of producing electricity. In this process, heat, defined as a pollutant by the Clean Water Act, is rejected to the environment, primarily through discharge to a receiving body of water.

Historically, the EPA and states have regulated the discharge of heat according to stringent technology and water quality-based limits established for heated water discharges. These limits did not take into account the unique characteristics of heat as a pollutant. Section 316(a) of the Clean Water Act provides an opportunity for a variance under which a discharger has the option to establish that an alternate thermal effluent limit is appropriate to ensure that a "balanced, indigenous population of shellfish, fish, and wildlife in and on the water body" can be maintained. Approximately 189,000 MW of the U.S. electric production (32%) currently operate with such alternate limits.

Over the past 20 years, many environmental impact studies, conducted pursuant to Section 316(a), have been conducted, and while some studies have demonstrated adverse impacts, the vast majority of the studies have established that technology- or water quality-based thermal limits are more stringent than necessary to protect the indigenous flora and fauna in the receiving body of water.

The Edison Electric Institute commissioned Stone & Webster to conduct an analysis of the cost if Section 316(a) was repealed. Based on the study, the capital cost estimate is a staggering $28.1 billion. Including the cost of replacement power, the cost rises to $41.3 billion in 1992 dollars. Another analysis, commissioned by the Department of Energy and written by John Vail from the Argonne National Laboratory concludes that the capital cost to the electric utility industry would be in the range of $22.7-$24.4 billion in 1992 dollars. While each of these studies has inherent limitations, in terms of accuracy, there can be no mistake that the cost is significant.

In addition to the direct economic costs, retrofitting cooling towers to existing plants has additional costs, including the costs associated with negative environmental impacts. There would be a significant loss in generation capacity that would have to be replaced with new generation which would increase atmospheric emissions of SO_2, NO_x, CO_2, and particulate matter. Other impacts would include increased consumption of water, airborne drift from cooling towers, fogging and icing, and aesthetic impacts.

Under Section 316(a), the appropriate balance between costs and benefits has been achieved. This section of the Clean Water Act should be preserved.

1.0 INTRODUCTION

The United States Congress, led by the Senate Environmental and Public Works Committee, is considering a bill (S. 1081) which would significantly amend the Clean Water Act. Among the bill's many amendments is a provision which would delete Section 316(a). This section of the Act is one of the more insightful provisions in the Act, and has proven over the past 20 years to be protective of the nation's waters while allowing site-specific determinations to be made which have prevented excessive retrofit costs for technology-based solutions to thermal discharges.

As Congress prepares to consider reauthorization of the Clean Water Act, it is important that they be informed with respect to this provision in the Act. Both the Edison Electric Institute (EEI) and the U.S. Department of Energy (DOE) commissioned studies to evaluate the merits of Section 316(a).[1,2] The purpose of this paper is to highlight important points addressed in those studies, draw upon industry experience, and to generally frame this issue for Congressional deliberations during the next legislative session. For more detailed discussions, the reader is referred to the literature references cited in this review.

2.0 WATER USE IN THE ELECTRIC UTILITY INDUSTRY

The steam electric power industry uses significant quantities of water in the system cycle. Non-contact cooling water is utilized to condense steam, exhausted by the steam turbine, back to water for reuse in the boiler. The fundamentals of the steam cycle in the production of electricity are illustrated in Figures 1 and 2. The amount of water used in the non-contact cooling process varies significantly and is affected by many factors, including the size of the power plant, its efficiency in terms of heat production and the efficiency of heat transfer in the condenser. For example, the amount of water used in cooling at selected plants on the Florida Power Corporation system are given in the table below.

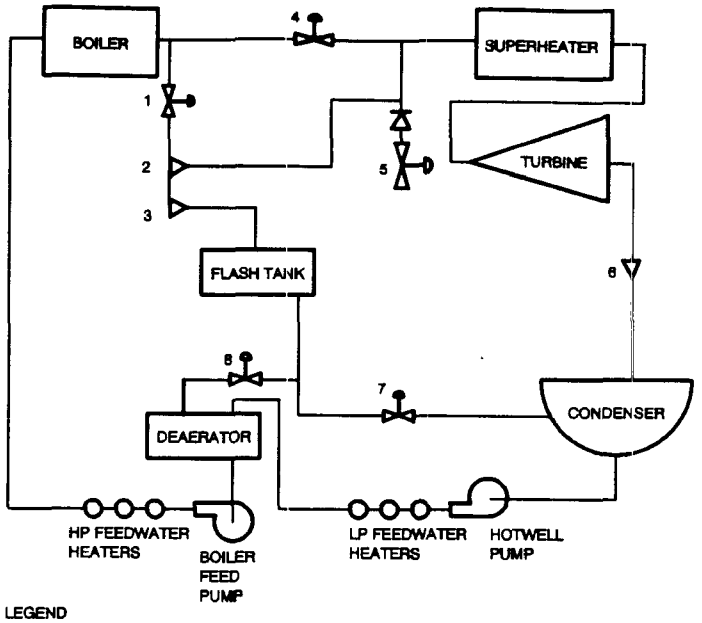
Anclote Unit 1	550 MW	465,000 GPM
Crystal River Unit 2	520 MW	328,000 GPM
Higgins Unit 1	46 MW	55,000 GPM
Bartow Unit 3	235 MW	170,000 GPM
Turner Unit 3	75 MW	50,000 GPM

The plants listed above, as well as many other power plants in operation today, use cooling water in a once-through mode. In this system, water is withdrawn from a source (e.g., lake, river, estuary), passed through the condensers, and returned to the receiving body. In this process, the temperature of the water is elevated through the transfer of heat in the condenser. Some power plants utilize cooling towers to reduce the temperature of the cooling water prior to discharge. These may be "helper cooling towers" or "closed-cycle cooling towers." In the "helper configuration," the cooling water is passed through the cooling towers one time and returned to the receiving water body. The cooling towers operate independently from the cooling water system and are generally built at a location which may be remote from the generating plant. In the "closed-cycle configuration," cooling water is recycled. The only make-up water requirement is that to offset evaporative losses and losses due to dissolved solids control. A fraction of the cooling water must be discharged (blowdown) to the receiving waters in order to prevent the accumulation of large quantities of dissolved solids in the cooling water.

According to the study conducted by Stone and Webster (1992), approximately 189,000 MW of 32% of the U.S. generating capacity operate in a once-through cooling mode and under a thermal discharge variance granted pursuant to Section 316(a) of the Clean Water Act. If this provision were not part of the Act, utilities would have to develop alternate strategies to meet stringent numerical criteria. Although options such a cooling ponds or reduction in energy production are possible, in most cases this would require the retrofit of some type of cooling tower. There are significant capital, operation and maintenance, and environmental costs associated with cooling towers. These will be discussed later, but first a brief overview of the regulatory provisions is in order.

3.0 REGULATORY HISTORY

Prior to the passage of the Federal Water Pollution Control Act in 1972, laboratory studies had demonstrated that extremely high temperatures could be harmful to fish and other aquatic life. Activities which could lead to elevated water temperatures were implicated in some circumstances. Initial

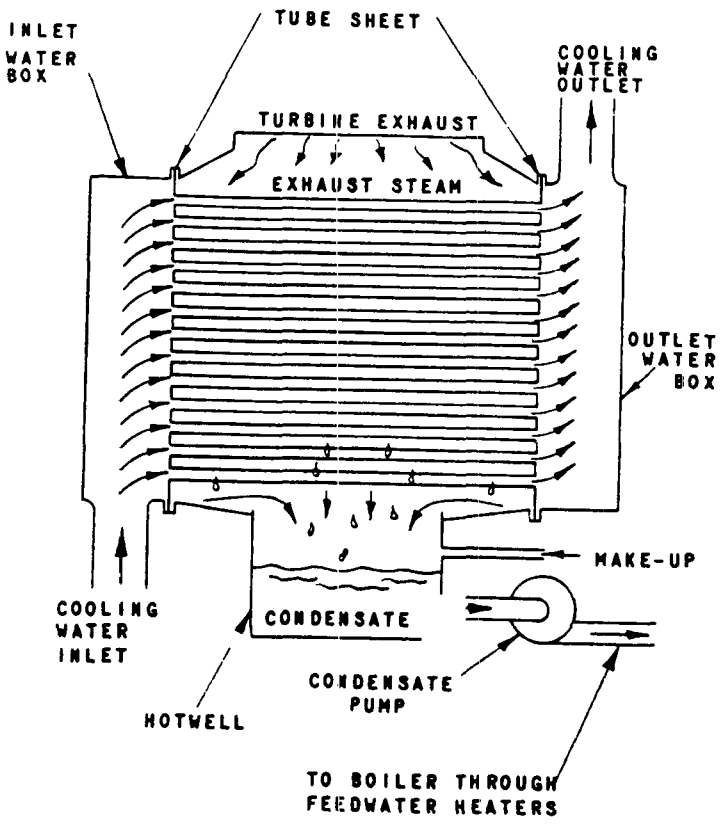


LEGEND

1. SUPERHEATER BY-PASS STOP VALVE
2. PRESSURE REDUCING VALVE
3. SUPERHEATER BY-PASS VALVE
4. H.P. SUPERHEATER STOP VALVE
5. H.P. SUPERHEATER STOP VALVE
6 TURBINE BY-PASS VALVE
7 FLASH TANK LEVEL CONTROL VALVE
8. DEARATOR WATER VALVE

FIGURE 1 OVERVIEW OF STEAM CYCLE

Condenser Principles



BASIC SURFACE CONDENSER (SIDE VIEW)

Figure 2

attention to power plants was limited to facilities located on small rivers where the discharge was into a shallow riffle or rapids area. In response, many states established stringent thermal limits as water quality standards. These were in the form of upper temperature limits (e.g., 90°F) or in the form of temperature differential from intake to discharge (e.g., 5°F temperature rise). These limits were very restrictive and did not take into account the many site-specific variables which may influence whether thermal discharges have an adverse environmental impact.

In 1972, the Federal Water Pollution Control Act established the framework for the promulgation of national effluent limitations for specific categories of dischargers and new source performance standards (NSPS). This approach effectively required that all new units and many existing units install expensive technology-based controls (cooling towers). The imposition of an industry requirement to install alternatives to once-through cooling was struck down in Appalachian Power Co. v. Train, 545 F. 2d 1351 (4th Cir. 1976). Subsequently, as regulation continued, an alternative was developed. Section 316(a) allows dischargers to establish, on a site-specific basis, that an alternate effluent limit is appropriate. More specifically, Section 316(a) subjects the discharger to a standard which requires proof that the discharge will ensure "protection and propagation of a balanced indigenous population of fish, shellfish, and wildlife in and on the water body." This requirement ensures that even if alternate limits are granted, degradation of the aquatic communities will not occur.

4.0 THE SCIENCE BEHIND SECTION 316(a)

Heated water discharges from power plant cooling water systems meet the regulatory definition of a pollutant. Heat is unique when compared with other more traditional pollutants such as suspended solids and organic or inorganic chemicals. Heat is not persistent in the environment. It mixes with the receiving body of water and within a specific distance from the source, the temperature of the receiving body of water is indistinguishable between upstream and downstream locations.

Many of the early laboratory studies established that elevated temperatures could produce harmful effects on fish and other aquatic life. However, it is critical to recognize that in order to produce harmful effects, there must be an exposure which is harmful to the species in question. There are many factors which influence the exposure in the natural environment which are difficult to simulate in the laboratory.

For example, the amount of cooling water used in the process can influence significantly the amount of heat in the receiving body. Smaller amounts of cooling water translate to higher discharge temperatures while large volumes of water will result in lower discharge temperatures. In addition, the size and configuration of the receiving body will strongly influence the degree of thermal effects in the environment. Clearly, a high-volume discharge into a small, shallow stream or river will have a more significant impact than the same discharge into a large, deep river or reservoir. Another factor is the temperature of the receiving body. The greater the degree of difference between ambient and the discharge water, the faster the discharge water will be cooled. In some cases, thermal plumes may "float" due to density differences brought about by temperature differentials. The manner in which the cooling water is reintroduced to the receiving body is also important. Configurations may include simple outfall pipes at the shoreline, discharge pipes placed a distance from the shoreline in order to get into deeper water, and discharge pipes with diffuser ports which enhance the mixing of thermal discharges and the receiving water. All of these factors are important to consider when evaluating potential thermal impacts to the aquatic life since it is the degree and duration of exposure which determine whether adverse environmental impacts will occur. Many of these factors are, of course, site specific in nature.

Similarly, there are many biological factors which must be considered in determining the potential for environmental impact. For example, fish and other mobile organisms have the ability to avoid undesirable temperatures. In other cases, the location of the discharge may prevent exposure of certain organisms to elevated temperatures. A discharge located near the surface in a deepwater habitat would preclude the exposure of benthic organisms to the effects of a thermal plume. The life stage of the

organism, when exposed to elevated temperatures may also play a role. Immature life stages of many organisms tend to be more sensitive to environmental stresses than the adult forms.

Over the past 20 years, many 316(a) studies have been conducted. In addition to providing us with important life history and species distribution data about many species, the studies have provided some important insights with respect to thermal environmental impact.

Results have shown that biological field data are often naturally variable, a factor which makes measurement of impacts difficult to discern with a high degree of certainty. In addition, the role of site-specific factors has proven to be the most important variable to influence the occurrence and degree of impacts. It is precisely the knowledge learned from these studies which has led to better and better site selection and plant design.

There have been relatively few adverse impacts at power generating sites where 316(a) studies have been conducted.[3] The consistency of these positive results highlight the importance of the 316(a) provision.

5.0 CONSIDERATIONS IN RETROFITTING COOLING TOWERS

In selecting the site for a cooling tower, it may be necessary to remove and/or relocate existing cables, pipes, or other structures. Also, the tower location may be influenced by potential interference with existing facilities such as air intakes or substation equipment.

In addition to the modifications which would be made to the temperature limitations in the existing discharge permit, there are additional permitting considerations which must be considered in planning and scheduling. In virtually every case, new construction permits would be required for air quality and water quality considerations. There are new environmental impacts to consider when cooling towers are installed. Consideration of these impacts by the regulatory agencies as part of the permitting process could delay cooling tower installation and operation, each of which would have economic penalties.

There will likely be extensive modifications, perhaps even total redesigns of piping and intake and discharge structures. Equipment and facilities no longer utilized would have to be removed, demolished in place, or otherwise rendered safe.

Because of the higher pressures inherent in the operation of closed-cycle systems, upgrades and/or modifications would be required for cooling water piping, pumps, condenser waterboxes, and condenser tubes. Also, new electrical service, water treatment systems, and new controls would be required for the proper operation of closed-cycle systems.

In closed-cycle systems, the temperature of the cooling water is higher than in once-through systems and the flow is lower. These factors operate to decrease the efficiency of the cooling system and create additional back pressure on the turbine-generator, thereby penalizing the unit's output. Other energy penalties include auxiliary power for operating fans in mechanical draft cooling towers, water treatment system mixers, and additional heating, cooling, and lighting. Energy penalties are often expressed in terms of a net heat rate increase (i.e., the increase in heat input required to offset the loss in electrical output to the system). In general, a heat rate increase from 1% to 3% is expected when converting from once-through cooling to closed-cycle cooling. This means a net generating capacity decrease on the order of 5 MW to 20 MW for typical plants.

6.0 ENVIRONMENTAL IMPACTS OF COOLING TOWERS

As discussed above, the construction of closed-cycle cooling results in a net decrease in station generation. On a system-wide basis, this reduction can be significant and require the addition of generation either by higher capacity factors on existing units or construction of new generation. In either

case, there will be increased environmental impacts due to mining additional fuel, transportation of the additional fuel, and an increase in total air emissions from burning the additional fuel. The magnitude of these impacts depends on whether the lost generation is made up by minor adjustments to capacity factors, in which case the impacts will be relatively minor, or whether new construction and generation is required.

Cooling towers achieve reductions in water temperature by evaporation. In some regions of the country (e.g., western U.S. and Florida), there are critical shortages of water. Operation of closed-cycle cooling towers would exacerbate the existing problem. An accompanying issue with operation of closed-cycle cooling is the quality of the blowdown water. Depending on the quality of the make-up water, and the cycles of concentration at which the cooling system operates, the concentration of chemicals in the blowdown stream can reach concentrations which exceed ambient water quality criteria and in some cases can be at toxic concentrations. This requires either additional capital for treatment systems, the acquisition of a site-specific mixing zone, or other administrative relief mechanisms. The current trend in environmental regulation is to discourage or prohibit mixing zones for chemical discharges. Cooling towers also present a problem in terms of fouling both with biological growth and sediment accumulation in the cooling tower fill. Biocides may have to be added as well as other chemicals to retard fouling and/or corrosion. Discharge of these chemicals also presents environmental concerns.

As cooling towers evaporate large quantities of water, the emissions include water vapor and aerosol-size particulate matter. Depending on the source of the make-up water, the cycles of concentration, and the efficiency of the drift eliminators, the drift can present environmental concerns where deposition occurs on equipment or sensitive vegetative communities. In some regions of the country, there is the additional concern with the formation of fog and/or ice.

Cooling towers accumulate solids in the basin of the towers which must be periodically removed. Locating a suitable disposal site can present a problem in some regions where landfills have very restrictive rules on what materials are acceptable for landfill disposal. In most cases, the waste will have to be tested to establish that it is not hazardous prior to disposal.

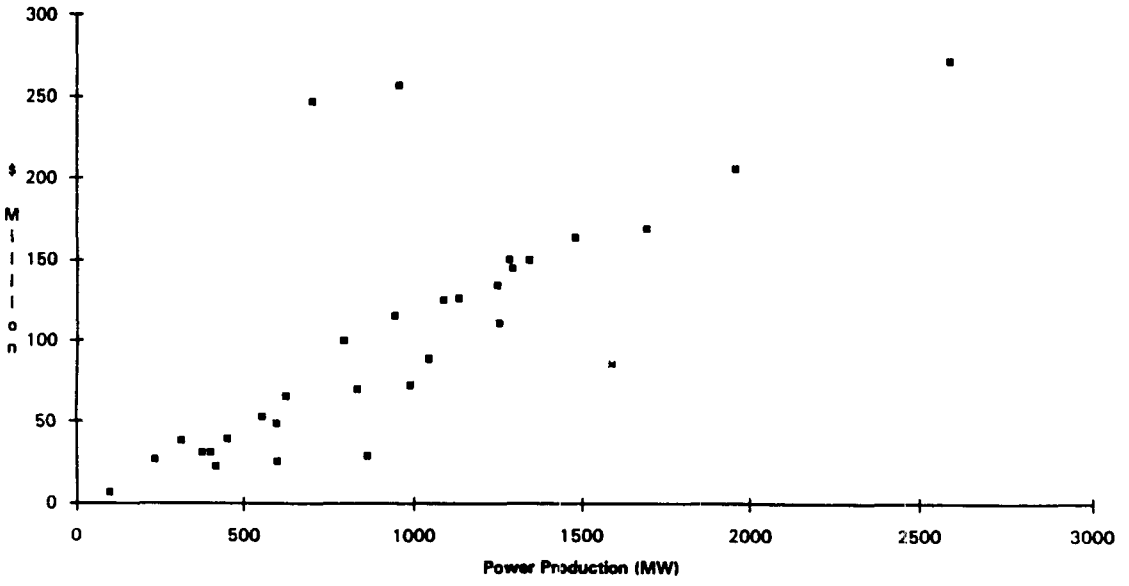
A less significant environmental concern, but perhaps more contentious from a public relations standpoint, are the aesthetic and noise impacts. In many areas, the construction of large hyperbolic cooling towers will create an unacceptable visual impact as far as the public sector is concerned. Installation of mechanical draft cooling towers requires the operation of large fans and motors which, depending on the site location and configuration, can lead to violations of a local noise ordinance or nuisance complaints.

7.0 COSTS

In developing a basis for cost analysis, Stone & Webster approached the problem by projecting costs for two hypothetical generating stations. Inherent in that analysis are many assumptions which may lead to higher or lower costs at a specific site. However, the analysis provides a useful comparison and certainly gives a good estimate of the costs one could face in a retrofit situation. Stone & Webster projects the capital costs to retrofit closed-cycle cooling on an 1100 MW nuclear plant to be approximately $251 million or $230/kW. The estimated capital costs to retrofit closed-cycle cooling on a 300-MW fossil fueled facility would be $39 million or $130/kW. A 15% allowance for contingency is included in each of these estimates.

In a separate analysis, the Department of Energy developed cost projections by interviewing individuals from power companies throughout the U.S. who had experience in retrofitting cooling towers, not all of which were closed-cycle. It is important to note that the estimates are not specific engineering cost estimates and the level of detail in providing cost estimates was not consistent throughout the survey. On average, the capital cost to retrofit cooling towers on a fossil-fueled power station was $108/kW and $171/kW on a nuclear station. The range of costs are illustrated in Figures 3 and 4 (U.S. Department of Energy, 1992).

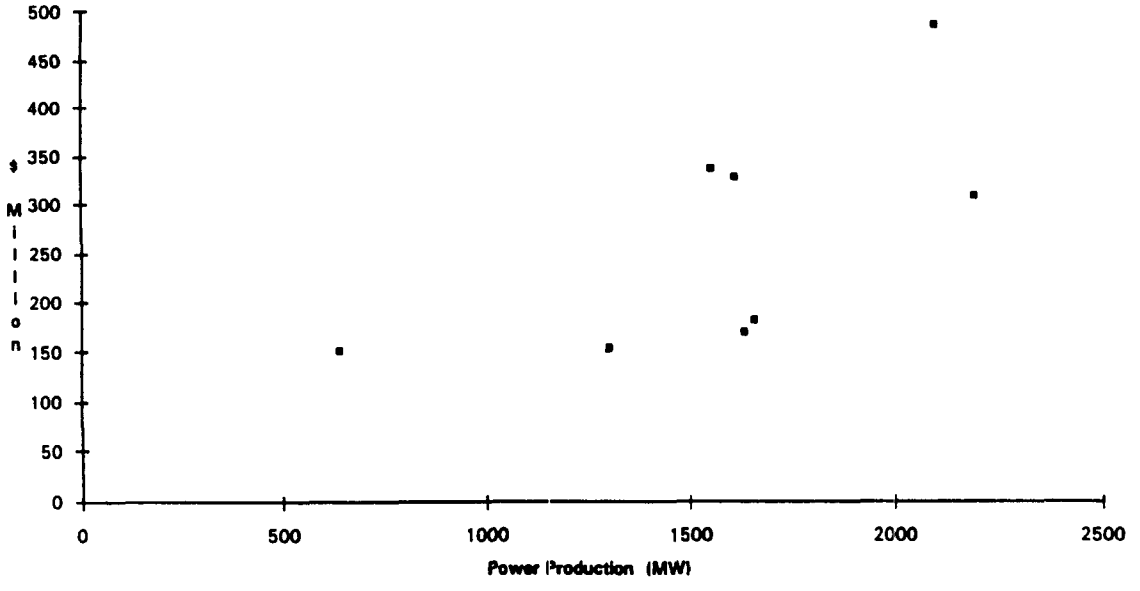
Figure 3 - Capital Cost to Retrofit Cooling Towers - Fossil



Source: U.S. Department of Energy 1992

Deletion of §316(a) - Capital Costs

Figure 4 - Capital Cost to Retrofit Cooling Towers - Nuclear



Source: U.S. Department of Energy 1992

Once the cooling towers are operational, there will be significant additional operation and maintenance costs. Cooling tower piping, spray nozzles, drift eliminators, fill, pumps, fans, and general structural components must be inspected and replaced on a regular basis. For those facilities located on salt water or estuarine systems, the frequency of equipment replacement may be more frequent. Control of biological and sediment fouling in the cooling tower fill and corrosion prevention will be required. This requires additional chemical storage and handling facilities as well as potential adverse environmental impacts from the addition of chemicals. Projected annual additional O&M costs range from $270,000 for the fossil plant to $1.7 million for the nuclear plant.

In addition to the capital and O&M costs, there are energy penalties associated with the operation of cooling towers. In the Stone & Webster analysis, replacement of lost power on a system up to 300 MW would be made up by constructing new combustion turbines at an estimated capital cost of $430/kW. For losses over 300 MW per system, the cost is projected based on construction of new pulverized coal generation at an estimated $1,510/kW.

8.0 CONCLUSIONS

The environmental impact of heated water discharges is very site specific and nearly 20 years of field studies and experience has shown that the real impacts are generally not significant.

Section 316(a) of the Clean Water Act is not a variance which allows unacceptable environmental impacts, nor is it a process which can be completed without a thorough analysis.

There are a significant number of generating facilities in the U.S. (32%) which have established that alternate effluent limits are protective of the nation's waters.

The cost to force fit a technology to reduce heated water discharge temperatures is significant ($30-50 billion including capital, O&M, and replacement energy costs, 1992 dollars).

There are additional negative environmental impacts associated with the construction and operation of cooling towers.

On balance, when considering the extremely high capital costs of retrofitting closed-cycle cooling and the probability that net environmental impacts will increase, there is no basis to support the deletion of Section 316(a) of the Clean Water Act. On the contrary, legislators, regulators, the environmental community, and the industrial community should acknowledge that at least on this one issue, we have achieved what should be our collective objective, namely a proper balance between the environment and the economy.

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Environmental Opportunities Missed: Can The Clean Water Act Make a Difference in the Future?

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ABSTRACT

This paper will examine the impacts of single-media environmental programs on research, development and commercialization of innovative technology with cross-media, pollution prevention benefits. It will also consider how regional initiatives which focus only on selected sources can fail to achieve their environmental goals. Finally, the paper will review the water-related findings of a multi-media study done between Amoco and U.S.EPA, particularly as they suggest potential opportunities and benefits for future multi-media permitting and technology innovation under a thoughtfully amended Clean Water Act.

1.0 INTRODUCTION

Since the mid-1960's when the first Water Quality Act was passed (and coincident with the passage of the first Clean Air Act (1963) and the Solid Waste Disposal Act (1965)), the United States has pursued environmental quality using an arsenal of statutory authorities constructed along media-specific lines. Subsequently, as regulatory programs evolved and became more complex, statutory authority was enlarged and became more prescriptive. A curious, negative feedback loop was created as many regulators endeavored to incorporate science into the programs they had been directed to implement, industry resisted imposition of standards onto its facilities' operations, and congress growing increasingly impatient over what it perceived as lack of progress in environmental quality, provided less and less discretion to regulators charged with getting the job done.

The fact is that substantial progress has been made in the nearly thirty years since those initial laws were passed. Measurable improvements have been made in many of the areas which needed attention—the air is cleaner, more water is "fishable, swimmable, and drinkable" and a tremendous amount of potentially hazardous material has been reduced with much of the rest rigorously managed.

But over time, our national environmental objectives have changed. The debate has been shifted by advancements which we could not foresee and in addition, by the successes that the "command-and-control" approach produced.

In the past, our efforts were based upon gross assumptions, available technical data, existing technology and short-term political priorities. The cost to the American public since 1970 of addressing environmental concerns in this way has been about $1.4 trillion dollars (in 1990 dollars) in taxes and higher prices for products and services.

As a nation, we are at a point in our environmental evolution where we are focusing our attention in areas where substantial progress has already been made. Our ability to measure incredibly small quantities of chemicals seems to be driving a desire to regulate those chemicals to the same infinitesimally low levels. Throughout the 1980's, we measured and reported emissions at the parts per million level. That is equivalent to being able to pick out one minute over a two year period. Today, we routinely measure and report emissions at the parts per billion level. That's equivalent to being able to pick out one second in thirty two years! Over the most recent few years, we have seriously been discussing at the policy level,

controlling emissions of some chemicals at the parts per quadrillion level. A colleague has calculated that it is the equivalent of picking out a single hamburger from a pile of hamburgers prepared at a rate of 35 billion per decade stacking up for a million years!

Meanwhile, the conservative approaches we have applied to the identification of chemical hazards still depend upon extreme assumptions like one molecule of an agent will cause cancer in humans if it causes cancer in rats. (And that may be based upon force feeding huge quantities of the substance until the rat dies).

Such factors: advances in analytical technology, conservative assumptions about risk and generally poor risk communication with the public by industry, media and government contribute to EPA projections of costs associated with environmental protection escalating some 30-40% by the year 2000 from our current annual spending levels of $130 billion!

2.0 BARRIERS TO COMMERCIALIZATION OF INNOVATIVE TECHNOLOGIES

An example of the high price we pay as a nation for the pursuit of environmental objectives using single media programs can be found in an Amoco example concerning wastewater treatment technology.

Amoco Chemical Company is the world's largest manufacturer of terephthalic acid (TA) and purified terephthalic acid (PTA). One of the significant challenges related to that process is the treatment of wastewater containing complex organic chemicals to levels suitable for discharge. Motivated by a desire to maximize the effectiveness of the wastewater treatment process, Amoco pioneered an anaerobic wastewater treatment technology. It was recognized as such a significant contribution to technology that it received the biennial Kirkpatrick Award in 1991. This award is presented by Chemical Engineering to the company that commercializes the most notable chemical engineering technology within the previous two years.

Some of the unique features associated with this technology are related to its anaerobic nature. The closed reactor, no-oxygen environment in which specially developed bacterial microorganisms metabolize complex organic acids to simple, non-toxic compounds generates much less biosludge compared to its aerobic technology counterpart (up to 85% less).

Better control of VOCs is possible due to the enclosed features of the system but safety is protected because it does not contain oxygen.

Significant energy conservation benefits are realized compared to equivalent aerobic systems due to reduced electricity demands. There are no mixers required in this process. In addition, methane offgas byproduct can be used as a boiler fuel at other units in the facility.

Resource conservation interests are served through lowered chemical demand due to partial stream recycling which is integral to process performance. It is more compact than the aerobic systems needing only one-third the physical space required for equivalent treatment capacity.

That's the good news. The bad news for the United States is that when it came time to scale this technology up from the pilot plant to the world scale, Amoco selected the world's largest (2 billion pounds per year) TA facility which it operates through a joint venture between itself and China American Petrochemical Company (CAPCO) in Taiwan.

The kinds of factors that drove this siting decision include: the fact that 85% reduction of organics will not meet U.S. Organic Chemicals, Plastics and Synthetic Fibers (OCPSF) standards as currently written; equivalent capital is required to build the anaerobic system as compared to the aerobic which discourages its consideration for U.S. facilities with existing systems even for replacement, since an aerobic

system would still need to be added on; only new U.S. facilities (which would be unlikely siting candidates) willing to build two systems could be considered. Other possible applications might be at new or existing foreign facilities lacking treatment capacity (like pre-installation CAPCO) and those imposing performance-based environmental standards or at any location where the economic benefits of lowered sludge handling and energy savings offset capital costs.

3.0 NARROWLY-FOCUSED REGIONAL INITIATIVES CAN IMPOSE HIGH-COST, LOW ENVIRONMENTAL BENEFITS

Amoco believes that regional initiatives can fall short of the expectations of their designers when they focus on one medium or source category. For example, the Great Lakes Initiative (GLI) is aimed at enforcing the Great Lakes Water Quality agreement signed in 1972 by both Canada and the United States (which was later amended in 1978) as well as the 1986 agreement among the eight Great Lakes state Governors. The 1990 Great Lakes Critical Programs Act requires EPA to set water quality criteria that will effectively set a zero discharge goal for the Lakes by certain deadlines. However, the technical complexity of such a document, (which will be required for adoption by all eight Great Lakes states—Michigan, Illinois, Indiana, Ohio, Pennsylvania, New York, Wisconsin and Minnesota) has confounded attempts to comply with deadlines.

The framework for the guidance echoes the recommendations of the International Joint Commission released in April, 1992. The bi-laterally appointed panel recommended that persistent bioaccumulative chemicals of concern be regulated using very stringent standards. Non-bioaccumulative pollutants will be somewhat less stringently regulated. Characteristics such as biodegradability and whether or not the chemical can be metabolized, are not considered.

Existing dischargers will not be allowed mixing zones after the year 2004 and will be prohibited for all new dischargers for purposes of meeting the most stringent wildlife (few of which exist), human health or aquatic life criteria.

Since many of the proposed criteria are below analytical detection limits, discharges will be challenged to document compliance with the criteria

It is expected that compliance will require the construction of additional wastewater treatment capacity to meet these end-of-pipe standards or move to a zero discharge system which would cost three times as much as add-on capacity. The latter may be required however, since existing technology of activated carbon and metals precipitation may not be able to achieve proposed criteria levels.

An additional cost of the zero discharge option is the likely loss of a facility's NPDES RCRA exemption. To the extent that a facility utilized such an exemption, the implications for Part B permitting and Subtitle C technical standards are significant. The predictable increase in tons of solid waste sludges subsequently sent to secure landfills is substantial.

The bad news part of this story is, that even based upon Toxic Release Inventory (TRI) data and studies of PCBs, mercury and lead, only a very small percentage of current loadings to the Great Lakes are from point sources. Most, if not all of these are impacted by the proposed criteria. However, the reports and studies reveal that most of the loadings of toxic chemicals come from non-point sources and from air. Many of the chemicals targeted by fish consumption advisories, such as PCBs and DDT, have already been banned in the U.S. Furthermore, the criteria that are being proposed will only apply to the U.S. facilities.

Surveys not yet published of the economic impacts of these criteria on affected point sources, (estimated to be less than 10% of the loadings), suggest that the low end costs of applying these standards will be $100 million each in capital costs for oil and petrochemical plants along with annual operations and maintenance costs of some $26 million.

This focus on more stringent control of already regulated point source discharges, while postponing or ignoring non-point and uncontrolled sources, and with a resultant minimal beneficial impact on Great Lakes water quality is very difficult to defend, in Amoco's opinion.

4.0 YORKTOWN LESSONS AND THE CLEAN WATER ACT

Some of you may have heard of a recently completed, voluntary, joint study between U.S. EPA and Amoco of its Yorktown Virginia oil refinery. That 2+ year, multi-million dollar effort had four primary objectives: to inventory releases from the refinery; to identify sources and reduction alternatives; to rank those alternatives according to certain criteria and to identify barriers or incentives to their implementation.

Over 10,000 analyses were conducted on samples taken from air, water, groundwater and solid waste. That sampling and analysis program revealed important facts about this particular site. Regarding water, those findings included:

1. That existing wastewater treatment technology does an excellent job on the water streams generated at this plant. The facility's effluent is discharging at about 10% of levels allowable by permit, under normal operating conditions. Most organics (except MTBE) in the discharge were below detection limits.

2. Of four major studies looking for impacts on the adjacent York River, none showed significant impacts. This project looked at new biomarkers as indicators of change. No impact of refinery discharge on the two species of fish were found. (However, the study did reveal the presence of contaminated sediment in a stormwater settling basin within the facility boundary which did effect individual fish). Thus, real improvements in water-related effects could be achieved by addressing these on-site sediments and not the plant's water discharge. Major stresses on river ecology are more likely to result from oxygen depletion as a result of natural thermal inversions and tidal action in the river.

3. Site-specific features of this facility reduced possible groundwater contamination. The existing underground process sewers are leaking—but inwards rather than out of—the system, collecting some 35,000 gallons per day of groundwater and carrying it to the facility's wastewater treatment plant. The effect is the prevention of off-site migration and contamination of groundwater.

The effort at Yorktown convinced Amoco of the value of site-specific data in identifying and prioritizing potential environmental investments at facilities. Such data would help to avoid overinvestment in command-and-control standards being applied to sources, which on a site-specific basis, do not present real relative risks.

We believe that the project also served to dispel some myths regarding industrial facilities, such as: all sites are the same and should be regulated in the same way; that large amounts of facility-specific data already exists and that environmental controls are always or equally economic.

5.0 IMPLICATION FOR AMENDMENTS TO THE CLEAN WATER ACT

Amoco believes that the three examples described here, taken from our own experiences, illustrate some of the cumulative negative effects of media-specific regulations. These effects can range from those on innovative technology development and commercialization, to potential inadequacy of narrowly-focused regional initiatives on long-term environmental quality and to the potential for overinvestment in mandated controls when they are tied to generic, industry-wide standards which do not allow consideration of site-specific conditions.

We believe that statutory language could be developed which would provide for innovative policy and implementation not unlike the innovation we seek in the area of technology. Waiver-like mechanisms to prescriptive provisions could be provided when certain site-specific demonstrations could be made. Those demonstrations should be crafted in such a way as to encourage the collection and maintenance of site-specific environmental data. This data would serve to document environmental performance across at least one, and preferably all media, so as to demonstrate continuous progress toward facility-specific goals.

Under such multi-media environmental demonstrations, maximum flexibility is afforded to the facility's management in meeting performance-based standards. Such flexibility encourages comprehensive assessment, source identification and potentially, innovative process modification or technology development aimed at achieving highest environmental benefit at lowest economic cost.

The potential to identify and implement pollution prevention routes to achieving such improvements is greatly increased. Furthermore, we believe site-wide data collections and assessments could support a systems-based self-auditing approach to environmental compliance. In theory, such a program could make enforcement much easier to administer and much more objective.

Amoco believes that such features would make a considerable difference in the economic viability of individual U.S. facilities and whole industrial sectors relative to our global competition.

We believe that this directly translates to retaining industry, jobs and tax bases in the United States while maximizing further environmental progress opportunities on currently controlled sources. The nation's environmental savings could be allocated to numerous alternative environmental investments like currently uncontrolled sources, resource conservation or habitat restoration. In fact, we might even consider investments in other societal priorities like research and development of innovative technologies, health care, education, rebuilding our national infrastructure or similar worthy expenditures.

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Voluntary Pollution Prevention Initiatives Will Shape U.S. Industry's Regulatory Relationships and Economic Future

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ABSTRACT

The environment of the United States remains among the best in the world. Environmental regulation of industry is pervasive and comprehensive, but has been widely accepted as essential to protecting and maintaining our quality of life. There is a perspective that, at best, underestimates the costs of environmental requirements on our industries, and at worst, concludes that no price is too great to pay. As in Eastern Europe and elsewhere, events throughout the world have demonstrated that without a strong and prosperous economy, the environment as well as living standards suffer.

Future water resource legislative actions and regulatory policies need to carefully consider:

- The significant environmental expenditures and accomplishments of water-intensive industries over the last 20 years;
- Customer and market forces can shape industries' actions and orientations as much or more than do environmental regulations;
- Major industry has demonstrated a commitment to sound environmental management by instituting voluntary pollution prevention initiatives; and
- Any additional regulation of water resources should recognize and incorporate the legitimate and historical use of surface water as an economic resource.

For its part, U.S. industry needs to continue to demonstrate the effectiveness and soundness of voluntary pollution prevention initiatives by its willingness to adopt increasingly sophisticated and comprehensive measures as alternatives to regulatory command and control.

1.0 INTRODUCTION

The condition of the environment of the United States is good and becoming progressively better. Twenty years of strict environmental controls have improved our waterways and air measurably. While cleanup of abandoned hazardous waste (CERCLA) sites has been slow, many non-CERCLA sites have been cleaned up by private parties. As important, the proper management of wastes generated today ensures that there will be fewer new CERCLA sites to clean up in the 21st century.

However, progress in restoring and preserving the environment will not likely come from additional pages of regulations or a command-and-control approach. With annual environmental expenditures accounting for at least 2.1% of our GNP, more cost-effective means must be employed to reach desired environmental goals and the timetables for some of those goals need to be revaluated. As voluntary pollution prevention initiatives take hold among U.S. industry, a new balance may well be struck between the necessary protection of the environment and human health and the need to maintain a strong and prosperous economy.

Selected factors that affect industries' response to environmental regulations and voluntary initiatives are examined. The pulp and paper industry is profiled as an example of a major industry, critical to our national economy, that has demonstrated leadership in pollution prevention initiatives.

2.0 FACTORS AFFECTING INDUSTRY INITIATIVES

2.1 Public Perception/Media

The public perception of an issue often will define that issue for policy purposes. For the U.S. public in the 1990s, environmental and human health protection receives top priority. A Wall Street Journal-NBC poll asked for a response to the statement, "protecting the environment is so important that requirements and standards cannot be too high, and continuing environmental improvements must be made regardless of cost." In 1991 90% of the respondents agreed compared to 45% in 1981. Even though pollster questions such as this one can be framed to produce a desired outcome, one does not need formal polls to show that virtually all of your friends, neighbors, and relatives also agree with this statement at face value. Public influence, even pressure, is a real and formidable marketplace force. Just recently a survey was made of the 100 largest manufacturers in Minnesota for their senior executives' opinions on environmental issues. Sixty-five percent of the executives cited the possibility of damage to their company's public image as a *major factor* contributing to their approach to compliance, with the possibility of fines having only a minor or no effect on their approach.[1]

2.2 Regulations

Regulatory-driven compliance programs have been the norm since Congress put teeth, and funding, into the first major environmental acts of the early 1970s, the Clean Air and Clean Water Acts. Federal environmental regulatory growth has been steady since the benchmark year of 1972. Over 18,000 pages of regulations appeared under Title 40 CFR in 1991. As recently as 1986, the number was half of the 1991 figure. The U.S. Environmental Protection Agency now has a staff of 18,000 and an operating budget of $4.5 billion. That accounts for about a seventh of the staff and a third of the spending of the entire federal regulatory system. In 1990, the Agency estimated that complying with its regulations was costing Americans $115 billion per year, or 2.1% of the GNP. In the 1990s, EPA projects that compliance costs will total another $1.6 trillion, *not* including the Clean Air Act.[2] The impact on the U.S. economy is clearly not incidental and a regulation approach can only achieve a finite level of success. Regulations set mixed goals, drain Agency and industries' resources and do not encourage creative risk taking by any of the parties involved. In the Minnesota executive survey, fully 75% of the respondents viewed the regulatory agencies as "enforcers" as opposed to a "resource."[1]

Fortunately, the signs of change are prevalent and led by EPA Administrator Bill Reilly. Encouraging actions are also forthcoming from the Administrator's senior staff. Region I Administrator Julie Belaga, a veteran of tough floor fights during her 10 years as a Connecticut legislator, has been winning points with New England business for her emphasis on voluntary compliance.[3]

2.3 The Industry Itself

If pollution prevention initiatives are to truly be successful, workers and executives need to "buy in." Pollution prevention starts between the ears and most of the highly successful programs, like the one initiated by Northrop, the manufacturer of the B-2 bomber, need to have the solid commitment of the highest levels of management. If U.S. companies do not want increasingly burdensome regulations, then U.S. CEOs must take the initiative and supply the vision matched with specific, but attainable goals. At Northrop, a cultural shift has occurred away from traditional compliance methods and the "trench" mentality of the pollution "war." The company is well on its way to its 1995 zero discharge goals set by its CEO. U.S. companies need to examine the leadership role adopted by Northrop and others and adapt an approach suitable to their company.[4]

3.0 INDUSTRY LEADERSHIP - THE PULP AND PAPER EXAMPLE

3.1 A Perspective of the Industry

The pulp and paper industry is truly one of America's current success stories and bright spots on the economic horizon. The United States has 12% of the world's paper and paperboard mills, 16% of the world's pulp mills, and is responsible for 30% of worldwide paper and paperboard production. As the world's number one producer, U.S. mill output is greater than that of the next four countries combined: Japan, Canada, Germany, and China. All told, U.S. mill production amounts to 5% of the total value of U.S. manufacturing output, placing pulp and paper among our nation's top ten manufacturing industries.[5] At a time when everyone is becoming acutely aware that global competitiveness is key to economic fitness, only two U.S. industries rate an "A" in competitiveness when compared to Japan and Europe, pharmaceuticals and forest products.[6]

3.2 An Environmental Profile

The pulp and paper industry has deep roots in the American manufacturing landscape and is one of the oldest heavy manufacturing industries still viable in our country. Growing awareness of environmental concerns by the public in the 1960s led the industry to increase its research funding in the area of pollution control technologies. The industry even established its own research arm devoted specifically to pollution technology research and evaluations, the National Council of the Paper Industry for Air and Stream Improvement (NCASI). The industry now invests over $1 billion per year in environmental controls and has extensive experience in voluntary chemical and wastewater reuse programs. Today, the industry regenerates about 98% of the chemicals used to produce pulp from wood chips and it uses 60% less water per ton of product produced than it did 23 years ago. Biological oxygen demand has been reduced by 70% even though paper production increased 50%. Since 1985, the pulp and paper industry has voluntarily spent over $1 billion on process modifications to reduce already trace levels of dioxin in its wastewaters by over 75%.[7]

The pulp and paper industry's ongoing environmental commitment is reflected in its strong participation in the U.S. Environmental Protection Agency's "33/50" voluntary pollution prevention initiative. The industry's level of participation in the 33/50 program is nearly double the average of other industries. Its commitment is also reflected through a set of mandatory environmental and forestry principles specified by its national trade association.[7]

Probably the greatest success story that the pulp and paper industry has to tell involves recycling. The industry has set for itself a voluntary goal of recycling for domestic use and export 40% of all by paper used in the United States by 1995. That amounts to nearly 40 million tons, 50% more than was recycled as recently as 1988. Today, U.S. papermakers utilize 24 million tons of recovered paper and paperboard accounting for 28% of the industry's fiber needs. Three out of every four U. S. mills recycle some recovered paper and 200 depend on it entirely. To reach its 40% goal, the industry has committed to spend billions of dollars on new manufacturing facilities and equipment. As of early 1992, 90 such projects were either under construction or publicly announced.[7]

3.3 Where Does the Industry Go From Here?

The simple answer is that there is always more to be done and that voluntary initiatives have the demonstrated ability to achieve the desired results. The pulp and paper, as well as all other U.S. industries, must continue to demonstrate the effectiveness and soundness of voluntary pollution prevention initiatives. To produce the achievements necessary to hold additional command-and-control measures at bay will require a focused commitment to public concerns, the concepts of environmental stewardship, and to

developing a fully integrated approach to mill production and environmental controls. Some areas for increased attention in the future include:

- Expand participation in the 33/50 program and evaluate commitment to voluntary state initiatives and agreements.
- Integrate Total Quality Management (TQM) efforts into mill pollution prevention initiatives. In some companies TQM efforts are being fully integrated with (previously separate) departments for environmental control, safety, and health.
- Perform formal Life Cycle Analyses (LCA) at a product's design stage to develop "environmentally compatible" products, thus preventing environmental damage and saving future environmental control costs.
- Promote university education in pollution prevention methods in process engineering programs as well as in the traditional pollution control courses.
- Remember the customer; next to environmental regulation itself, the customer/market forces are the primary motivation to change the way the industry makes paper.[8]

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Wednesday, October 21, 1992

Session 7: Economic Incentives—Future Role in Clean Water Programs

SESSION SUMMARY

MODERATOR: Richard D. Morgenstern

Claudia Copeland—*Funding Water Quality Programs Using Toxicity-Based Discharge Fees*

Scott Farrow—*The Existing Basis and Potential for Damage Fees and Tradeable Allowances*

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Zach Willey—*Implementing Market-Based Instruments for Clean Water in America*

Funding Water Quality Programs Using Toxicity-Based Discharge Fees

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ABSTRACT

The question of how to fund and pay for government programs in an era of fiscal and budgetary constraints is being raised with greater frequency. Water quality programs are no exception. Some in Congress have recently discussed creating a new source of federal funding to meet the needs of the nation's clean water programs. The concept underlying this proposal is to impose fees or charges on discharges or products with potential for contaminating or degrading the aquatic environment and obtain revenue to support activities for abating or managing water pollution. One component of the proposal under review in Congress is a system of fees for industrial discharges for conventional and toxic water pollutants, with varying fees imposed according to the toxicity of the particular chemicals.

1.0 INTRODUCTION

Whether one is talking about environmental, social service, educational, or other programs of government, today's funding problems find common ground: against a background of unchanged or even growing needs, traditional revenue sources (especially from the federal government) are increasingly scarce.

Water quality programs are no exception, and a particularly large funding issue is associated with municipal sewage treatment plant construction. Federal, state and local governments have contributed nearly $75 billion towards sewage treatment construction projects, yet remaining funding needs are estimated to be $83 billion. Those needs will not be fully met by the end of fiscal year 1994, when authorizations are due to cease for the principal federal program that assists sewage treatment plant construction, the revolving loan fund program in the Clean Water Act.

Recognizing that states alone cannot meet water program funding needs and that the federal government has a continuing responsibility to assist states and localities financially, some policymakers and others have recently sought new revenue sources to meet these needs. For example, a group called the Clean Water Council has recommended establishing a Water and Wastewater Treatment Trust Fund to be capitalized by the collection of federal fees imposed on water and sewer bills. These revenues would be deposited in the new Trust Fund, which would operate like existing federal transportation trust funds and would be used to finance local construction of water and wastewater infrastructure.[1]

Another recent proposal involved establishing a federal chartered private corporation for the purpose of disbursing funds for a long-term federal commitment to water pollution control projects. Under this proposal, a federal corporation would manage funds derived from two sources: $2 billion per year provided through appropriations from general revenues and $3 billion per year provided from fees on certain commodities that contribute to water pollution. The guiding principle of the second portion of the proposal was that "the source of funds should be intimately tied to commodities that affect that quality of the water we are seeking to keep clean."[2]

Interest in these recommendations led the staff of the House Merchant Marine and Fisheries Committee, Subcommittee on Fisheries and Wildlife Conservation and the Environment, to request assistance of the Congressional Research Service (CRS) in detailing the elements of a similar proposal, one

to establish a National Clean Water Investment Corporation. The central element of the Subcommittee staff's proposal was to be a system of assessing fees on discharges of conventional and toxic water pollutants from industrial sources, with varying fees imposed according to the toxicity of particular chemicals. The revenue goal was to be $2 billion per year. By incorporating toxicity factors in the charge rates, the industrial wastewater discharge fee has considerable potential for providing economic incentive to reduce pollution.

Environmental Fees and Charges

The concept underlying industrial wastewater fees is to impose a charge on chemical releases with potential for contaminating or degrading the aquatic environment and obtain revenue to support activities for abating or managing water pollution. The industrial wastewater discharge fee is directly intended to generate revenues. However, the related goal is to provide users of the chemicals with an economic incentive to reduce pollutant loadings.

Using market-based incentives to protect the environment differs greatly from traditional regulatory methods of protecting public health and welfare. Yet, the rationale for using market-based approaches is straightforward. By using direct or indirect price or cost signals on pollution, individual decision makers can determine what is best for their own circumstances. Environmental objectives are achieved through the response of polluters to governmentally imposed changes in the costs of using certain inputs and/or in disposing of waste products.

Environmental fees and charges have been implemented in a number of locations. In particular, the Federal Republic of Germany in 1976 enacted an effluent charge law for controlling water pollution. According to one evaluation of the German system, "Although the actual charge is lower than abatement costs in many instances, it has proven to be high enough to provide an incentive to reduce substantial waste discharges into public waters. As a consequence, compliance as well as water quality has improved and the costs of enforcement have decreased."[3]

Academics have been the major proponents of market-oriented changes in environmental regulation in the United States. More recently others have raised the issue in various forums. For example, a project sponsored by U.S. Senators Timothy Wirth and John Heinz presented market-type options for a number of air and water pollution, hazardous substance, and climate change problems.[4] Interest in examining alternatives or supplements to current regulatory systems comes from several sources, including recognition of the costs of environmental controls, the seeming intractability of managing toxics and nonpoint sources of pollution that are less amenable to traditional regulation than conventional pollutants, and the potential of environmental fees as a revenue sources.

2.0 FEES/CHARGES FOR WASTEWATER DISCHARGES

This proposal addresses a specified group of 192 chemicals (189 toxics and three conventional pollutants) released to surface water by industrial direct dischargers and indirect dischargers (firms that discharge wastes to municipal sewers for treatment by a local sewerage utility) throughout the United States. The revenue objective would be to generate $2 billion annually, but an alternative revenue goal could also be specified.

The 192 pollutants are grouped in five categories consisting of a base group and four other groups that reflect increasing toxicity to aquatic life and to human health. A rate is established for each of the five categories that would be applied to actual loads, or discharges, of the individual chemicals. Toxicity characteristics, developed by the Environmental Protection Agency's Office of Water in connection with standard setting under the Clean Water Act, yield a toxic weighting factor for each pollutant and, hence, a means of ranking and grouping the chemicals according to their relative toxicities. The EPA's toxic weighting factor system was developed as a tool for evaluating technological options for industrial water pollution control.

2.1 Pollutants Subject to Fees/Charges

Two key issues associated with this proposal are identifying which chemicals would be subject to fees and determining the rate or rates applicable to discharges of those chemicals. A fee or charge can be applied most easily to discharges from point sources, since the discharges can be accurately measured or calculated. Measurement or calculation based on actual or estimated discharges is essential. Also important is basing the entire proposal on as comprehensive a list of chemicals as possible, so that all pollutants with potential for causing environmental harm are made subject to the same manner of incentives to reduce discharges.

The group of 192 chemicals in this proposal includes three conventional pollutants (suspended solids, biological oxygen demand, and oil and grease) and 189 toxic pollutants. The toxics include metals and metal compounds; organic chemicals (halogenated and non-halogenated); non-metallic inorganics; pesticides; and acids, bases, and salts. The pollutant list is based on data received pursuant to EPA's Toxics Release Inventory (TRI), mandated by Section 313 of the Superfund Amendments and Reauthorization Act of 1986 (SARA). Section 313 mandates that firms in Standard Industrial Classification (SIC) categories 20 through 39 (major manufacturing categories) report to EPA and states the amounts of more than 300 toxic chemicals that they release directly to air, water, or land, or that they transport to off-site facilities, including POTWs, that treat or dispose of the chemical wastes.

This data set substantially addresses the issue of which chemicals should be subject to fees and charges, as it is both comprehensive and current. The 189 toxic pollutants were reported to be discharged to surface waters and publicly owned treatment works (POTWs) in 1988 from industries in the SIC categories that are subject to the TRI requirements of SARA. TRI estimated discharges to water in 1988 totaled 865 million pounds; 554 million pounds (64% of the total) were discharged to POTWs, and 311 million pounds (36%) were discharged to surface waters.

Some pollutants that are highly toxic when discharged to water, such as dioxins and some pesticides (DDT and endrin, for example), are not included in the list of pollutants to be subject to fees, because currently they are not subject to TRI reporting and data on actual or estimated discharges are not available. Moreover, the three conventional pollutants (TSS, BOD_5, and oil and grease) that constitute the core of the "base group" are not covered by the TRI reporting requirements. Conventional pollutants are included in the proposal because discharges of these substances can, in fact, impair water quality and because they provide a reference point for relative toxicity of the other chemicals.

Despite certain limitations, the TRI data are the best source of information available on discharges to surface waters and POTWs, since TRI has the potential for reporting actual discharges and is highly current. Moreover, the TRI list of chemicals, drawn from Section 313 of SARA, is known and understood by the regulated community that would be subject to the fee proposal—including industries that discharge wastes to POTWs, even though those industries (indirect dischargers) are not subject to Clean Water Act permit requirements.

EPA's Office of Water has other databases on discharges by sources required to obtain Clean Water Act permits. Such data might be more inclusive (in terms of industry categories, for example), but are likely to be less useful than TRI data because they contain estimated discharges only, are less current than TRI data (making the information questionable for assessing impacts of the proposal), and provide no data on indirect discharges for which permits are not required.

2.2 Design of the Fee/Charge System

Table 1 identifies 1988 estimated discharges to surface waters and POTWs in the five groups included in this proposal, the fee rate that would apply to chemicals in each category, and the estimated revenues (total and per category) from the proposal.

Table 1

Wastewater Fee/Charge Summary

	Median Toxic Weight	1988 Loadings (pounds)	Toxic Weight Ratio	Fee Rate Per Pound (dollars)	Estimated Revenues
Base	0.0002	3,384,921,191	1	0.00647	$21,896,209
Group 1	0.0075	13,767,152	37.5	0.2426	$3,339,610
Group 2	0.07	848,746,674	350	2.2641	$1,921,615,517
Group 3	0.876	1,421,109	4,380	28.3331	$40,264,459
Group 4	1.96	316,954	9,800	63.3938	$20,092,903
Total		4,249,173,080			$2,007,208,697

2.3 Toxic Weighting Factors Used in the Proposal

This proposal is based on the concept that the rate of fee or charge should be tied to the environmental harm or threat of harm that is caused by the discharge of chemicals or pollutants. Thus, the toxicity of the substance is important as a basis for determining the amount of the fee.

Under the proposal, toxic weighting factors are used to rank each chemical and place it in a group, for purposes of determining the applicable charge rate. EPA uses toxic weighting factors in the process of evaluating technological options under the effluent guidelines program.[5] Toxic weighting factors are derived from water quality criteria by a simple numerical computation using a methodology established in 1981 and applied to effluent guidelines rulemakings since then.

The cost-effectiveness analysis evaluates the incremental cost of a given pollution control option for an industry or industry subcategory and the incremental removal of particular toxic chemicals by that option. The cost-effectiveness calculation compares the annualized cost of a technology option to the "pound equivalent" pollutant loadings removed from surface waters by the technology. The analysis is based on the option's removal of "pound equivalents," or a pound of pollutant controlled by the technology weighted for its toxicity. This reflects the fact that some pollutants are more toxic than others and removal of pollutants by one technology may be more or less effective than another technology based on its ability to remove the more toxic chemicals. A weighting factor for a pollutant parameter is calculated by dividing the relevant water quality criterion, expressed as a concentration in micrograms per liter, into the criterion for a selected standard pollutant, copper.

EPA has developed toxic weighting factors for 127 priority pollutants and approximately 250 pesticides, because control of these chemicals has been the focus of regulatory activities since 1977. However, EPA has developed toxic weighting factors for less than one-half of the TRI pollutants discharged to water, since the list of TRI pollutants is broader than the list of priority pollutants subject to Clean Water Act regulation. For the purpose of this proposal, then, TRI pollutants for which no factor has been developed were assigned a factor equivalent to the median of the TRI pollutants for which such factors have been developed: 0.07. This somewhat arbitrary assignment provides a means of including these chemicals in the proposal, although it is likely that actual toxic weighting factors, if available, could well be lower or higher.

2.4 Other Toxicity Ranking Options

A ranking system based on EPA's toxic weighting factors is not perfect, principally because it currently does not cover all chemicals of potential interest or concern. Other systems of ranking chemicals according to their toxicity might be examined, but compared to toxic weighting factors, none has as adequate a database or as developed a methodological approach.

Under one alternative approach, a ranking system could be developed based on evaluating the bioconcentration and/or bioaccumulation effects of chemicals. EPA defines a bioaccumulation factor (BAF) as the chemical's concentration in the tissue of test species divided by its concentration in ambient water and the diet. Bioconcentration factor (BCF) is defined as the tissue concentration of the chemical divided by its concentration in water (but not including diet). These factors provide a measure for evaluating pollutants that are highly persistent in the environment. This approach may be useful for some but not all pollutants actually discharged into the aquatic environment (some highly toxic pollutants may not, in fact be highly persistent—formaldehyde, for example—and vice versa—manganese, for example). Further, at the present time, neither data nor methodologies are comprehensive enough for EPA to have developed BCFs or BAFs for all toxic pollutants discharged to water.

Another option could be a pollutant ranking system now being developed by EPA. It is based on summarizing scores assigned to 15 parameters in three categories: toxic effects (e.g., acute and chronic toxicity, wildlife and human health toxicity), environmental fate (bioconcentration/bioaccumulation and environmental persistence), and exposure data (frequency of detection in ambient water and sediments). As conceived by EPA's Office of Water, Health and Ecological Criteria Division, this ranking system could be used to prioritize pollutants for ambient water criteria development or by others in EPA to select pollutants for rulemaking or standard setting. While the inclusion of multiple parameters has the potential to strengthen the results of chemical ranking, sufficient data in the broader array of categories is currently lacking. EPA has so far attempted to rank about 300 chemicals using this system, but 30% were judged to have insufficient data to complete the analysis.[6]

2.5 Applicable Fee/Charge Rates

Fee or charge rates under the proposal are determined based on the categories of chemicals, their relative toxicity to one another, and the total amount of revenue to be collected. A rate of $0.00647 per pound of pollutant discharged is established for chemicals in the base category, which consists primarily of conventional pollutants and other chemicals with toxic weighting factors of less than 0.001 (very low toxicity). Each of the other categories' charge rates is then established in relation to the base rate in order to reflect relative toxicity. The median toxic weighting factor in a particular group is assigned to all chemicals in that group to simplify computation. Chemicals in Group 1, consisting of chemicals with toxic weighting factors ranging between 0.001 and 0.0099 with a median toxic weighting factor of 0.0075, are 37.5 times more toxic than pollutants in the base group, which have a median toxic weighting factor of 0.0002. Thus, the rate of fee for discharges of Group 1 chemicals is 37.5 times the base rate ($0.2426 per pound discharged).

Pollutants in Group 2 consist of chemicals with toxic weighting factors ranging between 0.01 and 0.099. Pollutants in Group 3 consist of chemicals with toxic weighting factors ranging between 0.1 and 0.99. At the other extreme, pollutants in Group 4 (consisting of chemicals with toxic weighting factors of 1.0 and above) have a median toxic weighting factor of 1.96 and are *more than 9,800 times* more toxic than chemicals in the base group. Industrial sources releasing chemicals in Group 4 would pay a fee of $63.40 per pound discharged. Table 1 identifies the toxic weighting ratio of each category compared to the base, the rate that would apply to chemicals in each category, and the estimated revenues (total and per category) from the proposal.

At first glance, the base rate and rates applicable in some of the categories appear exceedingly small. However, these rates result from several factors: (1) the large volume of pollutants on which the proposal is based—4.25 **billion** pounds of toxic and conventional pollutants discharged in 1988; (2) the desire to reflect relative toxicity in the rates applicable to each separate category; and (3) the defined revenue goal of $2 billion. For example, if the base fee rate were to be set at $0.10 per pound, while the same toxic ratios were retained for each group or category, the total estimated annual revenue would be approximately $31.1 billion! (Emphasis added by author.)

2.6 State-by-State Impacts of the Proposal

From the TRI data, it is possible to identify on a state-by-state basis the fees that industries in SIC Codes 20 through 39 would pay under this proposal for discharges of TRI chemicals, based on 1988 reported discharges. The amount of total fees paid by industries would range from $37,200 (Nevada) to $320 million (Louisiana). In the majority of states, fees of the size estimated here are likely to have minimal impact. For example, fees measured as a percent of a state's gross state product are one-tenth of 1% or less, except in the case of Louisiana, where the estimated fees would be equivalent to 0.4% of the 1989 gross state product.[7]

These results are valid for general estimating purposes only, since more precise discharge information will no doubt become available on all pollutants subject to the proposal. Dischargers would have incentive to improve the accuracy of reported amounts used as the basis for fees/charges. Since the program would apply to all industries which discharge these chemicals (not just those covered by TRI reporting requirements which are in SIC Codes 20 through 39), it is difficult to estimate the full impact of the proposal. For example, TRI does not currently cover the mining/resource extraction and agriculture/forestry industries, although their discharges of conventional and toxic pollutants to water are significant. If all dischargers were to be subject to the proposal and fee rates were unchanged, actual revenues would be higher than those estimated. Alternatively, if the industrial discharger base were expanded, but the $2 billion revenue goal remained fixed, impacts on individual dischargers would be reduced.

2.7 Industry-Specific Impacts

It appears unlikely that the industrial wastewater discharge fee described here would have a significant impact on the majority of affected industries. The major exception is the chemicals and allied products industries (SIC 28), which accounted for 68.6% of TRI discharges in 1988 and would pay 67.9% of estimated fees paid by all industries.

Impacts on most industries would not be large. For example, the industry-total amounts estimated in this analysis represent less than two-tenths of 1% of the 1989 Gross National Product (GNP) contribution of the food products, textile products, and metals industries, respectively, and less than four-tenths of 1% of 1989 GNP of the paper products industry. A slightly larger impact would occur with the chemicals and allied products industries, where the estimated fees represent 1.4% of their contribution to 1989 GNP.[8]

Likewise, in terms of corporate profitability, the estimated fees would generally have a small impact: 0.79% of the food products industry's corporate profitability and 1.41% of the metals industries' profitability in 1990. Again, however, the initial impact would be greater on companies in the chemicals and allied products industries, where the estimated fee represents 6.64% of 1990 corporate profitability.[9] To the extent that imposition of fees resulted in changed behavior (substitution of less toxic chemical inputs or processes involving reduced wastewater discharges), the actual and relative burdens of the fees/charges would be reduced.

Discharges of four chemicals—ammonium sulfate, phosphoric acid, methanol, and sulfuric acid—total 625 million pounds, or 72% of toxic chemicals discharged to water in 1988. Fees paid on these discharges would be $1.4 billion. A number of industries utilize and discharge these four chemicals, but four

industries would account for $1.3 billion of that amount: chemicals and allied products ($950 million in fees on these four chemicals), paper products ($251 million), food products ($58 million), and metals ($28 million).

3.0 CONCLUDING CONSIDERATIONS

The principal purpose of the industrial wastewater discharge fee described in this analysis is to raise revenues for a National Clean Water Investment Corporation. Indeed, the actual rates are based on three factors: volumes of the chemicals discharged, the relative rankings of chemicals in terms of toxicity, ***and*** the defined revenue goal of the proposal. So long as revenue-raising is a key objective of a fee system, it will be necessary to build into the system a means for making adjustments over time.

For example, to maintain a predictable revenue stream, the design of the system would need to provide for periodic changes in the fee rates to account for effects of inflation. Alternatively, if revenue needs were to decline over time by virtue of having met most or all funding needs for clean water activities, rates would presumably be adjusted downward.

Similarly, the fee system would need to recognize and adjust for uncertainties in its initial design. One major uncertainty could result if the imposition of fees led to reduction in use of the chemicals, since revenues would decline. It is difficult to estimate the extent to which chemicals use would be altered as a means of avoiding paying the fees, but the potential for reduced revenue should be considered.

Other adjustments would be required if the number of chemicals subject to fees was modified. Likewise, changes made to the industrial discharger base (sources that would pay the fees) would require certain rate adjustments if the specified revenue goal remained fixed.

The lack of comprehensive toxic weighting factors for all chemicals that might be included in the industrial wastewater fee is an additional uncertainty. For the purposes of this analysis and as a means of ranking the chemicals, a toxic weighting factor was assigned to those chemicals for which EPA has not developed toxic weighting factors. Better information would undoubtedly alter the relative rankings of some chemicals, the fee rates that would apply to those chemicals, and the revenues that could be anticipated.

These considerations are not likely to be obstacles to establishing a system of fees or charges, but they point to the need to design a system that is sufficiently dynamic to anticipate changes over time.

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The Existing Basis and Potential for Damage Fees and Tradeable Allowances

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ABSTRACT

The potential for using damage fees and tradeable allowances is discussed as an extension of existing authority in the Clean Water Act. The importance of geographic targeting of economically based policies is emphasized based on an index of fishable and swimmable water.

1.0 INTRODUCTION*

There is no secret about the two classes of economic instruments potentially applicable to water policy. Taxes, in their infinite variation, and tradeable allowances capture the span of direct economic incentives. The trick for market-oriented policy entrepreneurs is to surmount the thousand and one pitfalls between economic abstraction and real world implementation by Congress, agencies, firms, and households.

This paper focuses on two variations of taxes and tradeable allowances where potential for implementation already exists in the Clean Water Act and related legislation. The variations are a means of applying natural resource damages and total maximum daily load allocations in highly polluted waters. Prior to discussing these specific economic instruments, however, the issue is addressed of how much cleaner water should be to achieve economic efficiency.

Existing research by Myrick Freeman[1] and preliminary estimates by Randy Lyon and myself question the economic efficiency of current plans to make America's water cleaner. Importantly, however, it is quite likely that it is very worthwhile to make some waters cleaner, even much cleaner, but it is unlikely that all technologically improvable waters are economically worth improving.

A question related to that of economically efficient improvements is the question of determining the current status of water quality, and what the projected impact that new policies might have on water quality. The first section of the paper addresses this physical quality issue. The second section presents a resource damages approach to improving water quality that permits questions related to the explicit balancing of costs and benefits. The third section presents a tradeable allowances approach which focuses on the cost effectiveness of achieving the allowable maximum daily loading in a watershed. Emphasis is given to the fact that these approaches build upon existing legislation instead of creating economic incentives de novo.

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*This paper draws upon research the author has conducted with Randy Lyon and Jim Tobey. The views expressed, however, are solely those of the author and are not necessarily those of any organization with which I am or have been affiliated.

2.0 WHERE ARE WE? A WATER QUALITY INDEX FOR ECONOMIC ANALYSIS[b]

The fishable and swimmable goals for water quality in the Clean Water Act resonate with the actions and values of people throughout the country. Economists wishing to address the usefulness of economic incentives require a means to link economic valuations of improved water quality with physical water quality measurements. Elsewhere,[2] Randy Lyon and I have provided one such link, creating a baseline, continuous index for river and stream water quality in fishable and swimmable terms for each state and for the nation in 1988. The index that is created links an index based on physical units and is used to estimate household willingness to pay for improvements in water quality developed by Carson and Mitchell[3] with state-reported estimates of fishable and swimmable waters.

Economists[4,5] have found a water quality ladder, developed at Resources for the Future, to be a useful device to link a physical index of freshwater quality with individuals' willingness to pay. The water quality ladder links 5 physical measurements to aggregates such as "boatable," "game fishable," and "swimmable" that are economically meaningful to a larger population of individuals.

Given the significance of the water quality ladder as an index because of its link to existing economic studies of willingness to pay, it is useful to extend its application to national data. One approach is to compute the index for specific locations; on a limited scale this was done by Smith and Desvousges[4] for 43 sites in the Monongehela River Basin. In the spirit of Dawes' work on the usefulness of linear indices in the face of uncertainty,[6] it is possible to take the data reported by the states to EPA regarding fishable and swimmable waters and transform it into data consistent with the water quality ladder.

In 1988, 40 states, 2 river basins, the District of Columbia and Puerto Rico reported assessments from 1986 and 1987 for over 400,000 stream miles as to whether the miles achieved fishable and swimmable characteristics.[7] The EPA reports for each state the assessed miles that meet the fishable goal, the swimmable goal, and those that do not meet the goals. The states providing reports assessed 45% of the total river and stream miles with slightly under half assessed using chemical and biological data and the remainder assessed using mathematical models, professional judgement, citizen complaints, and other sources[c].

A variety of assumptions are necessary to link the EPA data with the water quality ladder. The key assumptions address: (1) the representativeness of the assessed water, (2) divergences between the miles assessed for the fishable and swimmable goals, (3) consistency between water quality ladder rankings and the data, and (4) the valuation on the water quality ladder assigned to the three ordinal categories provided by the EPA. These assumptions are discussed by Farrow and Lyon.[2]

What is significant in the current context is the basic result: even if streams and rivers are assumed to have the worst water quality within each category (i.e., if the water is fishable, it is the worst quality water that is fishable; if it is swimmable, it is the worst quality water that is swimmable, etc.) the national average water quality is between fishable and swimmable. Using a less stringent assumption, national average water quality is above swimmable quality and only Virginia and the District of Columbia among reporting units would have had average water quality below fishable. What these results emphasized even more clearly in a longer analysis is the variation in water quality within and across states. This leads to the following:

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[b]This section is based on Farrow and Lyon.[2]

[c]A more limited data set is reported for lakes and bodies of salt water. The lake water quality is indicated as exceeding stream and river quality and is not investigated here. As for bodies of salt water, the water quality ladder is not designed for salt water applications.

Recommendation 1: Economic incentives should be geographically focused and should be zero in some areas.

3.0 THE CLEAN WATER ACT AND DAMAGE COSTS IN HIGHLY POLLUTED WATERS

Rather than reinventing the wheel, it is useful to look at existing water-related legislation for potential applications of economic incentives. Both the Clean Water Act and the Oil Pollution Act of 1990 provide a structure for assessing and collecting natural resource damage costs. To date, these provisions have been used for discrete events, such as the Exxon Valdez spill, or historical, long-term point sources such as those in New Bedford Harbor or near Los Angeles, California. The damage costs collected are to be used for the recovery and restoration of the water bodies. A potential extension of the natural resource damage framework could apply to ongoing sources of pollution in highly polluted waters.

In highly polluted waters, those unable to achieve water quality standards specified in Section 303 of the existing Clean Water Act, there is an expectation that natural resource damages exist and that they are caused by pollution from many sources. These damages may include lost recreation values and increased costs to other water users such as industry and municipal water plants.

A market-oriented approach to achieving water quality standards in highly polluted waterways could specify an option for states to assess and collect natural resource damage costs from classes of polluters. Both judicial and administrative approaches are discussed in the sections to follow. Parallel to existing legislation, the damage costs collected could be targeted for cleanup and recovery efforts. In particular, they could be earmarked for existing state revolving funds that support investments in water pollution control and for non-point pollution control programs such as the Conservation Reserve Program in the Department of Agriculture. The collection of damage costs can be assigned to municipal water authorities, and state or county governments.

3.1 Existing Authority and Identification of Highly Polluted Waters

The Clean Water Act (Section 311), the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, Section 107) and the Oil Pollution Act of 1990 (Section 1002) all contain provisions that, in general, specify that the federal and state governments may: (1) assess liability for damages to resources for which they are trustees for the public, (2) recover clean-up, restoration, and damage costs prior to restoration from responsible parties.

The existing legislation is targeted at oil spills, or large sources of hazardous substances. Regulations that implement the Clean Water Act specify approximately 150 hazardous chemicals and minimum reportable quantities for spills of these hazardous substances. Among the listed hazardous substances are numerous forms of ammonia (the basis for most nitrogen fertilizers) and phosphorus. These substances and their chemical transformations are important causes of failing to attain water quality standards, as are various other identified hazardous substances. Clearly, however, not all, nor even most, water emissions are linked to hazardous substances.

The identification of highly polluted waters is based on the anticipated failure of a water body to achieve a water quality standard even after all technological standards are implemented (Section 303, CWA). In this paper, natural resource damages are either assumed to be zero for waters that meet water quality standards, or else such waters are assumed to already achieve an economically efficient balancing of natural resource damages with the costs of controlling such damages. In contrast, achieving the water quality standard in highly polluted waters can only be achieved by exceeding regulated technological requirements or by bringing new sources into the water management system.

Determining the cause and source of natural resource damages in highly polluted waters provides a comprehensive approach for all causes of failure to meet the water quality standards. Such damages may result from a variety of pollutant loadings, and may also result from low stream flows as a

result of large-scale consumption uses of water. EPA in a number of publications[8,9] has discussed the aggregate causes and sources of impairment.

3.2 Natural Resource Damages

The cause of pollution can be translated, with greater or lesser accuracy, into economic damages associated with that pollution. Research indicates that recreational benefits are the largest single category of benefits from water quality improvements.[1] However, many of the methods used to estimate natural resource damages are particularly debatable when applied to one-time spills in areas that are unfamiliar to the public. The ability to assess natural resource damages for a localized area and for common uses is thought to be substantially better than in cases such as the Exxon Valdez.

However, substantial duplication of effort and controversy would undoubtedly surround each analysis of natural resource damages. The federal government could provide information to the states by convening a natural resource damages assessment commission to evaluate the "typical" costs for natural resource damages and the local characteristics that would be expected to change the typical cost. Depending on how the Clean Water Act would be modified, the Commission could set a cost schedule to be implemented by the states. Such a commission would follow the model of the Federal Sentencing Commission, which set guidelines for calculating uniform federal criminal sentences derived from an algorithm incorporating many variables, and the recent review of Medicare and Medicaid practice that established standardized fees. Such a national commission can play the important roles of reducing research and transaction costs, and providing a predictable outcome for polluters and water users.

3.3 Collection of Fees

Several mechanisms may be used to collect fees other than lengthy and time consuming watershed-wide litigation as might be possible under the existing Clean Water Act. These alternative mechanisms may include: (1) an add-on item to state taxes based on the quantity of pollutants released as determined in total maximum daily load analyses (TMDL) conducted by the states under existing Section 303 of the Clean Water Act; (2) deposit/refund policies for those inputs used in a non-dissipative manner such as motor oil; (3) (with less economic justification) a damage cost placed on the consumption of inputs such as nitrogen fertilizers and the hazardous chemicals already specified in 40 CFR 116 if outputs are so hard to measure that an input proxy is needed; or (4) state-imposed water consumption fees payable to municipal water authorities, or to county or state authorities based on water withdrawal from surface or ground water. While these costs may have a small effect (in the correct direction) on polluting behavior, attainment of water quality standards is likely to be possible only by using the fees for restoration and recovery as currently directed in the statute.

3.4 Distribution of Funds

Existing legislation relating to natural resource damages specifies that the damages recovered are to be used for cleanup, restoration, and recovery. Applying that principle to damage costs under the proposed system could go a long way toward financing capital expenditures on water quality improvement. Such financing has been identified as an important limiting factor to improvements in water quality. In particular, damage costs collected by a state under these statutes could be directed to two existing programs, the State Revolving Fund for construction grants and the Conservation Reserve Program of the Department of Agriculture.

A 1988 "needs" assessment for municipal water quality improvements funded by the State Revolving Funds identified $84 billion in nationwide capital improvement, including $16 billion for investments related to combined sewer overflows.[10] To date these funds are not allocated for operating or maintenance.

The Conservation Reserve Program of the Department of Agriculture is intended to reduce sedimentation by subsidizing the removal of highly erodible land from production and the planting of various soil stabilizing plants. An option has been investigated by the Department of Agriculture to also target environmentally sensitive areas. Improvements in water quality account for approximately 40% of the comprehensive benefits that have been estimated for the program with the present value of benefits ranging from a low of $18 per acre in the Northern Plains to a high of $389 per acre in the Delta region.[11] The average land rental paid by the Conservation Reserve Program to remove highly erodible land from production is less than $50. The Conservation Reserve Program could be partially funded from natural resource damage costs. The program would provide a local means of implementing improvements in non-point pollution prevention and control.

A statutory and a technical basis exists for assigning damages due to some causes of water pollution. The assessment and collection of these damages on a broader scale than previously considered provides one market-based approach to water pollution control. The damage costs collected could be a funding mechanism for existing state revolving funds which invest in water pollution control. However, separate litigation is currently needed to recover damages based on a natural resource damage assessment. This situation could be changed by Recommendation 2:

> **Recommendation 2:** That explicit statutory linkage between ongoing pollution and natural resource damages be developed and that a Presidential Commission be convened to establish plausible resource damages from pollution in highly polluted waters.

4.0 TRADEABLE ALLOWANCES IN HIGHLY POLLUTED WATERS

An existing section of the Clean Water Act can be read as setting the ceiling quantity for the implementation of tradeable allowances. The allowance approach should be viewed as an alternative to the resource damage approach of the previous section. While the resource damage approach could address economic efficiency issues, the tradeable allowance approach is essentially limited to improving the cost-effectiveness of achieving a given level of pollution control.

While most of the Clean Water Act is devoted to technology-based approaches to improving water quality, one existing section, Section 303, is devoted to water quality standards. Under Section 303, states set standards for water bodies and determine the maximum pollutant loads for those waters categorized as highly polluted. Where economic costs of meeting water quality standards are too great, individual states may redefine their water quality standard.

Section 303 provides the majority of guidance necessary to provide for tradeable allowances in water pollution for the very areas that are most likely to benefit from the ability to trade. Indeed, such trade-offs are made implicitly in the current management of the program.

Several case studies exist in the literature regarding trading among sources of water pollution. The typical success story is Dillon Reservoir, the typical failure, Fox River. A short description follows of these cases and a case involving trading between point sources and agricultural sources in the Wicomico watershed.

- Dillon Reservoir: In the Dillon Reservoir near Denver, Colorado, the EPA funded a special study to evaluate the comparative cost of point and nonpoint source controls. It was reported that about 2 pounds of phosphorus could be removed through urban nonpoint source controls for every one pound removed from sewage treatment plants at 51% less cost than upgrading sewage treatment plants.

- Upper Wicomico River watershed, Maryland: it is estimated that agricultural best management practices were capable of reducing total phosphorus loads by 25% at 83% less cost than upgrading a sewage treatment plant to remove the same amount of phosphorus.

- Fox River: Trading was allowed in this heavily polluted area but is perceived to have failed. Some of the stated reasons for failure are a lack of clear authority to conduct such trades, the bureaucratic review of trades, and the lack of a bank to store load reduction credits.

To date, I know of no study of cost effectiveness on a national scope that exists that would complement these and other case studies by providing insights on the national level.

Discussions of these cases usually bypass the existing mechanism that identifies highly polluted water bodies and determines the maximum daily load from point, nonpoint and background sources that is allowable in order to achieve the state-determined water quality objective. The remainder of this paper focuses on the existing mechanism as specified in Section 303(d) of the Clean Water Act.

Section 303(d) requires that states identify and prioritize "water quality limited" segments. These segments are the most highly polluted water bodies and are not expected to meet state-defined water quality standards, even after full compliance with technology-based effluent limitations. These highly polluted areas (in one or more pollutants) are the most likely areas to have economic benefits associated with improvements in water quality and so provide a target area for market-based approaches.

For these water quality limited areas, states are required to establish an aggregate pollution ceiling, called "total maximum daily loads" (TMDL), that would achieve a water quality, as opposed to a technological, standard. In establishing TMDLs, statutory guidance is that point, nonpoint and background sources are to be distinguished. Section 319 of the Clean Water Act specifies the development of a state management plan for control of nonpoint sources. Taken together, reductions in permitted discharges and the implementation of the nonpoint source plan are to achieve the TMDL level.

4.1 The Potential for Trading in TMDL Defined Areas

Section 303(d) offers an opportunity to introduce a cost-minimizing program of *marketable load allowances* to achieve water quality standards in a comprehensive manner without departing radically from the existing system. Since a correctly prepared TMDL presently specifies the maximum allowable discharges for all sources of contaminants, it should be possible to rewrite permits in a divisible format and allow exchanges to be made with monitored reductions from permitted or unpermitted sources. The exchanges could thus occur among point sources or between point and nonpoint sources.

The ability to trade load allowances may not only reduce costs, it may be the only technically feasible method of achieving the targeted level of water quality. Regarding cost savings, studies have found that control costs for biochemical oxygen demand (BOD) under the traditional regulatory approach are 20 to 300% greater than a least-cost approach. Regarding water quality, the exchanges would take place within the constraints of the TMDL so that water quality would be expected to improve. Also importantly, tradeable allowances would provide long-run incentives for innovation since dischargers could sell their pollutant reductions.

While marketable load allowances may help achieve water quality standards in some areas, in other areas it may be economically inefficient to do so. Two existing mechanisms in Section 303 and the regulations that implement that section help integrate economic considerations. Section 303(d) requires water quality limited segments to be prioritized by the states. This would direct market based approaches toward the largest perceived pollution problems with the greatest potential benefits from emissions reductions.

Furthermore, existing EPA regulations state that nonattainment of water quality standards is acceptable (by redefining the water quality standard) when achievement of the TMDL would result in "widespread economic and social impact." This suggests that water quality limited segments for which the incremental costs of pollution abatement exceed the incremental benefits could be exempted from compliance. Provisions do exist to review periodically such a finding.

4.2 Existing Water Quality Limited Segments and TMDLs

A 1989 GAO report, focusing on EPA's Region X (the Northwestern states plus Alaska) found that those states had identified 602 water quality limited segments as of mid-1988. Only one TMDL had been set at that time. At the same time, Region IX states (California, Nevada and Arizona) had identified 77 water quality limited segments and developed 33 TMDLs. Region V states (six upper mid-west states) had identified 227 water-quality limited segments and developed 70 TMDLs by the end of 1987. Recent conversations with the EPA Region II office indicate that in New York, TMDLs have been identified for all water basins that are water quality limited (about 17 water basins). Essentially all surface waters are water quality limited in New Jersey, and approximately 10 TMDLs have been set.

This information on TMDLs, water quality limited segments, total and assessed river miles, and total and assessed lake acres is presented in Table 1. Care should be taken to note that the data are merely indicative and represent a collage of information from several different sources in the years 1987 to 1989. There also appears to be some variability across the states in the degree of detail supporting TMDL determination and the allocation of the TMDL between point, nonpoint, and background sources.

Table 1

Water Quality Information for Selected Regions

	Rivers		Lakes		Water Quality	
	Total Miles	Assessed	Total Acres	Assessed	Limited Segments	TMDL
Region II (NY only)	70,000	70,000	750,000	750,000	17	17
Region V (Midwest)	276,291	114,927	5,692,211	3,201,980	227	70
Region IX (CA, AZ only)	33,641	12,250	1,417,540	1,077,330	77	33
Region X (OR, WA only)	130,492	32,354	1,224,390	666,500	602	1

Sources: GAO[12]; EPA[8]

A separate source of prioritized areas is based on Section 304(l) Long Lists to identify water bodies where water quality standards are violated for any pollutant for any reason. While only a one-time requirement, it provides information very similar to the periodic reporting requirements under Section 303(d). The "water body tracking system" of the EPA is compiling this data and has found almost 18,000 impaired water bodies on the 304(l) Long Lists. EPA has estimated that nutrient load trading could be considered on over one thousand of these water bodies.

4.3 Issues for Further Consideration

1. While states have some experience with TMDLs, a comprehensive evaluation of the program would be an important step to determining the nationally targeted application of load trading. Particular attention should be paid to the extent that existing modeling procedures imply 1:1 trading among all sources.

2. Monitoring and banking: Institutions should be considered to monitor compliance, particularly for nonpoint sources, and who could bank load allowances. One possible mechanism for nonpoint sources is the Agricultural Stabilization and Conservation Service (ASCS) which, through the Conservation Reserve Program, is already subsidizing management practices that reduce water pollution. The ASCS has offices in most regions throughout the country.

3. States or individuals must have the authority to enforce contracts relating to load allowances. Section 319 of the CWA established a framework for states to develop state nonpoint source management programs which may include a variety of regulatory, voluntary, and cost-sharing components. Requirements in these state programs are not federally enforceable nor does EPA require that state programs be enforceable at the state level.

4. Consideration should be given to restrictions and opportunities for trading across classes of pollutants as many effluents contain a set of pollutants.

Section 303(d) of the CWA has been implemented to only a limited degree. Instead, most water pollution control efforts have been directed at the technology-based controls of the CWA. These and other CWA requirements have mandated timeframes which give them a greater emphasis than TMDL requirements. However, a strong policy emphasis on the 303(d) requirements may lead to a comprehensive approach to identifying and resolving water pollution problems regardless of the sources of pollution. The TMDL process provides EPA and the states with a listing of key water pollutants, the source of the pollutants, information on the amount of pollutants that need to be reduced, options between point and/or nonpoint approaches, and costs to clean up. Recommendation 3 results.

> **Recommendation 3:** A technical review should be conducted of the implementation of the 303(d) program. Vague language in the existing Clean Water Act should be clarified to establish the desirability of defining and trading among different types of load allocations in highly polluted waters.

5.0 CONCLUSION

Economic incentives do not operate in a vacuum independent of actual water quality. Nor must economic incentives be viewed as an entirely new element of Clean Water Act legislation. Existing EPA information can be used to geographically target those areas where it may be economically efficient to improve water quality. Existing legislation, with relatively minor modifications, could be adapted to either a natural resource damages approach to improving water quality or to a trading allowance institution in areas of highly polluted waters.

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Are Permits and Charges the Last Word in Water Pollution?

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ABSTRACT

Market-based alternatives to conventional environmental regulation have now moved out of the economics journals and into the policy debates. The sulfur-trading program in the 1990 Clean Air Act Amendments, the lead-trading plan in the lead phaseout rules for gasoline, and emissions-offset provisions in air-quality regulations of various states all testify to the growing understanding and acceptance of economic incentives, and to their increasing attractiveness to policymakers. The OECD council in January 1991 urged member countries to "make greater and more consistent use of economic instruments in managing the environment." Several environmental groups have joined in endorsing market-based solutions, most prominently the Environmental Defense Fund and even in some instances more traditional environmental groups like the Sierra Club.

Discussions of specific market-based strategies have been limited to two basic options: effluent changes, which put a price on each unit of emissions, and transferable discharge permits of the sort featured in the 1990 Clean Air Act sulfur-trading program, which allow sources to trade the right to emit a set quantity of pollutant. Along with economic instruments, economists recommend greater use of cost-benefit analysis.

Overlooked in this enthusiastic response, however, is a third and much older approach, also based on economic incentives: the common law tradition of private property rights.

For centuries, well-defined property rights have protected environmental amenities. A farmer enjoys the right not to have his field set ablaze. A landowner enjoys the right not to have trash dumped on his land, and may enjoy the right to clean water in the fishing stream on his land. In our own time, the Nature Conservancy buys tracts of land it feels have environmental value. With the organization's own resources at stake, economic incentives encourage good stewardship (air emissions allowances or effluent fees are in fact a sort of property right to the common airshed; they allow the holder of the permit or the payer of the fee the right to emit a certain quantity of pollutant).

Beginning in the mid-19th century, however, in an attempt to encourage commerce, U.S. courts began to move away from reliance on property rights, and toward a utilitarian balancing of costs and benefits. This shift accelerated after World War II, as the public demanded greater government attention to environmental issues. Rather than reviving common law protections, various state and local governments, and ultimately the federal government, sought to protect the environment by a far reaching expansion of their regulatory authority, and ironically by a concurrent weakening of property rights.

It is the aim of this paper to reexamine the common law tradition of enforceable property rights, and to compare this approach with effluent fees and transferable discharge permits. The paper suggests first steps toward implementing a private property approach, and discusses how this approach could be applied to water pollution.

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[a]The views presented are those of the author and do not represent the official position of the U.S. Treasury.

1.0 THE COMMON LAW TRADITION AND THE RISE OF THE UTILITARIAN ETHIC

Property rights for water resources have existed for hundreds of years in many societies. Indians along the Columbia River established rights to fishing sites long before the arrival of Europeans. Enforceable rights to coastal fisheries have existed for several centuries in England and for perhaps 2,000 years in Japan.[1]

Northeastern U.S. lobster fisheries have long relied on enforcement of traditional property rights by individual fishermen. American authorities have recognized private rights to oyster beds since the early 1800s. In Washington state, oyster beds may now be privately owned, and Maryland has now established rights to oyster seed beds in the Chesapeake Bay.[2] Shellfish are particularly sensitive to water pollution; allowing private ownership of shellfish beds promises significant benefits to water quality over the relevant bay or estuary.

Under English Common Law, the property rights specifically accorded to landowners on riverbanks (riparian rights) include transferable angling rights. Thus, hotels and resorts lease angling rights to a stream for the use of their guests. By limiting access to streams, enforceable angling rights help to protect fish and wildlife.[3]

Just as important, riparian rights include the right to legal action against those interfering with the "quiet enjoyment" of the river, including polluters. In England, the Angler's Cooperative Association (ACA), formed in 1948, immediately began to exercise property rights against polluters, most notably in the Pride of Derby case. The ACA has now represented local clubs in over 1,500 cases, demonstrating the efficacy of private enforcement actions under the Common Law.[4] (U.S. courts have sometimes allowed similar claims. In a 1913 New York case, a farmer sued an upstream paper mill for polluting the water. The court shut down the mill, ruling that under the Common Law, the farmer had a right to clean water. A 1907 case in Georgia and a 1921 Supreme Court case between New York and New Jersey treated similar claims.[5])

In the U.S., however, the general direction has been away from a reliance on private rights and toward the utilitarian balancing of costs and benefits. Early locomotives, for example, emitted sparks that sometimes ignited fields near the tracks. Under the common law, the railroads had generally been held responsible for damages.[6] In the mid-19th century, however, American courts, in an attempt to promote commerce, began to move away from this reliance on private property toward a focus on the "common good," attempting to balance the benefits of development against the harm to private landowners. Several important cases shifted the balance toward the railroads. Similarly, to promote commerce along the major rivers, courts successively weakened traditional riparian rights.

Accompanying this shift was the increasing popularity of the doctrine of "public trust," by which the government, not individual citizens, held property rights over unclaimed natural resources in trust for the common good. By the early 20th century, the federal government was using the public trust argument—and expectations of a timber famine—to place most remaining forests under political management. The timber famine never materialized, but the forests have remained in political hands.

This shift from private property to public trust and utilitarian calculus continues to occur. In a series of cases in the 1980s, courts further weakened riparian claims in the western U.S. In a 1984 case, the Montana Supreme Court eliminated landowners' riparian rights to restrict access in any way[7].

2.0 THE STANDARD ECONOMIST'S PRESCRIPTION

Pigou's doctrine of market failure, first widely circulated in the 1920s, conveniently fit the notion of a utilitarian balancing of costs and benefits by the state.[8] While markets efficiently allocate most goods, environmental amenities were said to be different. Pollution results from the failure of producers to pay the full social costs of the resources they use, with the result that they produce too much pollution. The market fails for two reasons. First, property rights cannot be defined with sufficient precision (water, it has

been asserted, must be treated as "common property" because the resource itself moves about[9]). Second, negotiations leading to mutually agreeable outcomes among all affected parties are not feasible.

The conclusion was obvious: private markets would not address pollution and "common pool" resources (the problem of "externalities"). The market would fail. Thus Robert Stavins, a contemporary environmental economist asks rhetorically: "Does anyone really believe that acid rain can be efficiently controlled by assigning property rights for U.S. airsheds and then effecting negotiations among all affected parties?"[10]

Wise government officials, acting for the common good and not from self-interest, would intervene in the market and thus solve the problem of pollution. But what form should this intervention take? The economic literature is unanimous in condemnation of the command-and-control approach.[11] For an efficient command-and-control solution, the regulators would have to know the marginal cost and benefit schedules for each source. As regulators will not have this information, they must instead choose a second-best solution, such as setting ambient quality standards, or a third-best solution, such as setting a uniform ceiling on emissions, or requiring a uniform percentage reduction in emissions. While these rules meet none of the economist's tests for efficiency, they may meet the all-important political requirement of fairness.

Pigou and most economists who followed proposed a different approach. To allocate a scarce resource in the absence of property rights, government should simulate a market, with effluent fees or transferable discharge permits substituting for prices. To quote Stavins again: "Economic incentive mechanisms avoid the impracticalities of the pure private property approach, while retaining the merits of decentralized market-driven policies."[12]

Unfortunately, this plan requires calculation of marginal environmental benefits, which governments have so far been unwilling to do. Thus, in the few instances in which a market-like approach has been tried, economists have recommended the approach of "efficiency without optimality,"[13] beginning with a political decision about the total amount of effluent to be allowed, with discharge permits issued for that amount. The Fox River (Wisconsin) experiment used this approach,[14] as did the sulfur-dioxide-trading provisions of the 1990 Clean Air Act Amendments.[15]

3.0 DIFFICULTIES OF THE STANDARD ECONOMIST'S APPROACH

Among the problems with the economist's solution are first, the political considerations will still set the level of discharges (under a private property approach, on the other hand, no central authority need be involved). The 1990 Clean Air Act Amendments set as a goal cutting sulfur emissions by 10 million tons annually. As Hahn notes, the target "was not based on scientific or economic grounds. It was selected because it was viewed as 'creditable'—that is, it was acceptable to Congress, the environmental community, and our Canadian neighbors."[16]

Second, and more generally, the process will inevitably become politicized, and in the process tend to destroy wealth. A firm or citizen may enhance its position by creating new wealth, or by laying claim to someone else's existing wealth. Examples of "transfer-seeking," or "rent-seeking" include lobbying for restrictions on potential new entrants, or encouraging regulations that harm one's competitor. Transfer-seeking tends to destroy wealth, not merely redistribute it, because the very pursuit of someone else's wealth requires lawyers, lobbyists, and other resources. Political management of a resource tends to reduce wealth creation and increase transfer-seeking. There is no reason to believe that transfer-seeking will stop because economists being to write the rules.[b]

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[b]Economists who argue for greater use of charges and permits are probably correct, however, that making the process more transparent would reduce the problem of hiding the size and incidence of control costs. Some of traditional special-interest opposition to simulated markets probably stems from the fear of public reaction if the costs of the current system were made visible.

Other political forces will continue to distort decisions. Politically preferred polluters such as state and local governments will continue to be held to less stringent standards and looser cleanup schedules. Priorities will continue to be set badly or not at all (e.g., Superfund, or the many "zero exposure" standards). And science will play a role only if it supports political decisions already made.[c]

Economists generally fail to recognize that the charge-and-permits approach has already been tried in another context. In the 1930s, recognizing the difficulty of operating an economy in the absence of prices, Oskar Lange and other socialist economists proposed that the state continue to set output targets, but then simulate a market by a system of computed prices and tradeable production quotas.[17] In this way, Lange and his colleagues hoped to achieve many of the efficiencies of market economy.

The free-market economist Friedrich Hayek countered by arguing that "market socialism" would fail for two reasons. First, as discussed above, political maneuvering and transfer-seeking will undermine attempts at efficiency. Second, the planning agency will not be able to get the information needed to set prices and quantities.[18] In retrospect, Hayek's argument seems particularly compelling now in the wake of the obvious failure of centrally planned economists worldwide.

Unfortunately, simulated markets for environmental amenities (the charges-and-permits approach) are merely market socialism in another context. Hayek's arguments against Lange apply just as well to effluent fees and permits as a remedy for pollution. Just as market socialism improved upon pure socialism, simulated markets for pollution improve upon current command-and-control regulations.[d] But problems unanticipated by mainstream economists of the time ultimately doomed market socialism in Yugoslavia and everywhere else it was tried. Simulated markets may encounter similar problems in the environmental bureaucracies of the OECD.[19]

The "market-failure" explanation rests on the neoclassical economic model of perfect completion. Absent from this model are information costs, negotiation, contracts, property rights, and even markets. Hayek instead had reached his insights by focusing on exactly these elements conveniently omitted from the standard model. Coase later pursued a related line of thinking with his view of the economy as a set of voluntary institutional structures adopted to facilitate the attainment of individual goals.[20] Buchanan and other of the Public Choice School have extended Hayek's criticism of market socialism and related policies, focusing on transfer-seeking (also called rent-seeking).[21] Even neoclassical economists turned during the 1970s to questions of incomplete or costly information.

Many economists fail to understand that private property rights themselves effectively address many environmental problems. For "common pool" resources, the discipline of the market encourages good stewardship. Political control of resources, on the other hand, weakens the incentives for stewardship by removing the decisionmaker from the consequences of his decisions.

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[c]The half-billion dollar NAPAP study evidently had little effect on Congressional decisions on the Acid Rain provisions of the Clean Air Act Amendments of 1990, with or without tradeable sulfur emissions rights.

[d]In defense of simulated markets, it must be repeated that these proposals promise a greater improvement over traditional command-and-control regulations. For example, there is good reason to be encouraged by the program now being designed at the South Coast Air Quality Management District in Los Angeles, for example, prompted by the Draconian penalties threatened by the Clean Air Act Amendments of 1990. The sulfur trading program written into the same act promises to save consumers roughly a billion dollars a year in compliance costs, although only a handful of trades have yet taken place. Yet 15 years after these ideas first gained wide currency in the public policy debate, examples of successfully implemented programs remain rate (see, e.g., R. Hahn and G. Hester, "Where Did All the Markets Go? An Analysis of EPA's Air Emissions Trading Program," Yale Journal on Regulation. Vol. 6, pp. 109-53. 1989.

Further, the protection afforded by property rights is self-initiating: as a resource becomes more valuable, the value to identifying and defending property rights increases as well. It is sometimes believed that pollution was not a problem before the industrial revolution with its accompanying increase in population density, and that after these developments, private property rights no longer addressed the problem of pollution. In fact, property rights to a resource need not be defined until the resource becomes valuable.[22] With increasing wealth and increasing population, greater attempts are made to assert and defend property rights, including the rights to clean water and other environmental amenities. For example, when rangeland could be claimed merely by filling a form (i.e., when its price was close to zero), settlers found it not worth their while to spend valuable time and money enclosing the range, or establishing firm legal rights to their claims. Similarly, clean water in the Chesapeake Bay is far more valuable now than it was 50 years ago; this rising value alone will encourage the definition and enforcement of private rights.

Third, the existence of property rights facilitates negotiation. The absence of property rights makes negotiation difficult and extreme solutions the rule. In economist's jargon, a Pareto improvement makes at least one person better off while making no one worse off. A potential Pareto improvement could potentially make at least one person better off without making anyone else worse off, perhaps by compensation from the winners to the losers. In a politicized system—as distinct from a system based on property rights—most potential Pareto improvements are never realized because no mechanism exists by which the gainers could compensate the losers.

Thus, the Sierra Club announced it would fight to the bitter end against opening the Arctic National Wildlife Refuge (ANWR) to oil exploration; no mechanism exists by which the oil companies could compensate those who might enjoy the ANWR environment for their perceived loss. By contrast, the Audubon Society has allowed limited drilling in the Rainey Wildlife Refuge which it owns, in exchange for royalty payments that allow it to extend its environmental mission.[23] Simulated markets for the environment would not remove this obstacle; they would leave no way for the affected parties to negotiate directly and make trades.

4.0 THE PROPERTY RIGHTS APPROACH TO A BETTER ENVIRONMENT

In many cases, private property rights already provide the right incentives to conserve resources (timber, ocean stocks of fish), or to avoid harmful discharges (angling rights to streams). In other cases, government action can encourage proper environmental management by recognizing, defining, or enforcing private property rights. When private property rights cannot be defined or enforced, the government can create regulatory tools (emission charges and permits) designed to work as much as possible like a market.

The private property approach applies most clearly in cases where the property right is easy to define, as with timber. In these cases, the resource is immobile, ownership can be clearly established, and detection of violations is relatively easy.

Water presents a more difficult problem than timber because it moves around, making property rights more difficult to define. Further, the large number of affected parties makes negotiation more difficult. (For the same reasons, water is a more difficult problem for the charges-and-permits approach or for the command-and-control approach.) On the other hand, water generally stays within its banks, unlike air, and point-source violators can often be identified. This makes it a potential candidate for the property rights approach. Protection of land- and water-dwelling wildlife also falls into this category of intermediate difficulty, as does trash and other solid waste.

Yet more difficult is air, because of the problems in defining property rights, and because of the problems of negotiations among affected parties.

Environmental organizations already address many of their goals through private ownership. Perhaps best known, the Nature Conservancy buys tracts it feels have environmental value. With the

organization's own resources at stake, incentives encourage good stewardship. The Nature Conservancy has even traded one parcel of land for another that is felt offered more benefit; in one case, it traded beachfront land in the Bahamas for forest land in Wisconsin—suggesting a careful balancing of all costs and benefits of the sort rarely found in ordinary rulemaking.

In many instances, private ownership can reduce pressures on wildlife—at the expense of private interests rather than the taxpayer. In the U.S., private zoos and game parks have been so successful at breeding large cats—all of which are endangered—that they have attempted to ship excess young lions back to Africa.

Conservation groups have used property ownership to protect offshore marine life as well. In Scotland, the Atlantic Salmon Conservation Trust has bought netting rights. In Iceland, private interests have indicated interest in buying rights to the Greenland and Faroe fisheries and shutting them down.[24] A small California company devised profitable methods for raising abalone without harming their major predator, the endangered sea otter (unfortunately, zealous state regulators in effect shut down the company; it has now relocated to Hawaii). Private sea farming accounts for a growing share of the salmon catch in Maine and Oregon, although cumbersome regulations and uncertainty about property rights continues to hamper U.S. mariculture. The industry is larger, more stable, and more profitable in Scotland and Norway, fostered by a long tradition of private rights to fisheries.

Private sanctuaries have preserved, endangered, or threatened species of birds. Peregrine falcons, once endangered, have made a dramatic resurgence because of the efforts of the private Peregrine Fund. The organization breeds falcons in captivity then reintroduces them into the wild. The private Hawk Mountain Sanctuary Association in Pennsylvania first stabilized and has now greatly expanded the population of hawks and other birds of prey. The private, nonprofit Ducks Unlimited maintains 4 million acres of wetlands as habitat for waterfowl, fish, and mammals.[e]

Further progress in designing private property solutions will come as the parties involved in both sides gain experience with the approach. With only a dozen or so professionals in the world working to devise private property solutions for environmental management (as against tens of thousands working on conventional approaches), it should come as no surprise that most analysis has focused on the conventional approaches.

One promising area of technical innovation that will encourage private property solutions concerns detection of violations (these innovations could also aid enforcement of effluent charges, permits, or traditional command-and-control rules). Tracers (odorants, coloring agents, isotopes) could be used to identify sources of pollution. Nations might adopt a national fingerprinting system to mark the nation and even the firm discharging pollutants. It should be noted that tracers are already in limited use in other contexts. By using radioisotopes to label power plant emissions, researchers identified sources contributing to impaired visibility at the Grand Canyon. As part of the international anti-terrorist campaign, most nations already label high explosives made within their borders.[25] Similarly, tracers of various sorts could identify sources of discharges into rivers and lakes.

Governments can also encourage private firms and citizens to pursue the property rights approach by removing obstacles caused by existing government policies. Market reforms could reduce environmental problems stemming from existing anti-maker policies. For example, 30% of all delivered water in the West comes from federal projects, which charge on average only 15% of the true cost for this water. Besides wasting labor and capital, the subsidies have brought marginal farmland into production, and increased the toxic runoff from agricultural chemicals.[26]

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[e]These and other examples of the private property approach to species conservation can be found in R.J. Smith, "Private Solutions to Conservation Problems," in Tyle Cowen, ed., Public Goods and Market Failures: A Critical Examination. New Brunswick, N.J. Transaction Publishers). pp. 341-360, 1992.

Second, states could reverse the century-long trend toward weakening riparian rights, and could encourage fishing clubs to seek title to fishing rights in rivers, lakes, and bays. Stroup has suggested other steps by which states could strengthen property rights, sometimes by limited interventions. States could reaffirm common law through statutes in the relevant areas. They could require branding of potential pollutants. They could reclaim regulatory responsibility previously ceded to the federal government. They could ensure financial responsibility by allowing insurance and bonding.[27] All these suggestions have application to water quality.

"Why is there litter in the public park, but no litter in my back garden?" asked economist Joan Robinson many years ago. Federal and state governments should remember the advantages of private property as a path to environmental management, including water quality. In the coming debates over the future of water regulation, stronger rights of private ownership may offer advantages not found in the conventional economist's approach of simulated markers.

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Implementing Market-Based Instruments For Clean Water in America

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ABSTRACT

American water quality policy does not prohibit the use of market-based instruments. Without explicit Congressional authorization of such instruments, however, many opportunities for both economic and water quality-related gains will not be realized. The Clean Water Act and an array of other federal statutes must contain clear language ordering the active design and implementation of markets for discharge permits, federal water rights, and other instruments affecting water quality.

There is an array of difficult technical, institutional, and legal issues to be resolved in implementing these markets. While these issues are often cited as reasons why market-based systems would not work, they are not insurmountable. Congress can order the Environmental Protection Agency and related agencies, with public consultation, to resolve them. The alternative—continuing the existing underfunded reliance on state and federal command-based water programs, public subsidies, and litigation—is increasingly unproductive and ineffective. The EPA and other responsible federal agencies need a market-based mandate to achieve water quality goals in the 1990s and beyond.

The first step toward making such a mandate politically feasible is probably underway already—declining federal funding will require local and regional entities to underwrite water quality improvements and protection themselves. The environmental gains, cost savings, and innovation associated with market-based systems should, therefore, become attractive to many current skeptics of shifts from command- to market-based approaches. Whether or not this will manifest itself in the political milieu of the next Congress, or in a subsequent one, will be determined by economic and environmental conditions in America's river basin communities during the next few years.

1.0 INTRODUCTION

As America embarks upon its third decade under federal clean water legislation, the weaknesses of existing water quality policies have become evident. The basic problem is that achieving the many economic benefits of improved water quality and related environmental values requires substantial changes in water use throughout the country. But this will not happen until water quality targets are linked to water uses, and major funding is directed toward financing changes in these uses. With prospects of substantial government funding fading each year, market-based instruments to achieve water quality goals offer the only alternative which can provide economic incentives to control water pollution, finance clean water programs, and reduce regulatory burdens on both government agencies and water-using industries.

The future of water quality policy lies in two major areas where changes from past policies are imperative. First, it is time to adopt goals or targets which are based on actual *performance* in terms of aquatic ecosystem functions and human health. Performance goals for water quality policy is not a new concept. In 1972, Congress had general performance goals in mind with its setting of "fishable and swimmable" at 1985 targets for the nation's waterways. Failure to achieve these goals is a reflection more of the failure to implement specific objectives which reflect these goals than on the feasibility of the goals. A key component of this specificity is the defining of what water-using entities' rights are to use aquatic ecosystems both for supplies of fresh water and for assimilation and dispersion of polluted discharges. And

once defined, monitoring and enforcement of the terms of these rights—tasks which have been notoriously neglected in the past—must become priorities.

Second, we need to develop and encourage businesslike means of achieving these objectives. This means clarifying the rules, and maximizing the flexibility, for *how* and *what* changes in water use occur. Let science, together with the political process, determine sound and acceptable objectives, and the water-using industries decide how to operate within the constraints presented by water quality objectives. Create markets for water use and pollution discharge rights, and finance environmental trust funds for acquisitions and revolving funds for loans from water use and pollution discharge fees. The reauthorization of the Clean Water Act, in order to be effective, will need to explicitly authorize and require the establishment of explicit water quality and environmental goals for each water body in which significant deterioration is occurring. To actually reach these goals, the Act will also need to require the use of market-based incentives.

2.0 THE KEY CHOICE OF ECONOMIC INSTRUMENTS: FEES VS. TRADING

Should government set prices for water resources, or should markets for these resources determine their economic value? Given the array of government agencies and government-chartered monopolies and monopsonies which continue to set prices for water supplies and pollution discharges, the opportunities to let markets set prices may be limited. In considering the use of economic incentives to achieve clean water and other environmental goals, however, the ability of existing institutional arrangements to perform must be considered. The key policy issue is whether government actions should concentrate on clarifying the goals themselves, and making them operational through systems of water use and discharge allowances, or on the administering of prices to use water resources.

The current system features administrated price-setting along with large uncertainties concerning water use allowances. This price administration, which occurs at federal, state, and water district and utility levels, continues to feature some, albeit declining, taxpayer subsidies which further distort use incentives. Water depleting and degrading activities are currently subsidized directly by government spending programs and indirectly by deductions, allowances, and credits. Further, most water supply and pollution discharge prices are set by government agencies or by state-chartered monopolies such as water districts. Such agencies, which often control water storage and delivery facilities, set prices according to average costs—a "cost-plus" ratemaking essentially allows the agency to recover its fixed and variable costs and avoid "excess revenues," which are frequently disallowed by state laws. The discrepancy of prices derived from these procedures from those which a market would signal is compounded in the case of federally developed irrigation water supplies. These reclamation contract prices omit the interest costs of the debt incurred to construct the water supply facilities. In addition, it is still common for some water supply entities, such as irrigation districts, to bill for service based on some criterion other than quantity of water consumed. Flat rate and acreage-served assessments are examples. Many sewage treatment and other pollution discharging entities have also received public subsidies in the past which have allowed their rates to be correspondingly lower. Most pollution discharge entities bill their customers on a nonquantity basis, usually a flat service fee set by customer class. No effects on quantities of water use or pollution discharge result from such nonquantity-based administered prices.

Attempts to make administered water prices and fees reduce water quality degradation would require an array of reforms. Overcoming the difficult technical and political obstacles to marginal cost-based pricing would be imperative. Extensive oversight of the ratemaking of water agencies and monopolies, as is the practice in electric utility regulation, would be necessary. Public subsidies would not be permitted in the determination of prices, since the resulting reduction in prices encourages water use and pollution. All pricing would be based on quantity of use, requiring metering and/or monitoring of both water supplies and effluent discharges.

Of critical importance is the uncertainty of use response to fees—the "price elasticity of demand" for both water supplies and pollution discharges may be "inelastic," so that fee increases will not

yield proportional reductions in use of discharges. Price elasticity estimates for water uses in the United States are displayed in Table 1.

Table 1[a]
Price Elasticity of Demand for Water Estimates: Average for the United States

Water Use/Season	Low	High
Residential/Winter	0.00	-0.10
Residential/Summer	-0.50	-0.60
Commercial/Industrial	-0.50	-0.80

Equivalent estimates for pollution discharges are not widely available in part because most existing discharges are neither priced nor metered (quantitatively or qualitatively). The presumption that discharges would be inelastic with respect to discharge fees has two implications for clean water policy. First, attempts to use administered fees or discharge prices as incentives to reduce discharges would probably require increases in the levels of these fees which would not be politically acceptable. Second, on the other hand, the probable unresponsiveness of discharges to fee level increases is countered by the relative certainty of the ability to generate revenues from discharge fees. This is discussed in more detail in the section on financing an environmental trust fund below.

Government-administered pricing is an issue for a number of commodities, the production of which depend heavily on water resources as an input and as a means of disposal. Agricultural commodity price supports, leases of timber rights on public lands, permits to graze livestock on public lands, and shipping, flood control, and hydroelectric production from facilities constructed and/or operated in part by public funds are examples. These kinds of programs tend to inflate net projects above those that would occur under market conditions for products and inputs. Therefore, they encourage overproduction and consequent overuse and depletion of water supplies and quality. Removal of subsidies together with the introduction of market instruments to price the right to use these resources would help to reduce water pollution. The extent of the reform agenda necessary to do this is indicated in the accompanying Figure 1, which examines existing pricing and tradeability among key water and related natural resources in the Pacific Northwest. An equivalent inventory of natural resource pricing

ENVIRONMENTAL COMMODITIES OF PACIFIC NORTHWEST WATERSHEDS

RESOURCE USE INSTRUMENTS	U.S & STATE LAWS		INTERNATIONAL AGREEMENTS
Water Rights/Contracts	RESTRICTED	* #	No
Water Pollution Permits	NO	* #	No
Hydropower Contracts	RESTRICTED	#~	Restricted
Power Transmission Access	RESTRICTED	~	No
Timber Rights/Leases	RESTRICTED	* #	No
Fish Harvest Quota	NO	#	No
CO2 Offsets	NO		No
Grazing Rights/Leases	NO	#	No
Inland Shipping Rights	NO	* #	No
Flood Control Entitlements	NO	* #	No
Land Development Rights	RESTRICTED	*	No

Government Subsidies: * = Funding # = Resource Access ~ = Carry Debt

Figure 1

[a]"Consensus Estimates for U.S.," Table VII-7, p. 137, in Planning and Management Consultants, Ltd., The Regional Urban Water Management Plan for the Metropolitan Water District of Southern California, Los Angeles. November 1990.

policies for other regions of the United States would reveal the same situation in general since federal policies govern the allocation of many of these resources.

3.0 SETTING BASIN- AND RIVER SEGMENT-SPECIFIC POLLUTANT LOADING CEILINGS

The necessary condition that loading ceilings be established which are specific to individual pollutants and basin segments requires the setting of performance criteria based on beneficial uses. Procedures to set "total maximum daily loads" (TMDLs) for non-attainment water sources exist. However, TMDLs have rarely been set, usually in response to crisis water pollution problems or to litigation. In order to achieve performance goals in terms of water quality and related ecosystem functioning, such loading ceilings will need to be established on a broad basis. TMDLs are the sum of waste loads from all sources—point and nonpoint—and establish the supply of discharge allowances for each pollutant in each basin or river segment.

The establishment of pollutant loading ceilings is within existing authorities under the Clean Water Act to avoid impairment of other water uses. Section 303(d) authorized EPA to establish guidelines for setting TMDLs in water quality-limited water bodies.[1] TMDLs are intended to make water body-specific environmental goals operational by defining these goals in terms of pollutant loading limits. Their establishment is necessary regardless of whether or not economic incentives are applied to achieve them. Similarly, allocation of TMDLs among a water body's pollution sources is necessary with or without economic incentives. However, waste load allocations may need to be structured somewhat differently depending upon whether or not trading waste load shares are allowed. For those dischargers which may be purchasing shares, and therefore increasing loadings at particular discharge points (in exchange for reduced loadings at other (seller) points), the possibility of local and third party effects will need to be considered. The existing processes embedded in many state water laws which require third party reviews of proposed water rights transfers provide valuable experience for clean water policies incorporating possible trading of pollutant discharge allowances. The variety of experience among states with alternative waste load allocation methods is also important in assessing how best to design allowances for tradeable loading shares according to local assimilative capacity limits.[2]

4.0 MARKETS FOR WATER POLLUTION DISCHARGE ALLOWANCES

Clarifying who is allowed to discharge what and where by setting TMDLs and allocating discharge allowances creates the possibility of achieving the environmental goals underlying TMDLs with tradeable discharge allowances, more commonly referred to as tradeable discharge permits (TDP). A system of TDPs would not only reduce the burden of price administration from government, but it would also create an incentive among dischargers to assure that compliance with the terms of discharge permits is occurring.

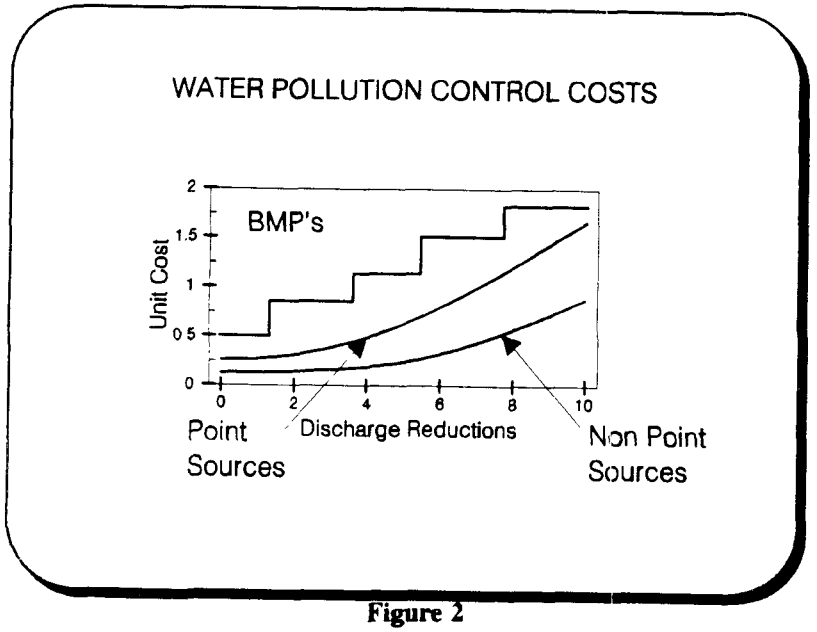

Figure 2

The existing NPDES point source permitting system has adopted technology-based treatment standards for

"traditional" pollutants such as BOD, suspended solids, and biologicals. But the performance of these standards, featuring "best available technology" (BAT), in improving water quality and beneficial uses has not been linked directly to permit issuance or renewal. TDPs, which *require* loading ceilings based on ecosystem performance criteria, would provide greater certainty of environmental performance for less money. Because permits or allowances would have value not only for regulatory compliance purposes but also in TDP markets, incentives to reduce loadings and sell freed up allowances would exist. Each discharging entity is free to reduce loads in a least-cost manner, and will do so to the extent that the cost of such reductions are less than the cost of buying discharge permits. The cost curves for discharge reductions in Figure 2 demonstrate cost differentials among dischargers which are likely to be present in many water bodies.

The NPDES permit system provides a starting point from which the benefits of TDPs can be developed. While over 85% of industrial point sources are in compliance with their permit conditions and 90% of municipal point sources have installed secondary or greater treatment, there continues to be heavy pollution loading and frequent violations of ambient water quality standards in many basins. The problem is not that the point source dischargers have not made significant improvements in the quality of their discharged effluent. Instead, the problem is that there continues to be substantial growth in the volume of loadings from municipal and industrial sources in many of the nation's watersheds which will continue to place heavier demands on treatment facilities and consequent loadings. In some basins, tertiary treatment is necessary to accommodate additional urban and industrial discharges.

TDPs have been proposed by Congressional leaders, and water quality control programs based on economic incentives and some trading have been utilized in Europe. A number of studies of trading potentials among point sources have been undertaken in recent years in the U.S. All indicate significant cost savings to achieve loading limitations.[3] Extensive pilot studies and projects involving potential trading between point and nonpoint sources of water pollution have been implemented in the Great Lakes Basin, Tennessee, and Colorado. While these studies have concentrated on nutrient and biological oxygen demand (although one focused on oil and grease and another lead), there is a variety of other trading possibilities as indicated by the array of pollutants contributing to non-attainment as shown in Figure 3. Indeed, the variety of pollutants in conjunction with the variety of sources contributors to non-attainment among industrial and municipal point sources and nonpoint sources.[4]

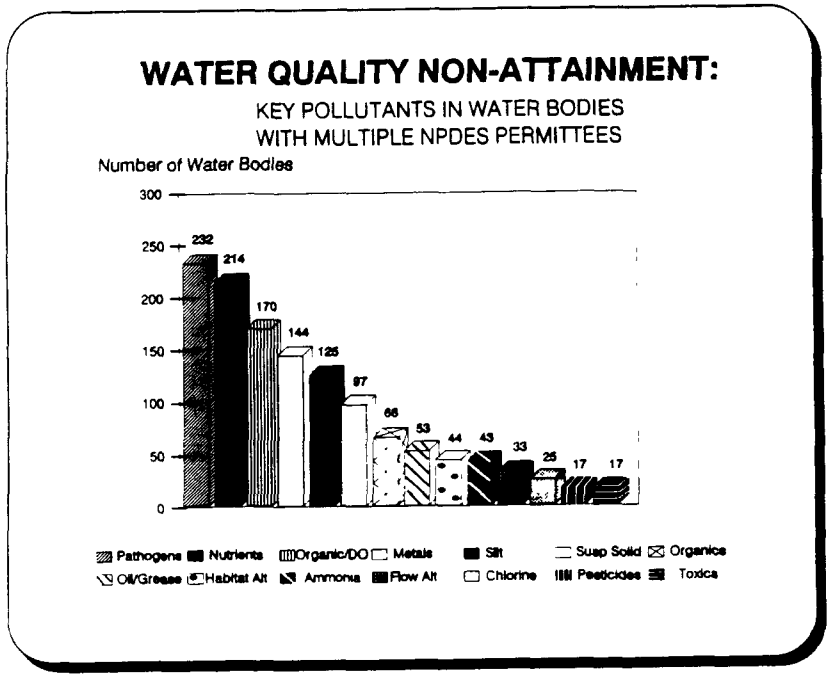

Figure 3

5.0 THE SPECIAL PROBLEM OF THE NONPOINT SOURCES

Nonpoint sources discharge substantial pollutant loadings from vast tracts of land containing diverse and dispersed nonpoint sources in agriculture, livestock, forestry, mining, septic tanks, atmospheric deposition, and urban storm runoff. But these discharges have yet to be regulated by permitting or other

systems which codify the terms under which they discharge. Nutrients, trace elements, salinity, pesticides, hydrocarbons, acidity, and heavy metals are significant pollutants for particular types of NPSs and regions. During the past 15 years, the federal government has expended considerable financial resources to identify and subsidize the implementation of various types of best management practices in some NPS industries. While uncertainty continues as to how much water quality improvement results from the implementation of BMPs in site-specific situations, it is the lack of credible systems of financing and enforcing that implementation that is preventing major new, cost-effective gains in reductions in NPS pollutant loading.

It has long been recognized that issuance of individual discharge permits to the NPSs is not feasible given their large numbers and diversity. Nevertheless, in order to control the NPSs in a way that is compatible with the existing NPDES system for point sources, *some* system is required. Larger geographical units would have to be the recipients of individual permits. The need to create institutions which could govern NPS areas with respect to water pollution has been recognized for some time. There are several types of organizations that manage water and water-related resources which might be adapted to the NPS governance task. Irrigation and drainage districts, soil conservation districts, resource conservation districts, urban storm districts, and land and water trusts are examples. Internal allocation of discharge rights within these units could then proceed in a variety of ways. Governance of these units, based on their charter and the preferences of landowners and other discharging entities, would determine how to implement the terms of the permits.

Section 319(a)(4) of the 1987 amendments to the Clean Water Act states that nonpoint source pollutant management should "to the maximum extent practicable develop programs on a watershed-by-watershed basis." The Act does not specify what type of implementation program is necessary—this is the state's responsibility. A watershed basis, which involves multiple sources of pollutants, holds the possibility of pollutant trading programs. Trading NPS allowances requires a legally binding system, probably in the form of discharge permits. While NPS permitting is not required under the existing provisions of the Clean Water Act, several states have begun to experiment with programs which are aimed at permitting discharges from NPS sectors. Florida, Pennsylvania, Nebraska, and Maryland have programs which have used the "back door" to NPS permitting. For example, the South Florida Water Management District was authorized by the state's legislature to control agricultural runoff through permit systems for consumptive use and for surface storage of water. Since both have water quality implications, the District has incorporated water quality concerns into the terms and conditions of those permits. In Pennsylvania, state laws on erosion control and clean streams have been applied to require conservation plans for agricultural and forestry operations which demonstrate how sedimentation will be controlled. In Nebraska, where fertilizer contamination of groundwater is a major problem, seasonal prohibitions of fertilizer applications in some areas of high percolation and subsurface nitrite concentrations have been applied.

These programs can be viewed as experiments in NPS permitting. Other states and regions are struggling with the same problem—the need to develop accountability among NPSs stemming from the growing evidence of consequent damages to downbasin water uses and values. Without such accountability, any serious policy of control of NPS pollution is difficult to envision. Certainly obtaining the contractual assurances needed to implement voluntary trading of pollutant loading rights among dischargers will continue to be practically impossible. Indeed, loading discharge compliances, reduction credits, or offsets—whether for regulatory or market-based uses—must be defined, monitored, and enforced if *any* system of NPS control is to produce real results.

Opportunities for trade among NPSs reiterates the need for accountability. For example, in California's San Joaquin River Basin, selenium loading from irrigation drainage poses bioaccumulation risks to fish and wildlife. In 1985, waterfowl populations at Kesterson Wildlife Refuge, which received irrigation drainage, experienced reduced reproduction rates and birth deformities. In order to implement a loading ceiling on selenium in the San Joaquin River, associated wetlands, and downstream estuarine systems, NPS selenium loadings units must be identified and accountability assigned. While there are some potentials for NPSs, particularly in downstream refinery operations, to participate in selenium discharge trades, most of the

opportunities may be among the NPSs themselves. That is, variations in farming and irrigation practices within the San Joaquin River Basin contain opportunities for some irrigated areas to invest in others to develop lower cost selenium reduction credits. But such transactions would not be possible unless water quality regulators have some sort of loading rights established and allocated among the NPSs. Institutions, such as drainage districts, to represent NPS areas will have to be formed.

Another important opportunity for the trading of loading rights exists among discharges into POTWs. Nondomestic wastewater from industrial sources often contains toxins which can interrupt POTW operations (typically not designed to treat many toxins, which can kill biological agents used in municipal sludge treatment). In addition, contamination of sludge as well as receiving waters can result from these toxic discharges. In order to address these problems, nearly 1,500 POTWs have pretreatment programs that regulate about 30,000 significant industrial users (SIUs). Each program issues loading rights to SIUs, usually in the form of a permit, as well as monitor, inspect, and enforce. TDPs are possible where a number of SIUs are linked to a POTW. Of particular interest here is the potential to increase funding for toxic source reduction programs and facilities among the SIUs.

6.0 MARKETS FOR WATER USE RIGHTS

Tradeability of pollution loading rights creates new opportunities associated with reduced quantitative use of water. For example, a key BMP for reduction of irrigation-induced loads is the reduction in amounts of water applied. Similarly, water conserving measures in municipal and industrial water uses have pollution load reducing impacts. Whether from more efficient use of water through installation of water conservation hardware for irrigation, industrial, and home uses; improvement of irrigation management practices, changes in cropping patterns, or outright removal of some lands from irrigated production; or adoption of arid designs for urban landscaping, reduced water diversions tend to yield reduced loads for many pollutants. Thus, various types of projects and programs designed to reduce water use would be obvious candidates for financing from trades in loading rights.

Complementary, and in some regions more powerful, economic incentives for reduction of pollutant loadings are possible if water supplies freed up as a result have significant resell or market value. Important policy experiments are now underway in many western states to create, facilitate, and regulate markets for quantitative rights to use water resources. Indeed, as water supply constraints develop in states east of the Mississippi, some of these states are examining the potentials and problems of water markets in the West. Relevant local, state, and federal water laws must be considered.

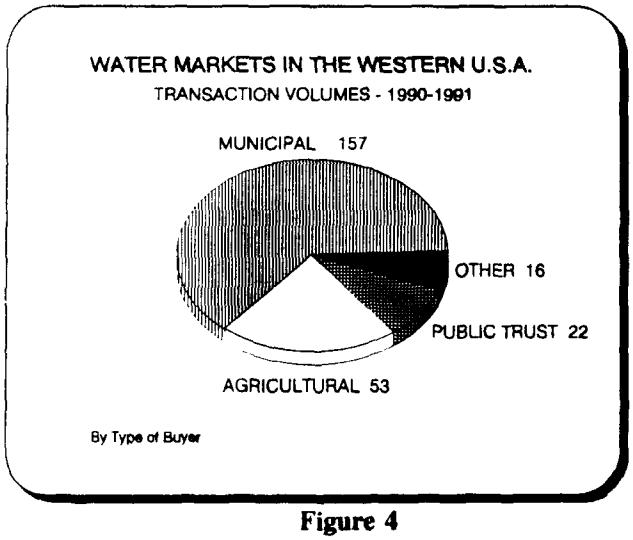

Figure 4

The prior appropriations doctrine underlying water rights in state laws is based on usufructuary principles. The emergence of limited water markets in the western U.S. during the past decade has been due to the simultaneous occurrence of (1) substantial supplies of water rights being applied to low-valued uses in agriculture, and (2) growing urban and environmental demands resulting from the region's demographic and economic growth. Arbitrage potentials—the difference between prices for irrigation water and those for municipal and industrial uses—are substantial in many regions, often exceeding an order of magnitude. Such arbitrage potentials exist for environmental purchasers as well, though typically with

lower margins. Figure 4[b] shows the volume of water marketing transactions in recent years in the western U.S. by buyer classification.

Water market prices often provide considerable latitude for water users such as irrigators to invest in improved systems and practices, which in turn would have NPS load-reducing results. At the same time, the costs of many water conservation practices and systems exceed water prices, which are most often administered by government agencies or by water districts or utilities to meet revenue requirements, not to induce efficient use. While there are frequently other reasons (such as agricultural yield improvements) for improving water use practices, in many cases the value of conserved water in reduced water costs does not cover the costs of investments in water conservation. Income from water sales and leases by holders of water use rights could be coupled with financing from NPS load reduction credits to underwrite many additional improvements in water use systems. Figure 5 lists the types of water market transactions which have been occurring in the western states.

But the evolution of water markets faces formidable legal uncertainties and political barriers in many states. Ambiguous definitions of "beneficial and reasonable use" of water in state laws have generally not been clarified by regulation to facilitate orderly trading. Basin-wide adjudications are underway in many regions, and trading in many regions, and trading in the midst of these legal uncertainties can be risky. Further ambiguities about who holds the rights to trade water—end-users such as irrigators, or intermediaries such as water districts—can make it unclear to potential buyers who the seller would be. These uncertainties are being heightened by an array of possibly conflicting claims based on the public trust doctrine, Indian water rights, and third party claims, including possible "area-of-origin" environmental, economic, and community effects. Groundwater pumping from common property (unadjudicated) aquifers is also a problem in some water market transactions.

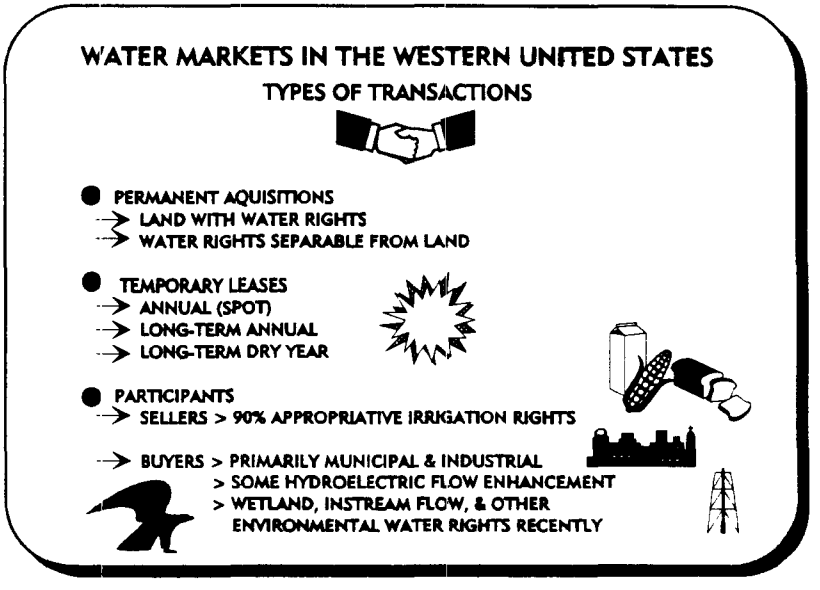

Figure 5

Figure 6 lists the most common types of institutional barriers being encountered in western states' attempts to both facilitate and to regulate water markets. These problems have slowed the development of water markets. Since state water laws were not originally intended to support transfers, most states are engaged in expensive and time-consuming reforms and litigation to define the rule within which water markets will operate. The information in Figures 7 and 8[c] demonstrate the level of legislative and court action in recent years related to water rights definitions and transferability. Federal reclamation water supply projects are also slowly being reformed to allow transfers of water contracts. A process to certify the

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[b]Compiled from data published in R.T. Smith and R. Vaughan, Water Strategist, Stratceon, Inc., Claremont, California, various issues. 1987-1992.

[c]Compiled from data published in R.T. Smith and R. Vaughan, Water Strategist, Stratceon, Inc., Claremont, California, various issues. 1987-1992.

Figure 6

regard to control and allocation of pollution discharge allowances.

NPS pollution reduction benefits of such transfers would undoubtedly broaden the incentives to participate in water markets.

The experience of the western states with water markets has important implications for implementation of TDPs. Much of the current conflict stems from a lack of clarity in defining water rights; poor measurement and monitoring, and enforcement of the terms of these rights; and administered pricing systems which undervalued the increasingly scarce resource. Federal clean water legislation should avoid, or at least mitigate, these pitfalls with

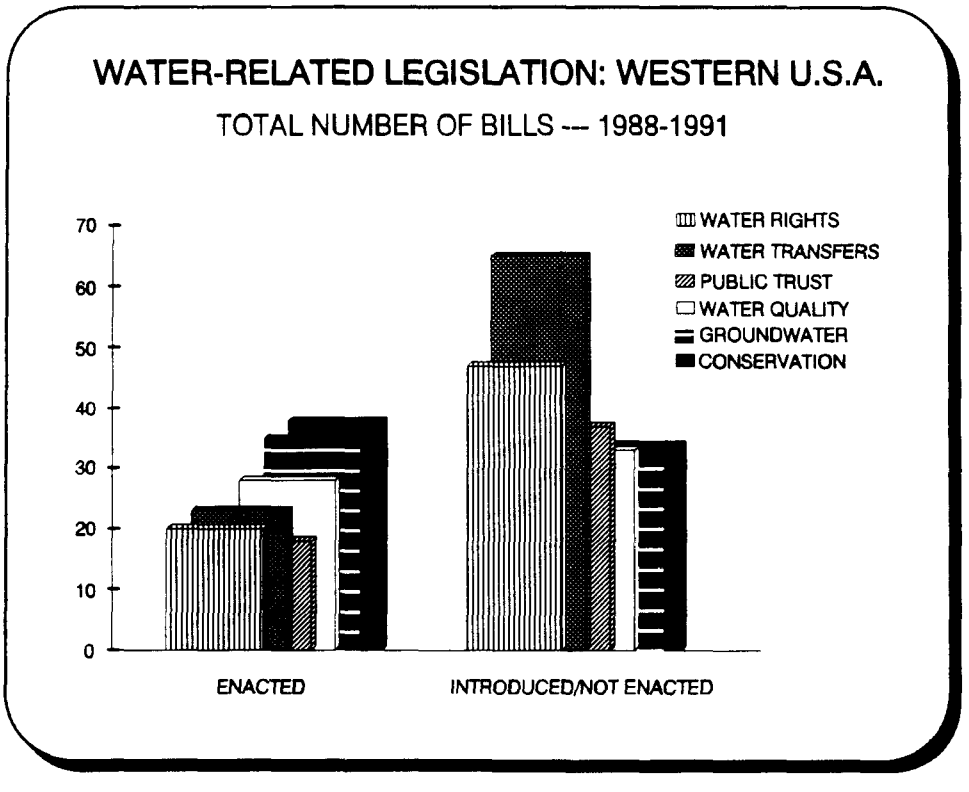

Figure 7

7.0 ESTABLISH AND FINANCE ENVIRONMENTAL TRUST FUNDS FROM WATER USE AND POLLUTION FEES

Reform of water use and pollution discharge pricing, along with implementation of markets for water rights and TDPs, would provide powerful incentives for conservation and pollution discharge reduction in both the public and private sectors. Arbitrage opportunities among holders of water rights and discharge permits would ensure that substantial financial resources would be unlocked to implement water quality improvements. However, there would continue to be cases in which further environmental improvement and restoration may be productive. Acquisitions of both water quantity rights as well as further reductions in pollution loads may be necessary to achieve clean water and environmental goals within many river basins. With public funding for all programs on the decline, substantive legislative appropriations for such acquisitions may not be forthcoming. For example, the 1987 Clean Water Act Amendments substantially increased water quality-related responsibilities for state and federal agencies, but corresponding funding has not materialized. Funding in the FY93 environmental budget continues to fall far short of what would be necessary to meet these agency responsibilities. Alternative funding sources will be needed to supplement the financing generated by water rights and TDP markets.

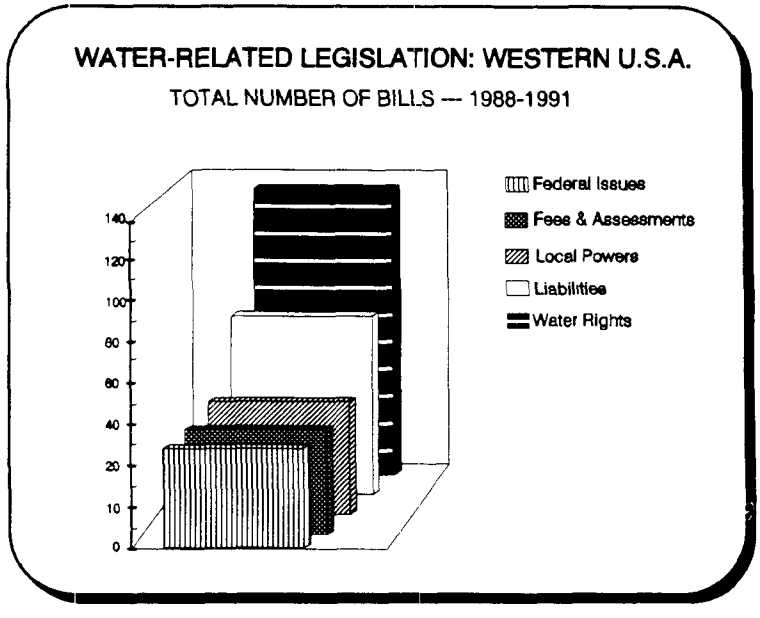

Figure 8

The most efficient and equitable means of generating this funding is through user-based financing. The simple principle is that those who use water resources should pay. There are two general groups of users—those who use water at the expense of the environment, and those who use water as an environmental resource. The schematic in Figure 9 illustrates how these user fees would interface with a trust fund, which in turn could be applied to direct acquisitions of rights to use water resources—both quantitatively and qualitatively—to meet clean water and environmental goals.

The first group is relatively easy to identify—it includes all water-using and polluting industries, including municipal utilities serving residences. Since these users divert, consume, and pollute, an environmental surcharge or fee for their use could generate revenues. There are already a variety of fees in 26 states, including for water use permits, waste disposal, underground storage, and other uses. In addition, Section 204(b)(1) of the Clean Water Act requires the development of user charge systems with the option of recovering operation and maintenance costs as wastewater treatment facilities. Further amendments to the Act could expand user charge systems to recover costs of water quality degradation and of environmental protection and restoration.

The design of a fee schedule for these users would not be as simple as the overreaching principle. For water quantity, most regulatory authority rests in state water law, although federal water agencies could implement fees for their water supply contractors—included would be reclamation contractors as "direct" users, and inland shipping, hydroelectric, grazing, timber, mining, and agricultural commodities producers as "indirect" users. Most water diversion and consumption, however, is governed by state laws and

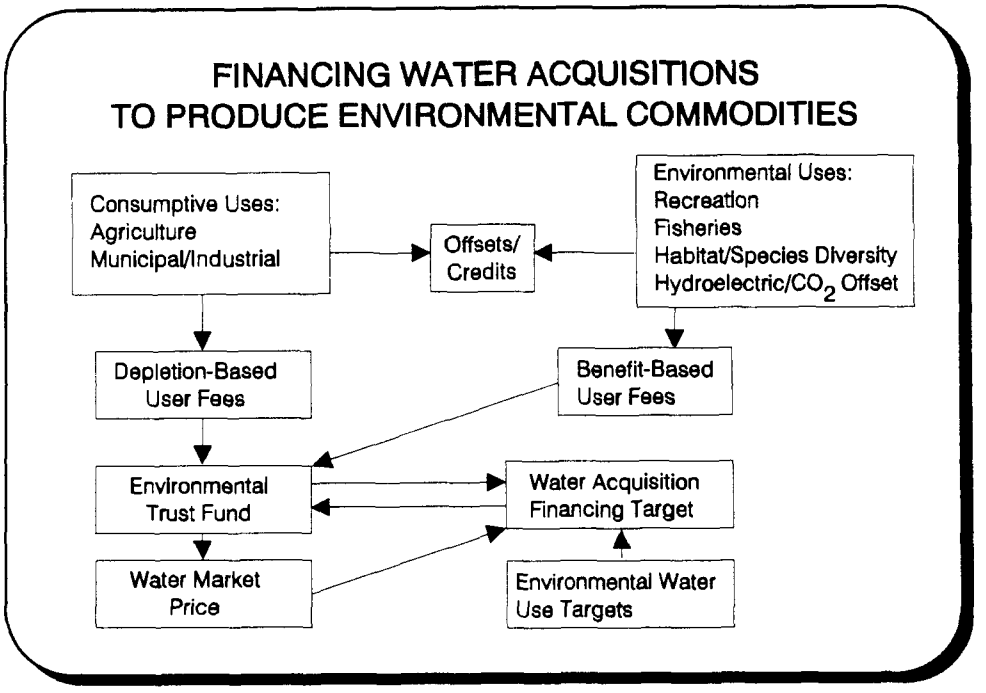

Figure 9

imposition of fees on such uses would require state actions. On the other hand, fees for pollution discharges could be implemented under the Clean Water Act in all states, under individual state laws, or combinations of both.[5] In the never ending federal-state sparring on funding of federal water quality and other environmental programs, federal demands for state cost-sharing could be answered at least in part by revenues generated from such water diversion, consumption, and pollution discharge fees.

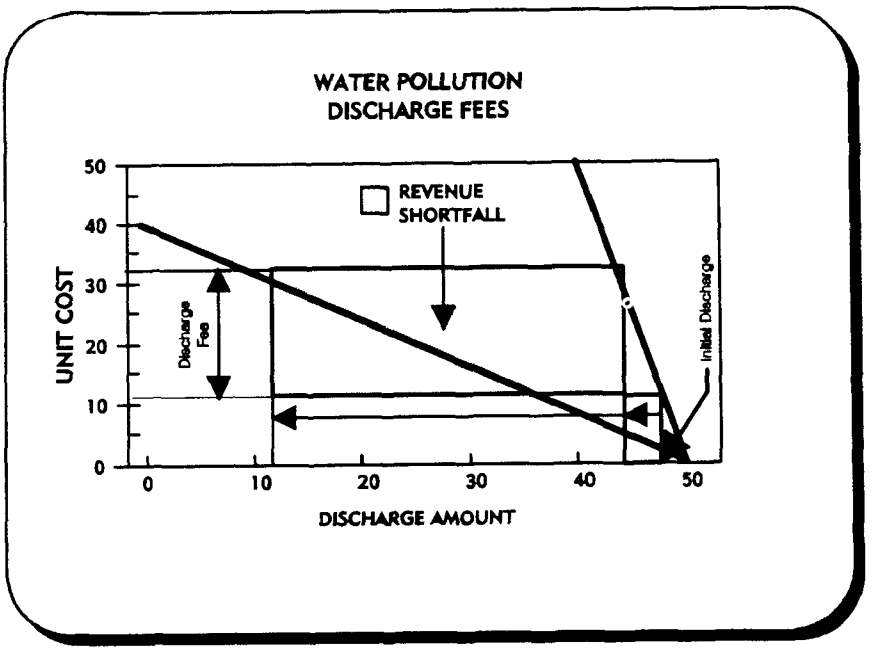

Figure 10

Such fees would be sized to a basin-wide or regional revenue target for environmental acquisitions. The graph in Figure 10 demonstrates the uncertainties of response to such fees with regard to both discharge reductions and revenues generated from fees. As noted earlier, "inelastic" responses are expected, making it difficult to use fees as a means of actually reducing discharges. On the other hand, this situation reduces the uncertainty of revenue generation associated with any fee schedule which might be imposed. To the extent that discharge levels respond to fee increases, revenue shortfalls can be expected when compared to those associated with lower

responses of discharge levels. This situation works in favor of viable environmental trust fund programs, since revenue needs fall in some proportion to reductions in discharges. The actual specification of fee characteristics would depend upon several factors. To be rational, fees would vary according to the water quality degradation and other environmental damages associated with the use. For water quantity, amount, timing, and location of diversion and consumption, along with the water quality and other environmental consequences of that use, would be the key factors. For water quality, these same considerations would need to be applied to significant discharges of individual pollutants. Mass loading and effects on beneficial uses within receiving waters would need to be considered in discharge fee specifications as well. There are substantial measurement requirements to incorporate these kinds of factors into fee design. As noted above, many consumption uses as well as pollution discharges are not now measured either for volumes or quality. Therefore, substantial measurement and monitoring improvements will be necessary. In the interim, fees based on customer classes may be the most practical means of implementation since they would not require as much user-specific information.

The other group of water users are those associated with environmental and recreational values. These uses require water quantity and quality to maintain aquatic ecosystems and associated beneficial uses. Establishment of fees for these groups is a very different matter from that for the consumptive use and polluting users. Instead of damages to the resource, benefits from its protection is the key. This is a more difficult undertaking in large part because environmental and recreational users tend to be harder to identify and measure. A portion, particularly recreational users such as boaters, fishers, and campers, are already charged for their use through day-use fees, licenses, and other instruments. A water quality or environmental protection fee could be included. But many users do not access water sources through organized charge systems, allowing the so-called "free-rider" problem (some beneficiaries do not pay) to continue. "Non-market" valuation studies and surveys are increasingly being undertaken to estimate benefits to such users, including those who do not directly use the resource but value its existence anyway. This type of research might be useful in helping to design a user fee system for these "non-captured" environmental and recreational users.

The setting of such fees should be based as much as possible on technical criteria. But it is also an inherently political process in which all stakeholders—water using and polluting industries, environmental and water quality interests, and local, state, and federal agencies—will seek minimum fees and maximum benefits. Regardless of how the pie gets sliced, environmental trust funds can be created to manage and disperse these revenues for water quality and environmental improvement projects. Priority systems will be needed, and trade-offs among potential projects will need to be addressed in some fashion. Both technical and political factors will be important, but competitive bidding procedures should be fundamental to disposition of these funds. In addition, a portion of fee revenues may be applied to the endowment of revolving loan funds which can leverage additional water quality and environmental investments. Finally, the use of a private entity to manage such a trust fund has been proposed,[6] and deserves serious consideration.

8.0 REVISIONS IN THE CLEAN WATER ACT—ENVIRONMENTAL PERFORMANCE AT LEAST COST

There are a number of sections in the Clean Water Act which should be revised to pursue the achievement of environmental and water quality goals within a framework of flexibility, innovation, and least cost. Section 101, which declares goals and policy, could be revised to state that CWA policy is to achieve actual environmental performance by setting clear pollution loading and water quality goals by basin, sub-basin, and river segment, where appropriate. It could also be revised to reflect a policy promoting the use of economic incentives as the preferred implementing instrument, and endorsing TDPs as the preferred economic instrument. Since identifications of basins which are in non-attainment status have been made in reports completed under Sections 304, 305, 319, and 320, basins can be specified for designation of TMDLs. Such designations ought to be required, along with reasonable timetables, under Section 303 and other appropriate sections. States should have the authority and responsibility to establish these TMDLs, and multi-state forums, possibly commissions, should be authorized where interstate basins are involved.

These revisions should be accompanied by others concerning the use of fees and TDPs. Section 516 should require that EPA report to Congress periodically on its progress in implementing economic incentives, and on headway toward establishing TMDLs for non-attainment water bodies. Section 317 should be amended to require analysis of discharge and, to the degree that conflicts with state water laws can be avoided, water depletion and use fees along with general user fees to fund CWA programs. Included here, or elsewhere if more appropriate, should be the study, design, and authorization of a trust fund for fee-based revenues to be managed, preferably by a private entity such as that mentioned above. Section 319 should also be amended to require that states use economic incentives, including fees and TDPs, in implementing their NPS programs as a condition of federal cost-sharing for such programs.

Several additional factors should be incorporated into the reauthorized CWA. Implementation authorities should continue to rest with the states, subject to timeliness criteria. Authorities for NPS control implementation should be locally based, with the establishment of appropriate local institutions by local stakeholders to be completed in a timely manner. Internal governance of these NPS institutions should be determined by local preferences. The key requirement of these institutions would be that they be based on hydrologic boundaries to the extent possible so that NPS drainage areas are represented, and that their charters authorize them to implement the terms and conditions of the pollution discharge permit(s) issued to them by the state, or by EPA.

As noted above, there are a number of other resource uses which impact water quality which are the subject of federal legislation and administration. In some western states, the Reclamation Act and associated projects have substantial impacts on water quality and environmental resources. While the Department of Interior issued a policy document in 1987 which was generally supportive of voluntary transfers and marketing of federal water contracts, actual implementation by regional Bureau of Reclamation offices has been slow. As a result, a number of Congressional initiatives have introduced water marketing and environmental mitigation into the operations on a project-by-project basis. Voluntary marketing of federal natural resources introduces price as a means of rationing use. Accordingly, market-based reforms of relevant federal statutes governing not only federal water contracts but also grazing, timber, hydropower, shipping, and flood control should be undertaken.

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5. Copeland, C. Funding Water Quality Programs: Revenues from a National Clean Water Investment Corporation. Congressional Research Service. July 10, 1992.

6. Copeland. op cit. 1992.

Wednesday, October 21, 1992

Session 8: Clean Water: Worth the Cost?

SESSION SUMMARY

MODERATOR: Martha G. Prothro

PRESENTERS:

Robert W. Adler—*The Economic Value of Clean Water*

Kenneth W. Chilton—*Clean Water's Muddied Future*

David Gibbons—Paper Unavailable

James P. Joyce—*Local Government Perspective on Clean Water and the American Economy*

Paul Portney—Paper Unavailable

The Economic Value of Clean Water

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Senior Attorney
Natural Resources Defense Council, Inc.

Marni J. Finkelstein
Research Assistant
Natural Resources Defense Council, Inc.

ABSTRACT

This paper will identify some of the key economic benefits of clean water and health aquatic ecosystems in the United States. Benefits will include the value of commercial and recreational fisheries, hunting and other water-based recreation, and wetlands. The paper will also identify some existing economic losses due to water pollution and lost or degraded aquatic habitat. Losses will include declining or contaminated seafood supplies, flooding and erosion, and drinking water contamination. Finally, the paper will discuss the economic losses due to the contamination of potentially valuable renewable resources, such as reclaimed wastewater and sewage sludge.

INTRODUCTION—FLASHBACK TO 1972

On June 17, 1972, five burglars broke into Democratic Party Headquarters at the Watergate Hotel overlooking the Potomac River. Watergate later became the symbol of a serious pollution of the American political process. But outside the windows of the hotel the water of the Potomac was equally polluted. In 1965, President Johnson condemned the quality of the Potomac as part of his pledge of "Clean Water by 1975," and in 1969 a conference in Washington declared the river to be "a severe threat to anyone who comes in contact with it."

At the time, U.S. politics were dominated by the debate over American military involvement in Vietnam. But slowly America realized that while it intentionally spread chemical poisons on the rice paddies of Vietnam, it was unwittingly polluting its air and water at home with equally dangerous chemicals. The modern war against air pollution began in 1970 with the passage of the Clean Air Act. But the battle against water pollution was still in the 19th Century, with an obscure law called the Rivers and Harbors Act of 1899 as its principal, badly outdated weapon.

Nixon ushered in the new decade by reminding the nation that ". . . the 1970s absolutely must be the years when America pays its debt to the past by reclaiming the purity of its air, its waters, and our living environment. It is literally now or never." The statement gave hope that the federal government would begin to take the war against water pollution seriously.

More visible political events, however, overtook President Nixon's promise and commitment to the environment. While the nation continued to debate the morality and the wisdom of the Vietnam war, an ever-present subtheme was the cost of the war to the American economy and the federal budget, and its impact on pressing domestic problems. Could America fight communism in Vietnam and still afford to fight poverty and pollution at home?

It was precisely this economic tradeoff that led President Nixon to veto the Clean Water Act just ten months later. Nixon's veto message reiterated his rhetorical pledge to address water pollution, but rejected Congress' solutions on economic grounds:

> I am also concerned ... that we attack pollution in a way that does not ignore other very real threats to the quality of life, such as spiraling prices and increasingly onerous taxes. Legislation which would continue our efforts to raise water quality, but which would do so through extreme and needless overspending, does not serve the public interest. There is a much better way to get this job done.[1]

It took Congress only one day to override Nixon's veto, by overwhelming margins in both Houses.[2] And some members of Congress openly criticized Nixon's decision to pay for bombs over water pollution control.[3] In the U.S. Senate the most eloquent response came from Senator Ed Muskie of Maine, who had led the fight for a more serious national water pollution control effort:

> Can we afford clean water? Can we afford rivers and lakes and streams and oceans which continue to make possible life on this planet? Can we afford life itself? Those questions were never asked as we destroyed the waters of our Nation, and they deserve no answers as we finally move to restore and renew them. These questions answer themselves. And those who say that raising the amounts of money called for in this legislation may require higher taxes, or that spending this much money may contribute to inflation simply do not understand . . . this crisis.[4]

But even more than during the 1970s, the 1990s are a time of limited economic as well as environmental resources. This decade brings a time of relative military security, but in the face of a staggering federal deficit. Once again, the question is raised: "Can we afford clean water?"

A number of values are at stake if the goals of the Clean Water Act are not met. Some of these values are practical, such as our basic needs for safe water and ample seafood supplies, and the desire to avoid getting sick from swimming in polluted waters. Others combine ethical and spiritual values, such as our moral responsibility to protect aquatic species from the ravages of human development, and the intangible benefits of sitting by a pristine lake or a free-flowing river, seeing or just feeling the presence and diversity of the life that inhabits these resources.

Because so much of the worth of clean water and healthy aquatic ecosystems transcends economic values, this question cannot be answered fully or definitively. No matter how hard economists try to "value" clean water, they will always miss much. This is not a criticism of economists or economics. It simply reflects that the units of economic value, that is, money, do not match up fully with the units of environmental value, just as the number of canvases in the Louvre—or the market price of those works—do not convey the spiritual and intellectual value locked into those paintings. Since the Clean Water Act was passed, for example, ten species of fish have become extinct. How do we measure the value of those losses?

Still, future debates over the Clean Water Act will continue to raise the issues of cost and economic benefits. It is essential, therefore, to address the economics of clean water as well as is possible given the limitations of economic valuation. This issue can be evaluated from two opposite but related perspectives. From one angle, we can try to identify the economic value of our existing aquatic resources. From the other side, we can try to get a sense of how much our economy has suffered from past destruction of these resources. Either way, past investments in clean water programs have reaped considerable benefits, and future investments are more than justified.[a]

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[a]It is not the intent of this paper to suggest a formal "cost-benefit" analysis. Even if we believed such a test were justified, it would be far beyond the scope of this analysis.

1.0 ECONOMIC VALUES OF WATER RESOURCES

1.1 Commercial Fisheries

More and more people are turning to fish and shellfish, a major source of protein. From 1972 to 1990, annual U.S. seafood consumption jumped from 12.5 to 15.5 pounds of fish per person.[5] And a recent projection by the U.S. Department of Agriculture indicated that by the turn of the century, this consumption rate could increase to 17.2 pounds per person. If correct, supplies of edible seafood products will need to increase by 18 to 31% by the year 2000 to meet the demand.[6]

A major and growing U.S. industry supports this demand. In recent years the United States has ranked about 6th among major fishing nations, behind the [former] USSR, China, Japan, Peru, and Chile. The following table shows trends in how many pounds of fish have been caught each year between 1976 and 1990 and the dockside economic value of each catch.

Besides providing food, commercial fisheries also provide employment for hundreds of thousands of people per year. In 1988 alone, 363,703 people were employed through commercial fisheries (fishing, processing, wholesaling)—a major increase from the 230,387 people employed in 1972. And, as fish consumption rises, so will the employment rate. Protecting clean water is essential to protecting these jobs.

1.2 Recreational Fishing and Hunting

Recreational fishing is the premiere outdoor recreational activity in the United States. Over the past thirty years, there has been a steady increase in the number of participants in fishing activities. In 1985, one in four Americans 16 years and older fished for pleasure (46.4 million total: about 40 million in freshwater; 14 million in saltwater; some in both). They took over 870 million fishing trips and spent a total of 977 million days on the water (734 million freshwater trips and 136 million saltwater trips.)[8]

As a result, recreational fishing supports a major U.S. industry. Total expenditures for recreational fishing in 1985 were $28.12 billion dollars (freshwater fishers spent $19.4 billion; saltwater fishers spent $7.2 billion; $1.5 million unknown). Of these expenditures, $13.3 was spent on trip-related expense such as food, lodging, and transportation, while $13.6 billion was spent on equipment and $1.3 billion on other expenses such as fishing magazines, licenses, and membership dues.[9]

Shellfishing is also a popular water-based sport. In 1985, an estimated four million people (2% of the U.S. population) aged 16 or older participated in recreational shellfishing. The number of days spent shellfishing was 28 million. Fifty percent of shellfishers live in the South and account for 59% of all shellfishing days.[10] Shellfishers estimated that they spent $2.3 billion to participate in the sport: $1.1 billion on trip-related expenses such as food, lodging, and transportation, $1.2 billion on equipment, and $63 million on other expenses.[11]

Another common water-based sport is waterfowl hunting. According to the 1985 National Survey of Fishing, Hunting, and Wildlife Associated Recreation conducted by the Department of Interior, 5 million hunters took 38.5 million hunting trips and spent 41.7 million days hunting waterfowl. Expenditures for waterfowl hunting totaled over $783 million.

The 1985 survey also shows that all forms of water-based hunting and fishing in the United States are on the rise, by comparing similar national surveys from 1955-1985. According to these findings, the total number of fishers and waterfowl hunters increased dramatically over the 30-year period, resulting in a major rise in expenditures made to participate in these sports. The following table illustrates this increase by comparing data from 1970 and 1985.

U.S. Landings[7]

Year	Lbs. of Fish Landed	Economic Value
1990	9.7 billion	$3.6 billion
1989	8.5 billion	$3.2 billion
1988	7.2 billion	$3.5 billion
1987	6.9 billion	$3.1 billion
1986	6.6 billion	$2.8 billion
1985	6.3 billion	$2.3 billion
1984	6.4 billion	$2.4 billion
1983	6.4 billion	$2.4 billion
1982	6.4 billion	$2.4 billion
1981	6.0 billion	$2.4 billion
1980	6.5 billion	$2.2 billion
1979	6.3 billion	$2.2 billion
1978	incomplete data	incomplete data
1977	5.2 billion	$1.5 billion
1976	5.4 billion	$1.4 billion

Other evidence confirms these trends, indicating that the economic value of clean water is on the rise:[13]

- Visitors to national seashores and lakeshores jumped from 18 million in 1981 to over 23 million in 1988.
- Fishing and boating on other federal lands rose dramatically from 1982 to 1989.
- Total fishing licenses increased (from 31 to almost 37 million) from 1970 to 1988, as did the cost of those licenses.
- The value of recreational boats in the United States almost doubled from 1970 to 1989, with total expenditures on recreational boating rising by a factor of five.
- Sales of fishing tackle rose from $540 million in 1980 to almost $740 million in 1989.

These trends are expected to continue. By the turn of the century about 84 million Americans are expected to participate in recreational fishing.[14] And according to some estimates, the available living aquatic resources in the United States are limited and not expected to satisfy demands for quality recreational fishing by the year 2000.[15]

Comparison of Major Findings - 1970 and 1985[12]

	1970	1985
Total Fishers	33.2 million	45.3 million
Freshwater	29.4 million	39.1 million
Saltwater	9.5 million	12.9 million
Waterfowl Hunters	2.9 million	3.2 million
Fishing expenditures	$5.0 billion	$28.6 billion
Hunting expenditures	$244.5 million	$783.3 million
Days spent fishing	706.2 million	1.1 billion
Days spent hunting	25.1 million	25.9 million

1.3 Other Water-Based Recreation and Intangible Values

Measuring actual expenditures is only one way to establish the value of clean water to people. Aesthetics, nature and the opportunity to view wildlife are other ways to value the importance of keeping our waters pristine. From swimming to boating to sunbathing, spending time in or near the water is a favorite way for people to spend leisure time. Measured by the number of trips away from home, our most popular outdoor activities include swimming outdoors (461 million trips per year), warmwater fishing (239 million trips per year), and motor boating (220 million trips per year).[16]

A broad array of activities are enjoyed near the waterfront. In 1985, 14.8 million people visited lakes or streams, 8.4 million people went to marshes or wetlands, and 5.7 million went to the ocean.[17] While at these sites, the majority of people enjoyed feeding, photographing, and observing birds and mammals. Others enjoyed observing and feeding fish, amphibians and reptiles, shellfish and marine mammals. Other recreational activities include water-skiing, walking along the shore, kayaking, canoeing, rafting, surfing, sunbathing, and picnicking.

Many of these activities, of course, do contribute to the economy directly in the form of equipment purchase, travel expenditures, and activity fees. However, it is difficult to place a value on the pleasure of spending a sweltering summer day in or near a cool, clean body of water, or on the satisfaction of seeing wildlife in their natural habitat. It is even harder to place a price tag on the assurance that these resources will be left for our children as well.

Some economists are beginning to assess economic values to intangible environmental benefits through techniques such as contingent valuation surveys. These surveys generally describe a hypothetical market in which a public good may be purchased and asks participants how much they would be willing to pay for an increase in the level of this public good.

A 1991 contingent valuation study conducted by Resources For the Future, for example, asked a national sample of Americans to value a set of water quality improvements.[18] In this study, respondents were asked to give a monetary value to minimum levels of boatable, fishable, and swimmable water. Those who gave useable answers were willing to pay an average of $106 per year for boatable water quality, plus $80 for fishable minimum water quality, and an additional $89 more to reach a national minimum of swimmable water quality. Altogether, people, on the average were willing to pay $275 per year to ensure clean water.[19]

Based on these answers, it was estimated that the economic benefits of achieving the national swimmable water quality goal for non-boatable water was $29.2 billion *per year* in 1990. However, a range of $24 to $43 billion dollars per year was considered reasonable.[20] When the results of this study were aggregated with other similar surveys and adjusted to correct for the number of current households and the Consumer Price Index, the estimated value of clean water became $46.7 billion. Clearly, the public places a large economic "value" on even the intangible benefits of our aquatic resources.

1.4 Wetlands

Because their importance has been hotly debated in recent years, it is particularly important to underscore the economic, as well as environmental, values of wetlands. While some may view wetlands as just swamps or even eyesores, they are actually rich areas that support an abundance of wildlife and provide services that may be worth billions of dollars in economic benefits. For example, an estimated 50 million people spend nearly $10 billion annually to observe and photograph wetland-dependent birds.

Wetlands also sustain much of the country's seafood. In the Southeast, 96% of the commercial catch and over 50% of the recreational catch is dependent on estuarine and other coastal wetlands. Commercial fishing harvests from wetlands are worth $10 billion per year.[21] And estimates of the value of coastal wetlands to commercial and recreational fisheries range from about $2,200/acre on the Pacific coast to almost $10,000/acre along parts of the Florida coastline.[22] Wetlands also provide habitats for valued mammals such as muskrats, beavers, and minks. Muskrat pelts alone are worth over $70 million annually.

A 1981 case study in New England illustrates the economic importance of wetlands. The wetlands used in this study were comprised of 8,535 acres in the Charles River Basin, Suffolk, Norfolk, and Middlesex Counties, Massachusetts. The economic benefits measured were flood control, increases in land value, pollution reduction, water supply, recreation and aesthetics, preservation and research, vicarious consumption and option demand, and undiscovered benefits.

In valuing flood control, the Corps of Engineers estimated that wetlands provide 75% of the natural water storage. Accordingly, the loss of wetlands used in this case study would produce an annual flood damage of almost $18 million, or about $2000 per acre (1978 dollars). The following table shows the annual property loss for each percentage of lost wetlands:

Annual Property Losses Due to Wetlands Storage Loss[23]
(for 8,535 wetlands acres in Charles River Basin, MA)

Condition	Annual Property Loss
Natural	$467,000
10% loss	$707,000
20% loss	$1,122,000
30% loss	$2,022,000
40% loss	$3,193,000

Wetlands also provide a wealth of recreational opportunity. The recreational value of the wetlands used in this case study were measured by activities such as small game hunting, waterfowl hunting, trout fishing, warm water fishing, and nature study. It was determined that one acre of wetland in the study areas was worth $187.74 per year. This figure was reached by calculating the days of use/acre/year, the expenditures/user/year, the pay lost/user/year, willingness-to-pay/user/year, and days of activity/user year.

A second analysis of the recreational value of wetlands determined the price at which people would *sell* their rights to recreate in wetlands (a variation on contingent valuation). The total price for this analysis was $3,366 per acre. When this figure was capitalized at 8.75%, it yielded a value (1977) for recreation of $56,100 per acre.[24]

The following is a breakdown of the economic benefits of one acre of Charles River wetland: flood prevention ($33,370), local amenity ($150 - $480), nutrient reduction ($16,960), water supply ($100,730), recreation ($2,145 - $38,469). Therefore, the total worth of just one acre was estimated at $153,000 - $190,009.[25] Not bad for "just a swamp."

2.0 ECONOMIC LOSSES DUE TO WATER RESOURCE DEGRADATION

2.1 Degradation

The flip side of the value of clean water is the economic losses that occur when water resources are degraded. Loss of natural and economic resources occur in a number of ways: pollution causes drinking water and seafood supplies to be closed or restricted, or increases treatment costs for drinking water; water and seafood contamination causes human illnesses, with attendant medical costs or lost productivity of the work force, not to mention human suffering; flooding and erosion devalues property; habitat destruction and chemical pollution decreases valuable recreational opportunities. Less obvious but equally important from an economic perspective are the loss of valuable renewable resources, such as reusable water and sewage sludge, when these resources are contaminated by toxic pollutants. As with the value of clean water and aquatic resources, too little work has been done to quantify the value of these economic losses. Some information is available, however, to underscore the tremendous current and potential future economic losses we face if we do not protect our aquatic resources.

2.2 Lost or Degraded Economic Resources

Seafood Losses Due to Pollution

The most obvious and immediate economic losses due to water pollution and lost or degraded aquatic habitat occurs when commercial fisheries decline or are closed due to contamination. A large number of major commercial fisheries have already been lost, or are declining severely. While little information is available to quantify these losses directly, one study exemplifies the severity of the loss.

The economic value of shellfish resources to the four states of New York, Rhode Island, Massachusetts, and Connecticut is considerable. However, over 75% of Connecticut's bays, harbors, and estuaries are restricted to shellfishing; 25,000 acres in southern Massachusetts are similarly restricted; and the harbor of New Bedford has been declared a Superfund site because of pollution by PCBs.

Shellfishing restrictions due to pollution cause detrimental effects on revenues in these states. In 1990, the ex-vessel value of commercial landings in these states exceeded $72 million. Using a conservative economic multiplier of 4.5, indirect revenues could approximate $325 million. The estimated annual value assigned to the potential harvest of shellfish from prohibited areas (areas closed due to pollution or other unsafe conditions) is approximately $36 million.[26] If these shellfish resources could be utilized, the value of commercial landings would be increased by about 50%, and total indirect revenues might be as high as $487 million.

Flooding/Erosion

Flood management and erosion control are other economic burdens that could be avoided with proper investment in and protection of aquatic resources. Flooding is the most costly natural hazard in the United States, causing a greater loss of life and more property damage than all other natural disasters

combined. In 1991, the Federal Emergency Management Agency (FEMA) estimated that there were about four million acres of floodprone land in the United States.[27]

Flooding causes approximately $3 billion in damages a year, and the loss of an average of 191 lives (which of course cannot be measured by economic value).[28] These statistics were the same or were exceeded for each five-year period since 1970. Moreover, they *greatly exceed* those for the 50 years preceding 1970. The rise in damages and deaths due to flooding may be partly attributed to the continuing loss of wetlands. "Studies in Wisconsin, for example, showed that watersheds consisting of 30% or more of wetland had 60 to 80% lower floodpeaks than watersheds with little or no wetland."[29]

Together with flooding, erosion is another serious condition that affects the country's shorelines. The Army Corps of Engineers determined that there are 574,000 miles of stream banks with erosion problems, with 142,100 miles seriously affected. About 78% of all stream bank erosion takes place west of the main stem of the Mississippi River.[30] In addition to natural habitat destruction, streambank erosion causes millions of dollars in economic damages annually:

Streambank Erosion - Average Annual Damages in Thousands of Dollars
[Source: U.S. Army Corps of Engineers]

Pacific Northwest	23,600	Great Basin	500
California	56,200	Colorado Basin	4,800
Alaska	1,200	Souris-Red-Rainy	1,200
Upper Mississippi	5,800	Missouri Basin	16,800
Rio Grande	10,500	Arkansas-White-Red	93,500
Lower Mississippi	38,900	Texas Gulf	7,800
Hawaii	0	South Atlantic Gulf	11,800
Tennessee Valley	900	Middle Atlantic	10,900
Ohio Valley	5,700	Great Lakes	2,700
New England	1,800		
TOTAL $294,600,000			

Erosion is especially serious for ocean-front property. Beach erosion in the New York to Washington corridor averages 2-3 feet per year.[31] In 1986, North Carolina predicted that 750 ocean-front structures insured at approximately $50 million would be lost to erosion in the next 10 years; 5,000 structures over the next 60 years; with 4,200 structures at immediate risk in event of a major coastal storm.

Drinking Water

Eliminating drinking water contaminants is important to protect public health. But it can also reduce overall costs of supplying safe drinking water—costs that are borne by public water supply users rather than by those who polluted the water in the first place (although in some cases these groups overlap).

The presence of contaminants in public drinking water supplies results in increased treatment costs. Of course, some costs will always be necessary to ensure a safe drinking water supply, especially since drinking water contaminants occur even in relatively natural water supplies. But the presence of pesticides and other artificial organic chemicals, and other pollutants introduced by human activities, results in the need to add expensive new treatment technologies at drinking water supplies around the

country. There is no national study available to quantify these costs, and to evaluate how much money could be saved by protecting drinking water supplies in the first place. But available information suggests that preventing pollution of drinking water supplies is a sound economic as well as public health investment.

One EPA study, for example, indicates that about 50 million people in the United States live in areas most vulnerable to pesticide contamination of groundwater. According to this study, estimated remedial costs of $250 to $750 per household per year can be avoided by protecting the water supply. These costs may total as much as $100 million to $150 million per year. In addition, people who live in areas subject to drinking water contamination are willing to pay as much as $50 per household per year for programs that evaluate ground water problems and identify efforts to resolve them. The total amount generated from this type of program could equal as much as $1.0 billion per year from households at risk from pesticide contamination.[32]

Similar results are apparent for major city drinking water systems, where supplies often come from surface waters. The estimated costs of filtering the New York City water supply ranges from $1.5 to 5 billion for construction, with operating costs of $300 million/year. If activated carbon is used to filter toxic contaminants, construction costs double and operating costs triple, up to $10 billion in construction costs and $900 million/year in operating costs.[33]

Some data are available to characterize drinking water treatment costs on a national scale. The following table, for example, shows the estimated annual costs for implementing amendments to the Safe Drinking Water Act:[34]

Estimated Annual Costs to Water Systems for Implementing 1986 Amendments to the Safe Drinking Water Act
(1986 dollars in millions)

Rule	Number of Systems Affected	Annualized Capital/ O&M Costs	Average Annual Monitoring Cost	Total Compliance Cost
Volatile Organic Chemicals	1,824	$32.7	$23.1	$55.8
Filtration	10,228	$511.6	$17.1	$528.6
Total Coliforms	200,183	0	$75.2	$75.2
Synthetic Organic Chemicals	2,284	$45.4	$33.2	$77.5
Inorganic Chemicals	1,896	$123.2	$12.4	$135.6
Lead/Copper Corrosion Control	43,927	$302.2	$32.9	$335.2
Radionuclides	22,867	$790.3	$2.6	$792.9
Disinfection	103,354	$474.8	$12.8	$487.7
TOTAL	386,563	$2,280.2	$208.3	$2,488.5

Loss of Potentially Reusable Resources

The contamination of domestic sewage by toxic pollutants from industrial, household, and other sources is part of a cascade of problems that causes pollution of air, land and water. And by contaminating these potentially valuable materials, we lose renewable resources that could be used to fertilize and irrigate crops, forests and other lands. The pattern looks like this:

1. Our failure to reduce or eliminate the release of toxic chemicals into our public sewers causes contamination of air (through evaporation of volatile organic chemicals), sewage effluent, and sewage sludge;

2. We discharge sewage effluent into our rivers, lakes and coastal waters, causing serious water pollution problems;

3. We treat sewage sludge as a waste to be burned in incinerators (causing more air pollution) or to be dumped in landfills (polluting ground or surface water);

4. Instead of using the valuable water and soil nutrients in sewage effluent and sludge, we drill for oil and manufacture chemical fertilizers, and build massive new dams and other water projects, all of which causes even more environmental harm.

Steps to eliminate this contamination of our sewage systems thus could reduce environmental impacts while freeing up valuable materials that would lower water supply and fertilizer costs around the country. While it is difficult to assess a precise national value on these materials, information suggests that we are currently losing a tremendous economic resource.

Wastewater Reuse

In 1985, approximately 31 billion gallons of sewage wastewater were discharged to surface water every day.[35] Put in perspective, this amounts to over 11 trillion gallons a year, or more than a third of total annual U.S. water withdrawals. Much of this wastewater can be reused productively, *if* it is reclaimed properly and *if* it is sufficiently free of toxic contaminants. Properly reclaimed wastewater can be put to uses such as groundwater recharge, industrial use, irrigation, recreational lakes, or direct municipal reuse.[36]

One author suggested five important reasons to use properly reclaimed wastewater.[37] First, we can reduce or eliminate the costs of building additional water supply, collection, storage, and transport systems. Second, we can reduce or eliminate the serious environmental harm from building these additional systems. "Such systems replace free-running rivers and dams with fluctuating reservoirs, and can change significantly the basin areas from which water is exported and into which it is imported."[38] Third, the reuse of wastewater helps to conserve scarce water resources. Fourth, wastewater reuse can reduce the rate of groundwater depletion for areas that obtain their water from wells. And fifth, we can protect water resources from pollution by reducing total sewage discharges.

In addition to these reasons, wastewater discharges are rich in nitrogen, phosphorus, and other nutrients needed to grow various crops. Replacing these nutrients uses scarce oil resources that we convert at petrochemical factories into chemical fertilizers.[39] Moreover, sewage reuse can be better for agriculture because nutrients are released more slowly and continuously, rather than in a single large dose, as is the case with chemical fertilizers, much of which runs off into local surface and ground waters. In test plots in India and Thailand, rice, wheat and cotton yields were considerably higher using reused wastewater than in similar plots that used well water and commercial fertilizer.[40]

Some wastewater is reused in this country, rather than dumped in surface waters. There are over a thousand wastewater reuse projects in the United States in which water is reused for irrigation,

industrial cooling and processing and groundwater recharge. Los Angeles and Orange Counties, California, for example, reuse about 70 million gallons of water a day for irrigation, cooling water, and groundwater recharge, about 15% of the area's current wastewater volume. But despite these efforts, only about a fifth of 1% of water use in this country is met by reclaimed water. By comparison, reclaimed water met 4% of Israel's water needs in 1980, and is expected to reach 16% by the year 2000.

To make better use of reclaimed wastewater, however, we need to answer two critical questions: First, what reclamation (treatment) levels are necessary to protect human health and the environment? And second, is wastewater reuse cost effective relative to new water supplies or water conservation (i.e., what are the economic benefits of wastewater reuse?).

To answer the first question, it is important to note that different uses of water carry different potential for human exposure—from uses that have little or no human contact (like industrial cooling water) to direct human consumption. One author[41] suggested that depending on the category of reuse, wastewater may be treated at the primary, secondary, tertiary, or advanced level.[b]

Clearly wastewater reuse is controversial, and two opposing stands have been taken on the health risks associated with reused wastewater. One view is that reclaimed water is similar to the water supplies of many large American cities and thus poses no greater health risks. The other is that potable water should be taken from the best possible source:

> There is legitimate concern for fail-safe disinfection technology when reclaimed water is to be used for purposes involving close human contact where inhalation or ingestion are possible. This is of considerable concern because the majority of waterborne diseases reported can be traced to water treatment plant failure.[42]

But use of reclaimed wastewater that does not include direct human ingestion over a long period of time seems to pose few if any direct health risks.

This view is accepted by public opinion surveys. The weighted mean of seven studies performed in 1988 to test the percentage of opposition for different uses of reclaimed water[43] showed that the majority of respondents were opposed only to the uses where contact is very likely. Thus, reclaimed water should start to be used for those purposes where risks are low and public opinion is high.

The second key question is whether wastewater reclamation and reuse is cost effective, that is, whether the added treatment and distribution costs necessary to make use of reclaimed water exceed the cost of other water sources (new supplies or water efficiency). For the reuse of wastewater to be cost effective, and therefore, considered an economic benefit, it must allow users enough savings over fresh water, in the long run, to compensate for any extra costs incurred by its use. Some studies have shown that wastewater reclamation and reuse can provide significant economic benefits.[44]

Distribution and treatment costs (including energy costs), of course, are unique to each situation. For example, the cost estimate for groundwater spreading is low because there is little equipment involved. On the other hand, groundwater injection involves using pumps and additional equipment which brings its distribution cost to the moderate level. A wide range of variables must be considered in evaluating the economics of particular treatment and reuse options.

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[b]Primary treatment is the removal of suspended solids to designated levels. Secondary is the reduction, by activated sludge process, of the biological and chemical oxygen demand of wastewater to regulation levels. Tertiary is the specific treatment process of coagulation, clarification, and filtration to improve the effectiveness of disinfection. And advanced treatment includes reverse osmosis to lower the dissolved solids and activated carbon to absorb organic compounds.

Because of these variables, it is difficult to place a *national* price tag on the value of reclaimed water. But consider that even if savings were only a penny a gallon over alternative sources of water and fertilizer, the potential economic value of the 11 trillion gallons of wastewater a year we waste by dumping it into our surface waters would be an astonishing $11 billion a year! And this does not even take into account the economic and environmental harm caused by existing sewage pollution. Clearly, by investing in better pollution controls so we can reuse rather than release sewage wastewater, society can save on both the economic and environmental costs of providing water and fertilizers, as well as the ongoing environmental costs of water pollution from sewage releases into our surface waters.

Sludge ("Biosolids") Reuse

Sewage sludge, or "biosolids," is another sewage by-product that is not being used to its full potential, in part due to contamination by toxic pollutants. As with wastewater, contamination of sewage sludge leads to a related pattern of economic and environmental problems: We burn this sludge in incinerators or dump it in landfills, causing air or water pollution; and we throw away valuable nutrients and soil conditioners, which must be replaced by artificial fertilizers made from limited petroleum resources.

Sewage sludge is the solid, semi-solid, and liquid residues removed from wastewater during treatment. Sludge is mostly made up of water, organic matter, and nutrients such as nitrogen, phosphorus, zinc, calcium, and magnesium. With inadequate pretreatment and sewage treatment, however, it may also contain bacteria and toxic and other pollutants.

Because nutrients make sludge a valuable economic resource, thousands of municipalities are recycling sludge for agricultural and other uses. It has been used successfully in the production of food, feed, horticultural crops, sod production, turf maintenance, reclamation of mined lands, and forest production. For example, in 1988, all sludge from Washington, D.C. was used on land. Over one-third was used on 7,000 agricultural acres in Virginia, and around 30,000 tons were applied in Maryland.

However, on a national basis, less than 40% of all sewage sludge is used beneficially. Most of it is discharged into water bodies, incinerated, or landfilled. By the year 2000, that the amount of sludge that could have been used beneficially will quadruple.

Sludge is full of nutrients required for plant growth, including nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg), as well as trace elements which in small quantities are beneficial to plant growth. In all, sludge typically contains $50 to $60 worth of nitrogen, phosphorus, trace nutrients, and organic matter per ton.[45] Some heavy metals and other contaminants, of course, can pose human health and environmental risks if present in sufficiently high quantities, underscoring the need for adequate sludge quality standards and pretreatment requirements.

These nutrients provide benefits to agriculture in the form of fertilizer. A 1985 study showed that cotton lint yields were comparable to commercial fertilizer when sludge was used at rates of 20 to 80 mg/ha. At the high application rate of 466 mg/ha of solids, grain and fodder yields were the same as with commercial fertilizer. Also, sludge application on corn yielded similar results as with commercial fertilizer. However, there was a three-fold increase in snap bean yields grown using sludge rather than commercial fertilizer.[46]

A 1991 study on sludge conducted at the University of Florida Institute of Food and Agricultural Sciences demonstrated the successful use of municipal wastes, including sewage sludge, to grow vegetables and tropical crops. Processed Municipal Wastes (PMW) include processed sludge, yard trash, newsprint, and food wastes. For this study, three different PMWs were evaluated. The first was Daorganite (processed from sewage sludge by Metro-Dade County). The second was Compost (sewage sludge mixed with yard trash and garbage). And the third was Agrisoil (composted solid waste). The results were as follows:

Tomato—Yields of large, marketable, and total fruits were higher when sludge was placed in the trenches and either 3 t/a or 6 t/a was incorporated. And, after flowering, tomato plants with 5 and 10 t/a of Daorganite had enhanced growth compared to untreated plants, especially in flooded areas of the field.

Squash—Low rates of processed municipal wastes resulted in higher squash yields.

Areca Palms—Plants were potted with 0, 15, 30, and 45% sludge or compost. After nearly a year, plants showed elevated growth in height, width, circumference, and growth index in 15% Daorganite sludge; in 15, 30, and 45% compost; and a combination of 15% and 30% compost.

Papayas—Sludge and compost applications increased the number of medium-sized fruit, but the total number of all fruit. Sludge applied at 1.5 t/a and compost applied at 1.5 to 3 t/a increased medium and total fruit numbers compared to untreated plants.

Sludge also has a beneficial effect on soil. Studies have shown that sludge and sludge-based compost decrease the bulk density of soils, rendering a better environment for plant root growth.[47] It also increases soil aggregation which provides less potential for erosion. One study showed that as a result of applying sludge, runoff and sedimentation rates were reduced.[48]

Water retention and hydraulic conductivity increase with sludge application. This allows plants better access to water, especially during dry periods or stress.

Sludge is not just beneficial for agricultural uses. It is also being used increasingly in forestry to revegetate and stabilize forests that have been damaged by harvesting, fires, landslides, etc. Sludge helps to shorten wood production cycles by speeding up tree growth. The use of sludge as a forest fertilizer results in height and diameter increases from two- to ten-fold in various tree species.[49] Also, trees grow twice as fast on soil that has been fertilized with sludge.

Other cost-effective uses for sludge are to revegetate areas destroyed by mining, dredging and construction, and to fertilize highway medians and cover landfills. In a strip-mined area in Illinois, reclamation using sludge cost $3,660 an acre, compared with a range of $3,395 to $6,290 per acre for other methods.

As with water, the total national economic value of sewage sludge is difficult to ascertain because of the many variables in sludge quality, transportation costs, etc. But based on current prices of sludge products, the market value of the sewage sludge currently being burned or landfilled is substantial. Heat-dried, high nitrogen content sludge with a consistent nutrient value is being sold from $90.00 to $190.00 per ton in bulk. Less consistent nutrient content and more odorous products are being sold from $20.00 to $60.00 per ton in bulk. Lower nitrogen sludges are selling for about $4.00 to $16.00 per ton in bulk and after alkaline stabilization for $2.00 to $10.00 per ton in bulk. In smaller quantities, sludge products sell from around $5.00 to $16.00 per 40 pound bag, equal to $250.00 to $800.00 per ton.[50]

Clearly, additional investment in clean water programs designed to reduce levels of toxics in sewage sludge, making them usable for fertilizer and soil conditioner for a range of applications, could yield substantial environmental as well as economic benefits.

Jobs

Finally, by not investing in clean water, we are also losing access to potential jobs. Different sources indicate that investment of $1 billion in water and wastewater infrastructure will generate between 6,400 and 15,600 jobs directly involved in project completion. Estimates of indirect effects could be as large as 13,600 jobs per billion dollars invested. Total effects, including direct, indirect, and induced have been

estimated at 34,200 to 57,400 jobs per billion dollars invested. And, the estimated $8.3 billion (1991 dollars) shortfall in funds for water and wastewater capital for the period 1993-2000 could represent 2,865,900 to 4,810,000 job-years of employment.[51]

2.3 Case Study - The Chesapeake Bay

In 1987, the Chesapeake Bay was estimated to be worth $678 billion to the economies of Maryland and Virginia.[52] This figure was the sum of two parts. The first was the value of the annual incomes generated by bay activities which could not take place without the Bay. The second was the land premiums that people were willing to pay for waterfront, waterview, or water access homes.

It was estimated that the 1987 annual impacts from commercial fishing, activities for the ports, ship and boat building, ship repair, and Bay-related tourism was $632 billion. The average annual land premiums for waterfront, waterview, or water access land around the bay was $46.1 billion.[53]

The annual value of commercial fishing in the Chesapeake Bay region was $520 million (1987 dollars). This was the total for the actual dockside value of the fish plus the processing value that includes businesses that prepare fresh or frozen fish and other seafood for shipment.[54] The $520 million is subject to annual fluctuations.

Diseases to oysters, reproduction problems with rockfish, weather, and other changing conditions affect annual yields of harvest. Time, nature, and the health of the Bay each will determine the fortunes of commercial fishing in the Chesapeake Bay.[55]

Tourism accounted for $8,396 million. Recreational activities included boating, fishing, hunting, sightseeing, and regional cuisine. Recreational fishing is mostly done for fin-fishing; however, crabbing and oystering are also popular activities. Each of these activities depend heavily on the environmental health of the Bay.

Hunting also depends on the condition of the bay. Waterfowl hunting is a popular Bay activity. The expansion of ducks and geese partly depends on the preservation of natural waterfowl refuges along the Bay.

The site value premium for Bay residences was $46.2 billion. People will pay higher prices to live on or near the Bay. If the Bay were to vanish, premiums would go way down. Also, if the beauty of the Bay were to be affected by pollution, then it would also adversely affect the land premiums. Premiums for Bay-area properties are different depending on the neighborhood and size of the lot. However, realtors assess premiums of $35,000-$50,000 for waterfront, waterview, and water access locations.

3.0 CONCLUSION

In Earth in the Balance, Senator Al Gore quoted Oscar Wilde: "A cynic is one who knows the price of everything and the value of nothing." It is easy to dwell on the costs of clean water, while forgetting the tremendous value of aquatic resources to our economy. We share a large stake in the protection of our rivers, lakes and coastal waters, and must be willing to make the investments necessary to preserve them.

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Clean Water's Muddied Future

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ABSTRACT

Determining the current quality of U.S. water sources is problematic at present. EPA's most recent water-quality assessment, reflecting data collected by the states in 1988 and 1989, is largely encouraging. Health and ecological effects of polluted water have not been adequately studied, however, making comparison of costs and benefits of clean water policy incomplete, at best.

Point sources have decreased their effluents substantially since 1970. Pollutants from agricultural and urban runoff (nonpoint sources) have increased and, in some cases, have more than offset industrial and POTW improvements. According to the EPA, agricultural and urban runoff pose the same amount of risk to human health, and more risk to the environment, than does point source pollution.

Technology to control nonpoint source pollution is available and, in general, is relatively low cost. Implementing nonpoint programs will not necessarily be easy, however. Farmers and municipalities lack the "deep pockets" of private industry; thus, following a "polluter pays" principle may be politically difficult in these situations.

Water-quality science must improve before Congress can responsibly enact added restrictions on industrial dischargers. Even without added requirements, future costs of water-pollution abatement will be huge—nearly $650 billion over the next ten years. At present, the objectives of the Clean Water Act are clear but needed policy changes, if any, are murky.

1.0 INTRODUCTION

Proposals to reauthorize and revise the nation's primary statute to protect water resources surfaced in the 102nd Congress but failed to reach the Senate or House floor for final consideration. It appears likely that the 103rd Congress will try once again to amend the Clean Water Act of 1972.

The sheer magnitude of costs associated with improving water quality calls for a critical analysis of the future direction of water-resource legislation. In addition to costs, Congress must not overlook several other key issues. First, benefits to public health and the environment from further abatement initiatives are currently ill-defined. Second, the relative significance of pollution from nonpoint sources—agricultural, urban, and forest runoff—compared to pollution from point sources—emissions from industries and publicly owned treatment works (POTWs)—must be considered. Finally, the effectiveness of recent EPA programs resulting from the 1987 amendments to the Clean Water Act cannot be evaluated for several more years. The following discussion considers these issues and also offers some practical recommendations for future water pollution control policies.

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1.1 The Price of Clean Water

Improving the quality of America's water has been, and will continue to be, an extremely expensive process. In a 1990 report, EPA estimates the cost for water pollution cleanup efforts at nearly $620 billion (in 1992 dollars) for the period of 1972-1990 (see figure). These expenditures account for over 40% of total U.S. pollution abatement expenditures since 1970.[1]

Investments will need to steadily increase to reach nationwide attainment of national fishable/swimmable goals, drinking-water-quality goals, and municipal secondary treatment requirements by the year 2000. The figure shows that EPA estimates expenditures totalling nearly $680 billion (in 1992 dollars) for the period 1991-2000—more than the total amount spent in the previous nineteen years (1972-1990).

These expenditure estimates would be significantly higher if groundwater protection, an issue of growing concern and rising cost, was included. In its 1990 study, however, EPA includes most expenses incurred for groundwater protection under other categories, including the Resource Conservation and Recovery Act, Superfund, and the Federal Insecticide, Fungicide and Rodenticide Act.

Beyond revealing the high costs of water pollution abatement efforts, the EPA report shows that the agency's resources have been focused on point source discharges (the significance of which will be discussed in more detail later). Indeed, costs associated with controlling point sources account for over 90% of abatement outlays. These expenditures have been mostly for publicly owned treatment works and industrial direct discharge and effluent pretreatment controls.[1] A good deal of future capital expenditures will go toward meeting drinking water regulations and constructing additional municipal wastewater treatment facilities.

1.2 Gauging Water Quality

What improvements in water quality have these expenditures produced? Surprisingly, the answer is unclear. One major reason for this ambiguity is that knowledge of past and present water quality is deficient.

Measuring water quality is far from a straightforward matter. States, rather than the U.S. Environmental Protection Agency (EPA), are responsible for monitoring surface water quality. State agencies gather and analyze data and submit their results to EPA. Monitoring methods, analytical techniques, and comprehensiveness of reporting vary from state to state.[2] Thus, collecting uniform and complete national water quality data is problematic.

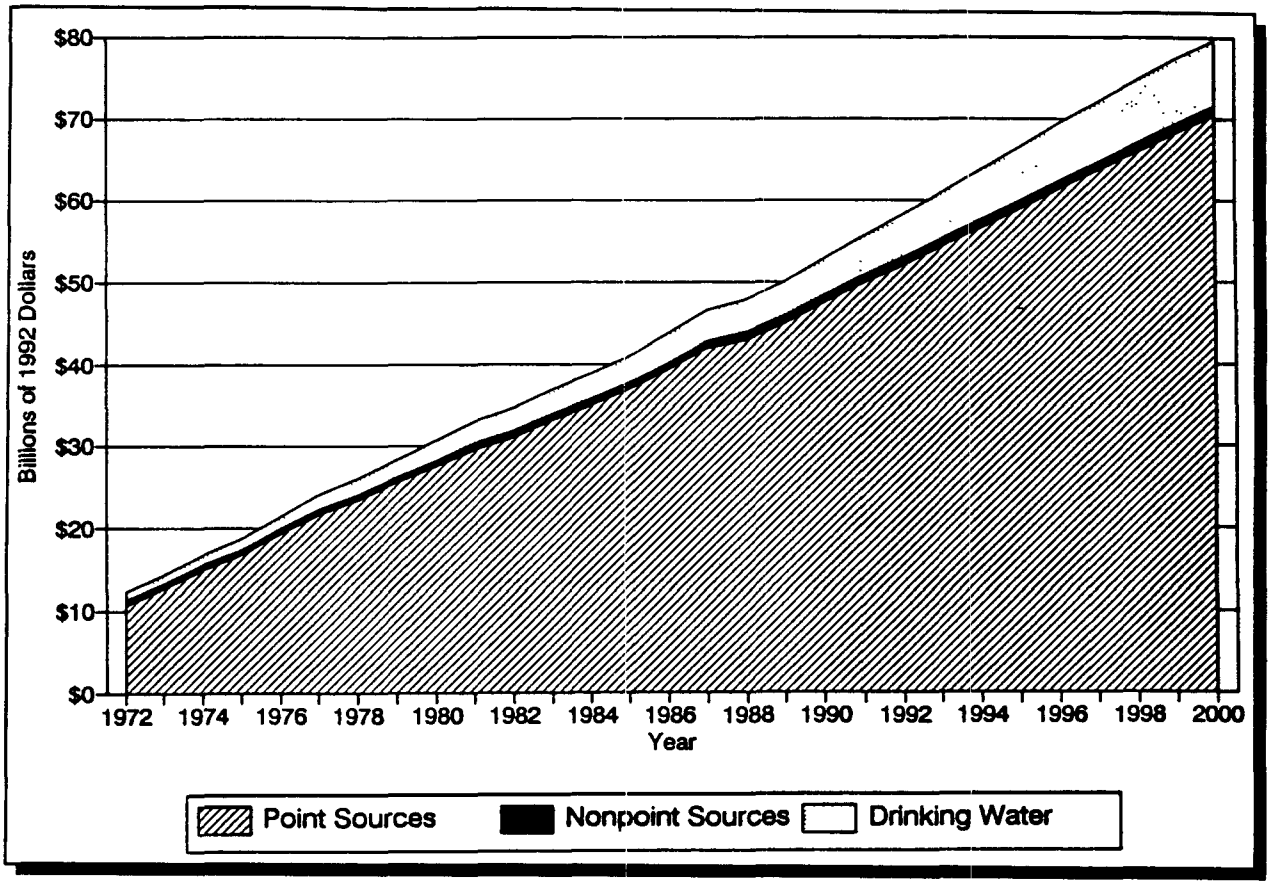
Recognizing that varying state monitoring approaches and the lack of comprehensive data limit the quality of aggregated data, EPA has issued guidelines to encourage the use of consistent procedures. As improved monitoring techniques and better methods of analysis are developed and deployed, the scope and accuracy of water quality data will improve. Until this occurs, however, the nation's policymakers must be aware of the limitations of the available information on water quality.

1.3 Water Quality Trends

As a result of low quality historical data, much of the evidence of progress in cleaning up America's water resources is anecdotal. In the 1970s, pollutants spewing out of discharge pipes could be seen and smelled. Today, many rivers and lakes have fully recovered from these past abuses.

In New York, for example, the tributaries of Lake Erie were plagued by discharges from municipal treatment facilities and food processing facilities. Fish populations were choked out as a result of low levels of dissolved oxygen (a measure of the concentration of oxygen in water). Today, recreation and

tourism are increasing due to recovering populations of coho and Chinook salmon, steelhead trout, and smallmouth bass.[3]



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In the 1950s and 1960s, manufacturing and steel production flourished along the shoreline of the Cuyahoga River in Cleveland, Ohio. Severely polluted with oil and chemicals, this river actually caught fire in 1969. The Cuyahoga has since recovered and, while still no babbling brook, the river is now surrounded by thriving restaurants and hotels.

According to EPA, every state can cite similar specific cases of water-quality improvements. Knowledge of overall water quality betterment, however, remains limited.

Historically, state efforts have been directed towards controlling conventional pollutants such as total suspended solids (TSS) and biological oxygen demand (BOD). Industrial direct discharges of TSS and BOD have decreased dramatically in the last 20 years, far more than many people appreciate. Between 1973 and 1987, 96% of TSS and 93% of BOD discharges to water were eliminated. Widely applied control technology and treatment techniques, as well as industrial process changes, are responsible for decreased industrial waste discharge. However, these declines also occurred in part because companies have increased discharges of BOD substances and TSS into municipal treatment plants—so-called indirect discharges.[4]

Municipal treatment plant discharges of TSS and BOD material increased significantly from 1960 to 1973. Due to construction of primary and secondary treatment works, however, these discharges

decreased significantly from 1973 to 1980. For the 1980-1988 period, the discharges increased once again but still remained below 1973 levels—BOD, 20%, and TSS, 30% below.[4]

Sewage treatment service has improved dramatically since the first Earth Day in 1970. The number of people receiving service by a combination of primary and secondary sewage treatment rose from 85 million in 1972 to 176 million in 1988.[5]

Although point source discharges have improved, conventional water pollutants from nonpoint sources have been steadily increasing. In some cases, EPA reports that nonpoint source pollution has "more than offset" improvements in point source discharges of conventional pollutants.[4]

EPA has only recently begun focusing on nonconventional pollutants such as toxic substances and heavy metals and has expressed concern that these pollutants may be more significant than TSS and BOD. However, the states' water quality data for toxic chemicals and heavy metals, when they exist at all, are limited to recent years. Thus, EPA has been unable to establish trends in toxic pollution.

EPA does provide a "snapshot" analysis of the degree of conventional and nonconventional pollution in its *1990 National Water Quality Inventory* (released in 1992).[2] The agency's findings are largely encouraging. This information says very little about adverse human health and ecological effects resulting from polluted water, however.

According to EPA, knowledge of the link between water quality and human health is "limited." The agency states that some toxic pollutants that appear in water resources and in fish and shellfish tissue have been "linked to human health problems such as cancer, kidney ailments, neurological disorders, and birth defects." But uncertainty abounds over the relationship between the amount and duration of exposure to these toxic chemicals and resulting health effects in humans.[2]

The benefits from cleaner water are by no means limited to avoidance of human health effects. Increased recreational and commercial activities also result from improved water quality. Although these benefits may be large and must not be discounted, few states report on such information. Even fewer states are currently able to attach value to increases in economic activities, making it virtually impossible to accurately compare the costs and benefits of further clean-up efforts.[2]

1.4 Focusing on Nonpoint Source Pollution

Acknowledging that nonpoint source pollution currently is the greatest threat to the quality of America's waterways is a critical first step towards improving the nation's water resources. EPA's most recent water quality inventory shows that for bodies of water not meeting quality goals, agricultural runoff is a significant source of pollution in 60% of rivers, 57% of lakes, and 18% of estuaries. Urban runoff contributes to water quality problems for 11, 28, and 30% of the impaired rivers, lakes, and estuaries, respectively. In comparison, point sources contribute a nominal percentage of pollutants that impair the nation's rivers and lakes. Only in estuaries are point sources a significant source of pollution: municipal sewage treatment plants significantly pollute 35% of assessed square miles.[2]

EPA's analysis of public health risk (such as it is) shows that nonpoint and point source pollution pose an equivalent level of risk. Nonpoint sources, however, pose substantially more ecological risk than do point sources. Nevertheless, EPA's staffing and expenditures overwhelmingly reflect the agency's need to comply with statutory mandates that focus on point source pollution.[1] Recall that 90% of all water quality investments have been associated with point sources.

Nonpoint source controls (a.k.a. "best management practices") are, in general, lower cost and lower tech than controls for point sources. Installing porous pavement and constructing structural barriers and detention areas to retain rain runoff are examples of urban nonpoint controls. Most best

management practices, however, are appropriately targeted for agriculture (croplands, pasture lands, and livestock facilities). Reduced tillage, crop rotation, windbreaks, winter cover crops, and buffer strips between farmland and bodies of water are all used to reduce runoff of sediments and nutrients. Although costly to construct, concrete pits for manure storage can further reduce runoff pollution. Changes in the amount, timing, and frequency of fertilizer and pesticide applications can improve the purity of runoff as well. Developing more efficient irrigation methods can also enhance water quality.

Implementing these controls, in some cases, is in the economic interest of the farmer. Excessive fertilizer, pesticide, and water use drive up farming expenses. Also, soil that is washed away constitutes a loss of future crop yields. Farmers themselves are concerned about chemical use: approximately half of some 800 U.S. farmers polled in 1990 by Jefferson Davis Associates stated that they were concerned about the effects of agri-chemical use on their own health.[6]

Some agricultural nonpoint controls may not be in the self-interest of farmers, however, or may require a high initial investment and a long pay-back period. For instance, low till techniques that require specialized equipment and construction of a manure storage area for a small farm may cost as much as $30,000.[7]

Similarly, municipalities do not have excess revenues to apply to urban runoff and combined sewage and stormwater system problems. Thus, following the "polluter pays" principal may be administratively and politically difficult for agricultural and urban runoff. In these instances, federal, state, and local officials may find it necessary to establish a trading regime between point and nonpoint sources to reduce costs to industry, while paying for agricultural and urban projects. (EPA is currently encouraging the development of such strategies.)

The fundamental problem with applying these methods is that nonpoint source pollution by its very nature is site specific. Natural factors such as the amount or regularity of rainfall and the physical features of a watershed—contour of the landscape or the ground's absorbability—directly affect the severity of runoff pollution. Also the use of land and proximity to water differ greatly for each farm and urban area. In its 1990 water quality inventory, EPA cites several examples of successful nonpoint strategies, stressing, however, the diversity among these programs.[2]

Beyond site-specific considerations, best management practices involve the politically sensitive issues of land use and land management that, until recently, were almost exclusively the province of state and local governments. Both the site-specific nature of the problem and land use concerns suggest that detailed national solutions are impractical.

1.5 Federal Role

The federal role in controlling nonpoint pollutants should include primarily oversight activities and sharing of information. The U.S. EPA should stick to offering technological assistance by disseminating information about successful management practices.

Consistent with a federal role of information provider, in 1989, EPA initiated its five-year "National Nonpoint Source Agenda." Under this initiative, the agency has begun providing information on possible solutions and developing better tools for scientific assessment and analysis. EPA is also attempting to improve coordination with the U.S. Department of Agriculture and the National Oceanic and Atmospheric Administration to control nonpoint pollution. A 1990 General Accounting Office (GAO) report evaluating EPA's commitment to abating nonpoint source pollution suggests that the agency may have difficulty meeting the goals of its five-year agenda.[8]

Oddly enough, in fiscal year 1992, EPA proposed to decrease funding for its nonpoint source program by 50%. Congress subsequently restored 1992 funding to approximately the same level as the previous year. Again for fiscal year 1993 EPA has requested only half of the funding levels appropriated

in fiscal year 1992. In response of its reduced requests in both years, the agency commented: "It is inappropriate for the federal government to involve itself too heavily" in localized land-management practices. The GAO report states, however, that funding limits proposed for EPA's nonpoint program may severely limit the agency's ability to meet its own responsibilities under its five year agenda.[9]

GAO explains further that the resource constraints EPA is facing, "have been exacerbated . . . by funding priorities that over emphasize controlling point source pollution at the expense of nonpoint source pollution."[9] According to GAO, the degree of water pollution cleanup in the United States could be enhanced by shifting some of the resources now devoted to point discharges to nonpoint discharges.[10] Indeed, refocusing water quality policy should dramatically improve water quality and help preserve the nation's resources for other worthwhile purposes—environmental and otherwise.

1.6 Legislative Initiatives Ignore Progress and Problem

During the 102nd Congress, neither the House nor the Senate were able to pass revisions to the Clean Water Act. As the 103rd Congress convenes in January, clean water will once again be a legislative priority. The question is, "Will Congress view the Water Pollution Prevention and Control Act of 1991 (S. 1081)—the leading legislative proposal in the 102nd Congress—as the base from which to start or will they take a fresh look at the real issues affecting continued water quality improvement?" Hopefully, the 103rd Congress will start with a clean slate. S. 1081 ignored the relative significance of nonpoint source pollution, favoring tighter restrictions on point source polluters. The legislation also disregarded actions taken by EPA since 1987 that, in many cases, will require several years before their effectiveness can be assessed.

1.7 Recent Initiatives

Congress amended the Clean Water Act in 1987, including the first significant legislative effort to control nonpoint source pollution. Earlier statutes focused on planning and problem identification for these sources. Now, states are not only required to identify waters that are adversely affected by nonpoint pollution, but must identify specific sources of pollutants and develop "Best Management Practices" (BMP) that control and reduce nonpoint pollution. According to EPA all states now have EPA-approved assessments and management programs.

In order to pay for the nonpoint control provisions, Congress authorized $400 million to supplement state funding efforts. Appropriations of the $400 million have been limited, totaling $142.4 million through fiscal year 1992.[9] EPA is currently in the process of awarding the $52.5 million appropriated in 1992 to the states.

Water pollution resulting from stormwater drew more attention in the 1987 amendments. Municipalities with populations of 100,000 or more, and over 100,000 private sector sources—petroleum refineries, chemical manufacturers, and wood preservers, for example—are required under "phase I" requirements to obtain discharge permits for stormwater runoff. Gasoline stations, dry cleaners, large parking lots, and golf courses could be regulated under phase II permitting provisions.

Although both phases of permitting are in their infancy, the stormwater program has proven to be controversial, and for good reason: implementing an NPDES permit for a community of 250,000 costs $500,000 on average.[11] Also, command-and-control permitting limits the flexibility of EPA, state agencies, and municipalities to solve stormwater-runoff problems through alternative, possibly more cost-effective, policy strategies. On the positive side, EPA and state agencies' emphasis on "general permits" has alleviated some of the administrative burden of stormwater discharge regulation.

The 1987 amendments further addressed the control of toxic water pollutants. Under the Toxic Control Program, states were required to list waters that are impaired by toxic pollutants. States must also identify the source and amount of toxic pollutants and develop an individual control strategy for each

responsible point source discharger. EPA reports that as of March 1991, 529 bodies of water had been identified as being impaired primarily by discharges of toxic pollutants. States listed 686 point sources as responsible for the impairment of these waters. Nationally, approximately 76% of the required individual control strategies were in place as of October 1990.[2]

Further, each state must evaluate the amount of toxic discharge municipal treatment facilities contribute. Municipal facilities that do discharge toxins must develop their own control strategy to reduce or eliminate toxic discharges.

The 1987 amendments to the Clean Water Act also addressed the financing of the municipal wastewater treatment construction program. Congress decided to decentralize funding practices further than any prior effort, phasing out federal grants for construction. In doing so, however, Congress chose to capitalize state revolving loan funds with $18 billion in seed money over nine years. States are required to supplement the federal contributions with a 20% match.

Using these funds, states can lend money to local governments at low interest rates for water quality improvement projects. Loans are paid back over 20 years, replenishing the fund. As of March 1991, all fifty states had developed statutory and administrative frameworks for their revolving funds.[12] The creation of the revolving funds has allowed states to help localities finance the construction of wastewater treatment plants. States also have more discretion than ever before in that they can use these funds to control pollution from nonpoint sources and to protect estuaries as well as constructing municipal waste treatment plants.

States estimate, however, that funding provided through the revolving loan program will fall over two-thirds short of meeting their construction needs for publicly owned wastewater treatment facilities by the end of this decade. This leaves unfunded an estimated $60 billion of the more than $83 billion the nation will need to spend by 2008 to meet the wastewater requirements under the Clean Water Act.[13]

1.8 Misguided Legislation

Two particularly onerous themes ran through S. 1081. First, this proposed law ignored relative risk- and cost-effectiveness considerations, requiring strict pollution prevention measures for point source dischargers instead. Basically, this provision would have introduced more command-and-control regulation on point sources.

Regrettably, this theme of the Senate's bill is reminiscent of the landmark 1972 Act, reemphasizing the goal of *eliminating* wastewater discharges from point sources. S. 1081 actually stated that EPA would have to "eliminate the discharge of pollutants to navigable water if the Administrator finds that such elimination is technologically and economically achievable."[14] S. 1081 would have also promoted a zero-discharge goal through strict pollution prevention measures.

Pollution prevention involves reducing the volume or toxicity of wastewater through source reduction and recycling. These pollution methods are appealing, holding the promise of reducing waste and promoting efficient use of resources. The laws of chemistry and physics, however, make the task of prevention more difficult. Elimination of all wastes is technically impossible.

In most cases, economic constraints demand a level of pollution abatement short of prevention. In general, for every additional degree of effluent purity achieved, incremental (or marginal) abatement costs increase.

For example, in 1970 it cost a beet sugar plant less than $1 a pound to reduce BOD (biological oxygen demanding substances) up to 30%. But it cost an additional $20 a pound to reduce BOD

by 31 to 65%. The average cost of eliminating a pound of BOD soared to $60 in order to go from a 65% to a 95% control level.[15]

Similarly, it cost the pulp and paper industry $3 billion between 1970 and 1978 to achieve a 95% reduction in its water effluents. To reach 98% by 1984—a reduction goal proposed by EPA at that time—the industry would have had to spend $4.8 billion more, a 160% increase in cost.[16]

While incremental costs increase as effluent controls tighten, incremental benefits, in general, decrease. After the low-cost, highly effective measures have been applied, each dollar spent on abatement produces smaller and smaller benefits.

Potentially, the Senate bill would have forced point sources further along the path of increasing costs and decreasing benefits. The EPA would have had to revise all effluent guidelines to "rely upon and require, to the maximum extent practicable, toxic use and waste-reduction measures and practices including changes in production processes."[14] In effect, EPA would be forced to establish federal standards for production processes and inputs. Such approaches work at cross purposes to the most successful techniques for preventing pollution—allowing people closest to the production process to discover less polluting operations.

Manufacturing processes are numerous and extremely complex. To mandate process changes and input restrictions, EPA would need extensive knowledge of the intricacies of each industry regulated. The Chemical Manufacturers Association contends that the proposed change in effluent guidelines would replace "industrial manufacturing decision-making with EPA decision-making." Process changes and input decisions are better left to knowledgeable people closest to the operation—the firm's own employees.[17]

The second troublesome theme in the Senate's bill was "toxic use reduction" (TUR)—one of the new buzzwords for many environmental groups. TUR involves minimizing or, as in this case, eliminating the use of toxic chemicals in the production process. This approach to controlling toxic chemicals is much more heavy-handed that pollution prevention. The Senate's bill would have banned the discharge of seven chemicals including benzidine and mercury. Subsequent additions to the list would have to meet the vague and undefined criteria of being "as toxic as" the listed chemicals. These prohibitions would not have considered whether water use or human and ecological health is even affected by discharges of trace amounts of these chemicals.

During hearings on this bill, industry rightly asserted that such bans would impose huge costs on the economy, as companies are forced to change manufacturing processes.

Some constructive provisions did surface in the Senate's bill. For example, S. 1081 would have affirmed Congress' promise, made in 1987, to capitalize the state revolving fund at $18 billion. Congress would have authorized $15.3 billion over the fiscal years 1993-1998.[14] Congress also would have authorized $80 million annually through 1998 for research relating to the "cause, source, effects, extent, prevention, detection, and correction of water pollution."[14] Improved water quality science would benefit policymakers at every level of government. If these funds were used effectively, policymakers would be able to measure and compare the costs and benefits, and success or failure, of varying policy alternatives.

1.9 Market-Based Solutions

In a time when most local and state governments are struggling to balance budgets and provide essential services and the federal government is trillions of dollars in debt, funding future water quality improvement programs will be troublesome. On the other hand, the nation's financial constraints make market-oriented policies more attractive.

Effluent fees and marketable permits can allow dischargers more discretion and provide incentives to prevent the discharge of pollutants. Dischargers are encouraged to avoid the cost of polluting by investing in research and development to improve control technologies. For many years economists have argued that relying more heavily on market-based approaches would be more cost-effective than the current reliance on inflexible standards.

2.0 CONCLUSION

The fundamental objective of the Clean Water Act should be to provide Americans with the desired level of water quality for the least cost. The public desires uncontaminated fish, clean drinking water, and virus-free and bacteria-free swimming waters. The protection of natural ecosystems is also an important objective.

Developing water quality policy to ensure these societal demands, however, is presently an arduous task. During the debates on the 1990 Clean Air Act reauthorization, air quality data were abundant and emission control requirements could be linked to specific air quality improvements. Such is not the case for water quality. Current and accurate data are not available. Also, health and ecological effects of polluted water are less understood than are the effects of polluted air.

Knowledge of the effectiveness of the Clean Water Act Amendments of 1987 is also unknown and may not emerge for several years. Natural systems take time to respond to changes in human activities and EPA and the states are only beginning to implement comprehensive programs to control agricultural and urban runoff.

Controlling nonpoint source pollution is difficult, however. Solutions are site specific and often farmers and municipalities do not have the economic incentives or the financial resources to pay for best management practices. Following the polluter pays principle, therefore, may be administratively and politically difficult in these situations.

States and municipalities need to make a greater effort to find innovative ways to help fund nonpoint source control programs. Alternative solutions such as effluent fees or permit trading show promise, but their application has been limited to date. EPA, though, is emerging as a strong proponent of innovative and cost-effective market-oriented solutions.

The most significant financing option for states is the use of existing environmental revolving funds. Municipalities, however, are inundated with wastewater treatment needs, and federal funds will likely fall short of investment requirements. Indeed, financing current water-quality programs will be one of the greatest upcoming challenges for EPA and the states.

Water quality and health effects data must improve before Congress can responsibly impose added restrictions on industrial dischargers. Of course, better science will not necessarily provide an objective answer to the question of what level of water quality is the "correct" level. At present, even rudimentary analysis of this question is frustrated by the paucity of reliable information.

Considering that, even without added requirements, future costs of water pollution abatement will be huge, major changes in the Clean Water Act are premature. In other words, it is time for Congress to "take aim before it opens fire."

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Local Government Perspective on Clean Water and the American Economy

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ABSTRACT

To meet Clean Water Act requirements, Columbus, Ohio spent $200 million (its largest capital project ever) in 1988 and is continuing to invest large sums to comply with legislative mandates. Local government revenues have not increased to match expenses and sewer ratepayers have been increasingly resistive to rate increases that have averaged 10 to 12% each year to pay for the improvements, many of which are required by environmental mandates.

Understandably, city leaders were shocked to discover that they had only just scratched the surface of complying with costly federal environmental mandates (e.g., CWA, SDWA, CAA, CERCLA, SARA, FIFRA, AHERA, RCRA). It seemed that no one had adequately examined the overall financial or social impact on individual communities, communities that are having enough trouble funding traditional services.

This paper will address legislative credibility issues and future costs identified for Columbus and eight other Ohio cities. It will discuss recommendations for improving allocating scarce resources more effectively at the local level before a backlash by voters develops against costly environmental regulations that often appear unnecessary.

1.0 INTRODUCTION

I join with you on this panel today as the Director of the Department of Public Utilities of a viable, progressive, midwestern city—the 16th largest city in the country. Columbus, Ohio, has made a herculean effort to comply with the many environmental mandates that have come out of Washington. We brought to bear every community resource to comply with the July 1, 1988, Clean Water Act and invested over $200 million in this one venture alone. This investment, I might add, did not provide any increased wastewater treatment capacity, but only modified the two existing secondary wastewater treatment plants to advanced secondary treatment in order to meet new water quality standards. The resulting improvement to water quality has been significant. The state environmental protection agency recently announced that the Scioto River, which receives the discharge from both of our wastewater treatment plants, has shown a tremendous improvement in water quality. We in local government are very proud of this fact—there was a need for improvement and our investment reaped significant returns in terms of improvement to the water quality. I am not sure, however, that the citizens, or at least a majority, appreciate the work we have accomplished. They are very aware, however, of the rate increases that have been required to support this effort. Over the past few years, our sewer rates have increased 10 to 12% each year. A few years ago, one-third of our sewer revenue went to pay for servicing the debt, now more than 60% of the budget goes to service the debt. The cost to the rate payer does not include the total cost to the community when considering the efforts required of local industry to comply with pretreatment regulations. Now we find it increasingly difficult to go back to the citizens to ask for more money to properly maintain the investment we have built and also to have the additional resources necessary to replace other parts of an aging infrastructure.

Over the past few years, and more recently at a seemingly increasing rate, City Council has been asked to pass legislation dealing with various environmental compliance issues and to appropriate monies to support their associated costs. In the past, most environmental legislation before City Council was

dealing primarily with the Clean Water Act, but now matters such as asbestos abatement, cleanup of hazardous materials at the city garage, and underground storage tank regulation compliance, begin to appear regularly on the Council's agenda. In response to Council and Administration inquiries, a city-wide committee was created in February 1991, comprised of representatives from the major departments in city government and chaired by the representative of the Columbus City Health Department. The Health Department has the responsibility for managing compliance with most of the environmental regulations other than those dealing with safe water and solid waste. The Health Department was seeing more and more of its limited resources, that, in the past were used for direct human health matters, being commandeered by such programs as CERCLA, SARA, FIFRA, AHERA, RCRA, as well as underground storage tank and PCB regulations. Traditional community health programs such as health education, rabies control, and occupational safety and health have had to be reduced.

Heretofore, no one had looked at the cost of these regulations in total as to the economic impact on the community. Previously, each section of city government had only looked at its share. The results of the study were overwhelming. The Committee identified over one billion dollars (in 1991 dollars) in costs which will be incurred by the City to achieve compliance with environmental regulations over the next 10 years. With an expected average inflation factor of 4% per year, the actual cost will be over $1.3 billion. A perspective on the magnitude of these costs can be gained by realizing that the *entire* Columbus City budget for 1991 was $591 million. Identified environmental compliance costs in 1991 were $62 million or about 11% of the total budget. It is expected that the City will increase its expenditures on environmental compliance from this $62 million level in 1991 to $107 million in 1995.

The rapidly growing cost of maintaining or achieving compliance with all environmental mandates will put new and increasing pressure on the City's strained finances. It will mean that fewer funds will be available to provide other City services and that City leaders will have fewer choices and less freedom in budgeting.

Columbus's scrutiny of the cost of environmental mandates caught the interest of communities across the country. Officials in Anchorage, Alaska; San Diego, California; Phoenix, Arizona; and Lewiston, Maine, contacted us with stories similar to ours—stories showing the overwhelming burdened of state and federal environmental mandates.

In cooperation with the Ohio Municipal League, nine Ohio cities, representing small, medium, and large communities, including two metropolitan districts, formed a committee to look at the cost of environmental mandates on a broader base throughout Ohio. These cities, representing about one-third of the households in Ohio, were asked to calculate costs associated with 14 specific environmental regulations or general environmental issues. These included:

- Asbestos Hazard Emergency Response Act of 1986;
- Clean Water Act;
- Clean Air Act;
- Federal River and Harbors Act;
- Federal Insecticide, Fungicide, and Rodenticide Act;
- Resource Conservation and Recovery Act;
- Safe Drinking Water Act;
- Occupational Safety and Health Act;

- Toxic Substances Control Act;
- Title III of the Superfund Amendment and Reauthorization Act; and
- Other regulations concerning infectious waste, solid waste disposal, explosive gas monitoring, and underground storage tanks.

Only direct costs resulting from these mandates were considered, including debt service for financing of capital project construction. The nine participating cities identified $2,855,409,587 in costs associated with these 14 environmental mandates. This total reflects costs to be incurred during the period 1992 through 2001, and represents 1992 constant dollars for the 10-year time frame. The costs are *greatly* understated because only five cities felt confident in assigning costs to all 14 mandates. Even with limited reporting, it is evident that the cost of compliance, $2,855,409,587 in 1992 dollars, is substantial and that, in actuality, the total cost for environmental compliance is likely to be significantly greater.

Although the report seemed to focus on the costs of regulatory compliance, the overall goal of the committee was to look at ways to achieve more effective, efficient, and cost-effective environmental legislation. It is extremely important that a community's limited resources be utilized to achieve the maximum environmental benefit for its citizens. To achieve this goal, we believe that four basic principles must be considered when regulation or future legislation is developed. These are:

2.0 ENVIRONMENTAL LEGISLATION AND RESULTING REGULATIONS BE FORMULATED ON A WELL-FOUNDED, PEER-REVIEWED SCIENCE BASE

It is absolutely imperative that sound science be the basis for environmental legislation and that science is diligently applied as regulations are developed to fulfill legislative mandates. We are at the bottom of the money barrel so we better be sure that we are attacking "real" environmental risks that are scientifically proven and not just perceived risks that we have often chased in the past and I am sure we are still chasing. We are running out of resources chasing shadows. Columbus is taking the initiative to become more aware of scientific aspects of proposed legislation and regulations by establishing an Environmental Science Advisory Committee that will consist of a distinguished body of engineers, scientists, educators, and other professionals who are all recognized in their field. It is planned that this committee will evaluate the accuracy and scientific basis of costs and financing projections of environmental mandates, and also evaluate the accuracy and scientific basis of environmental projections and health information.

3.0 LOCAL GOVERNMENTS BE ABLE TO PRIORITIZE THEIR RESOURCES TO ACHIEVE THE BEST UTILIZATION OF LOCAL TAX DOLLAR EXPENDITURES FOR ACHIEVING THE GREATEST ENVIRONMENTAL RISK REDUCTION

Under current federal and state environmental policy, all communities are treated equally and all mandates are applied uniformly across all mediums of land, air, and water. With this practice, local communities are forced to allocate limited resources to whatever initiatives are mandated by the federal government even though the most serious environmental risk to a community is not addressed. Discussion needs to occur with local communities that allows for a process to first identify the appropriate environmental risks, and then allows the local community the opportunity to meet with the state agency and, where appropriate, U.S. EPA, to establish a workable time frame to obtain compliance in a realistic manner that targets the most severe environmental risk first.

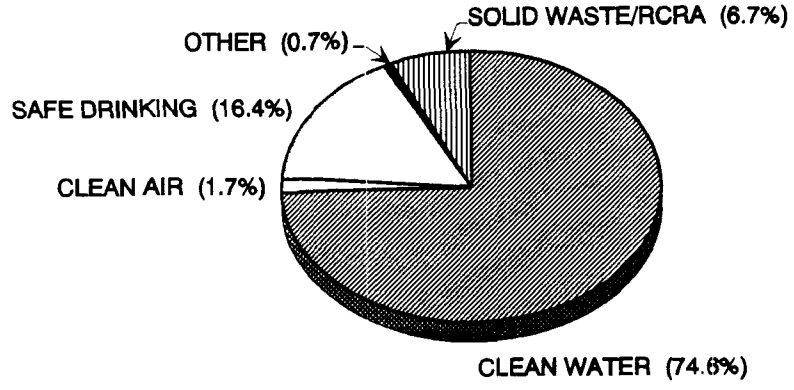
4.0 ALLOW FLEXIBILITY FOR CONSIDERATION OF LOCAL ENVIRONMENTAL CONDITIONS AND THAT THIS FLEXIBILITY BE INCORPORATED AS A MATTER OF PROCEDURE INTO THE FEDERAL AND STATE ENVIRONMENTAL REGULATORY PROCESS

Current environmental mandates treat all communities the same regardless of local conditions. This practice has led to certain environmental control policies that are not defensible for specific local communities. Examples include the requirement in the Safe Drinking Water Act that dictates testing annually for the pesticide DBCP in Ohio, which has not been used for 15 years, and, even when it was used, the primary use was on pineapples in Hawaii. We must remember that this is a big country with a vast range of topographic, geologic, and climatic differences. But still we are forced to apply the same stormwater mandates in the arid Southwest as are applied in the eastern part of the country. There has to be a recognition of the differences between regions of the country, and a process that permits flexibility in solving environmental problems. I firmly believe that local communities are committed to a cleaner environment, but attempting to apply "across the board" solutions to local environmental problems results in a waste of local resources which could otherwise be utilized in a far more efficient manner.

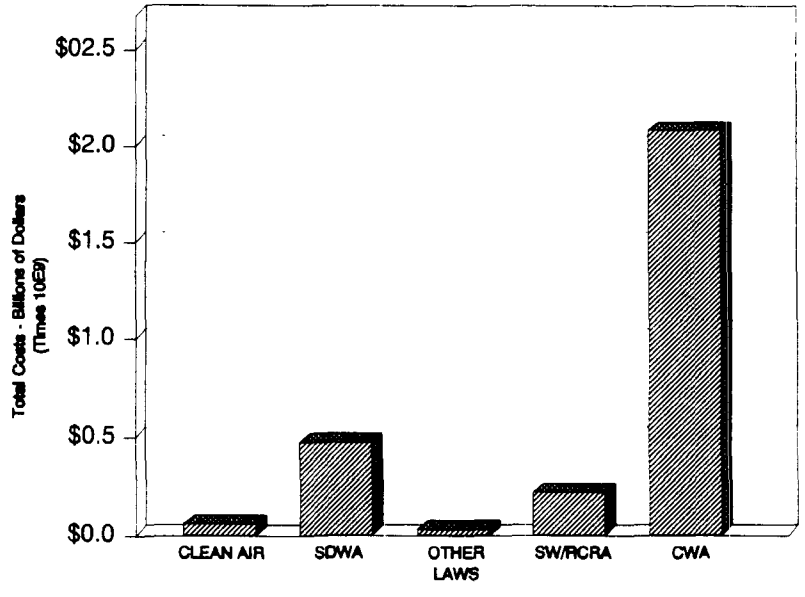
5.0 LOCAL GOVERNMENT BE AFFORDED THE OPPORTUNITY FOR FULLER PARTICIPATION IN THE FEDERAL AND STATE ENVIRONMENTAL LEGISLATIVE AND REGULATORY PROCESS

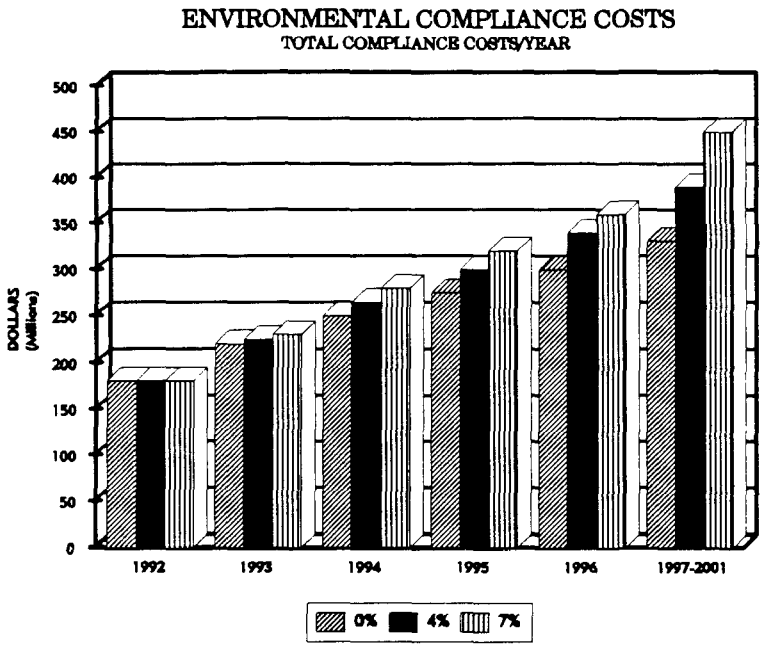
Legislation enacted at the federal and state level and the subsequent rulemaking, has a tremendous impact on local government. This is particularly true with respect to environmental legislation. Environmental and business organizations have been very effective in forming coalitions with interested parties to influence public policy. The interest of these groups might not be in the best interest of good public policy, and sometimes lack the common sense input of the local government representative who will have to implement these new legislative initiatives. For example, strict environmental regulations not based on science, could literally drive a company looking for a new site to virgin agricultural land away from the city, rather than attempting to locate in a vacant urban industrial area. This leads to the erosion of the local tax base and contributes to urban decay leading to a host of social problems. I ask, is this good policy? I think not!

ENVIRONMENTAL COMPLIANCE COSTS
STATEWIDE SUMMARY BY LAW



ENVIRONMENTAL COMPLIANCE COSTS
STATEWIDE SUMMARY BY LAW




ENVIRONMENTAL COMPLIANCE COSTS
TOTAL COMPLIANCE COSTS/YEAR
DOLLARS (Millions)
500
450
400
350
300
250
200
150
100
50
0
1992
1993
1994
1995
1996
1997-2001
0%
4%
7%

Luncheon Address

F. Henry Habicht, II
Deputy Administrator
U.S. Environmental Protection Agency
(transcribed from audio tape)

This is, needless to say, an important conference and an important group, and I think I'll be relatively brief and see if anybody has any questions left for what Bill Reilly and I see in terms of how all this fits with our agenda.

What's important, and I hope it came through over the last couple of days for those of you who haven't worked directly with this team, that they have spent a lot of time over the last two years in a very busy office. Like all of us in the Agency, I'd like to characterize it as being open for business during renovations. We have a lot of basic, traditional, important work that we have to do, that we have to get out.

And we don't have enough time or people to do it, but we're also changing the way we do business and that takes time and effort. The water office spent a lot of time over the last two years reviewing the whole picture of the water plan as they call it, and what should the strategic direction of the program be. And I think obviously this conference is the result of those efforts. This is very exciting stuff. That's why I'm glad to be here.

I also think it's important to bridge the cultures of the environmental policy community and the economists. There is a story that some of you have heard. One of the problems with this gap is that this gulf or this gap hasn't been bridged in the past. It is the story of a bank robber who successfully robbed a bank in the Northeast and got away single handedly with $1 million.

Federal agents chased him across the country and they finally cornered him in a small town in the Southwest. And when they cornered the guy, he didn't have the money. He didn't speak English. He spoke an arcane foreign language that no one understood.

They finally found one person who could serve as a translator and he proceeded to interrogate this guy for hours, working on him and working on him, and he refused to talk. Finally the agent pulled out his revolver and put it to the prisoner's head and said to the translator, "Now you tell him in his language that if he doesn't tell me where the money is right now, I'm going to pull the trigger."

So the translator translates it for him. The guy broke into a sweat, and he said in his own language, "All right, all right, I'll tell you. I buried the money under the oak tree in the town square." The agent said, "Well, what did he say?" The translator said, "He said he's not afraid to die."

There are communications problems in a whole area of disciplines, and I know you discussed what is really one of the standard stump issues in the campaign now, which is, is there a dichotomy or a tension between environmental protection and jobs, environment and economy. And I guess my thesis and the thing that I think we need to come away with, and I'm sure you will, and I'll just give you a few things to think about that might pull together some of the discussions you had over the last few days, is that we don't have the ability to answer that question.

I think most of us who are both optimists and been around the field enough to know how important environmental protection is in terms of preserving resources, in terms of the compatability of improving productivity and reducing waste and pollution, believe that there is not an inherent tension

between the two, that properly conceived environmental programs are actually helpful to the economy, both in the near term and especially in the long term.

But we don't have the ability to prove it. We haven't advanced our discipline far enough to be able to really make that case, develop data to show it, although we are doing. We are beginning to do that and that's what this conference is all about. And what I want to get into is what I think we need to do over the next few years to really make that happen and be able to show that.

I hope most of us here believe that there is not a fundamental incompatibility, and that our society has organized itself around a very sound approach to development in a way that is totally consistent with technological advances and growth and jobs and everything else that you all care about, including keeping a good quality of life in this country and around the world, so I think that's what this is all about.

So I will try to give you a few thoughts at the risk of being repetitive. The only way I couldn't be repetitive is if I talked about stratospheric ozone. But you may have covered that too.

Anyway there is hope. There is another good campaign story about the importance of hope. President Truman was on his whistle stop campaigning tour and he stopped in a town. While he was talking to the citizens and shaking hands, one guy told him, "President Truman, I just wanted to come up to you and tell you that I'm going to make sure to vote in this election. The reason I'm voting is so I can vote against you. I think you're an idiot, and even if a horse was running against you, I'd vote for the horse." And Truman said, "Thank you very much." And he turned to his aide and he said, "Put that man down as doubtful."

Hope springs eternal, and that's what this is all about. I really think that the major thrust of our agenda, and those of you who work at EPA—and I see a number of our stars here—have heard some of this before, but I want to put into context where economics fits into the overall generic strategic thrust that we have all been pushing at EPA.

The key thing is the importance that we institutionalize economic sophistication in everything we do at EPA. We build bridges through the economic community. And those of you outside of EPA and for those of you who are economists inside of EPA, that's part of the dismal science. Those of you who lie awake at night hoping to see how it will work in practice, can work in theory, will work to advance resource economics and environmental economics as a discipline, as something we encourage students to get into, and we can weave into everything we do at EPA, for our overall agenda.

And I think a lot of us say, well we've been doing a lot of economics relative to these issues. We've been doing all kinds of economic analyses. But I think it's fair to say that as I have interacted with economists, and I'm not an economist, I have a little knowledge, which is a dangerous thing, that the economic discourse about the environment has either been at almost an irrelevant level of distraction in theory or at a myopic level of specificity that has left us unable to weave together important principles of economic discipline and what we do. So that's what the agenda is all about.

At EPA, I hope not an excessive number of themes that I've tried to keep repeating over and over again at the Agency at the broadest level, the things that we try to do at the Agency to simply keep doing better and better as an institution have been to focus on two of what I think of as shortcomings institutionally at EPA over the years, which I have mentioned many times.

The first one is that we have been too compartmentalized. We have taken too much of an ad hoc stove pipe approach to our work because of the way the statutes are written and all the other reasons that you are familiar with. We all know it's a problem, but if we are going to get through it, we have to focus on it as a problem.

It has to be a major priority to the Agency to come to grips with and to address once and for all, and that obviously involves Congress—even within the water program and its compartmentalization. I think the watershed approach is a major breakthrough in our ability to function in protecting both water resources, but also environment.

The second shortcoming is that, again, probably more than anything else, things have been so busy because there has been a great mistrust in environmental protection. We have been too insular. We haven't built a lot of relationships. We haven't engaged state office holders and constituent groups early in the processes. We've kind of wanted to know sort of where we wanted to come before we engaged people. That has changed. That is not something that is truly the case now. But that's been improved a lot. Our agenda is focused on building partnerships and bridges, listening to people, and to looking at the environment without being compartmentalized.

The water office has helped the Agency in building our foundation on science, setting risk-based priorities and trying to separate the important long-term risks from the less significant. And organizing our activities coherently such as around watersheds, around the geographic area above the Great Lakes, or the Chesapeake Bay. These are critical components of the new direction of the agency, a strategic risk-based integrated approach.

The second major element is pollution prevention which, once we've set the priorities, is the approach of choice. It's obviously the choice to prevent as much as we can. The important element that I keep talking about is prevention, which is inherently an approach which can go toward market-based kinds of approaches to a few self-interested firms and also a few voluntary approaches.

And then, finally, using principles or adapting principles in total quality management to help implement these programs. I won't belabor that. I'd be happy to respond to questions. You've heard me talk about it before. It's obviously not just taking over Japanese theories and trying to apply them to the EPA, but it's taking those principles and applying them to a government agency with a very important mission.

So that's why it's so important in order to achieve any of those goals and it's going to take a lot of time to do it, through pushing cluster groups and geographic and watershed approaches. We have to invest more in science. We have to invest more in economics. Well, as we move on from what we've learned here, let me just offer three areas, which I hope you heard in one form or another, as I think of economics at the Agency, that I think are important to take what we've learned here and try to institutionalize it as much as we can.

The first is to use the science of economics to value resources more effectively. I just learned today that the water office, for reasons that are totally understandable, has not been involved in the regulatory impact analysis for the corrective action rule under RCRA, which I hope is going to be breaking new ground, if you will pardon the expression, in valuing groundwater resources and getting away from simply arguing benefits of the groundwater protection rule based on avoidance, which we know has gotten us into a hole.

There's more to it than that, and we haven't done a good job of being able to quantify what the other economic benefits are so we can make healthy decisions. So we are continuing to improve our ability to value resources, so we can set priorities, so that we understand better what the benefits are.

I think I would agree that not everything we do in the environmental field and every reason for doing it is reducible to dollars and cents. Obviously there are fundamental value choices that are involved, trying to transcend whether there is an equation between cost and benefits.

But the gulf is so wide now because there is a perception that is often a massive gulf between cost of reducing pollution and preventing it and the benefits, as I'm sure has been discussed quite a

bit over the last few days. I think we can go a long way to closing that gulf and understanding the choices we make much better by really working on a value. And I think the resource economics field is worth it. Many of the things our people have done—and the SAB economics committee is doing—I think it really has hope of advancing the ball in this area.

But we all have to invest in that. And I do think that if a watershed approach can help us to be able to quantify and characterize in terms that people can understand these benefits. I know in reading some of the economic literature on resource economics, we have a long way to go in terms of communications.

It's kind of like that interrogator in the foreign language. I have read environmental resources referred to by economists as social overhead capital with quantifiable service flows and hedonistic values. Well, that's going to grab your average person on the street about why we're protecting Lake Superior, but it's a start.

But nonetheless, we are at least beginning to get a conference focusing on what does it mean to address this issue. And I do think watershed approaches is, again, the way to organize our thinking on it. So that's the first point. Just improve general valuation. Bring resource economics into the valuation of national income accounts around the world. This is certainly something that is a gain worldwide and we can take the lead on that as a group evaluation.

The second area is to better understand and capitalize on the incentives that operate on individual firm and marketplace. And we're doing that as well. It helps to be disciplined and rigorous and institutionalize, to focus on the firm, what motivates the behavior of the individual firm, whether it's a farm or a manufacturing entity or a gas station or whatever it happens to be. I want to flag this as a very important part of why we've done what we think we've done over the last few years.

The relationship between total quality and firms' decisions to reduce waste because there are economic benefits or energy efficiency, or water use efficiency if water resources were priced reflecting their real value for cost, there would be clear economic firm-related interests to reducing energy use, reducing water use, or reducing waste and so forth. You have all seen plenty of data about that, and that keeps getting better and better.

And that's why I think new approaches that we have been pushing through voluntary programs, such as designed to the environment, which is a systematic way of looking at the environmental, economic, and basic product quality impacts of different approaches to manufacturing. I have been making a choice based on optimizing environmental impacts, costs, and product quality. It's the wave of the future.

I think how we do it is not necessarily going to lend itself to traditional regulatory approaches, in a few weeks we'll be having a demonstration by the dry cleaning industry of a wet cleaning, a nonsolvent, a nonperc approach to dry cleaning clothes. We don't know if it will work. We don't know if it might create more problems than it solves, but the point is that a designed to the environment approach may work with that industry, with the printing industry, with the computer work station. I just met with them yesterday and they are actually gung ho about trying to design to the environment every product that the computer business industry manufactures. What they told me is not only did they see long-term cost structure benefits to it, but they also see that it's being driven by their customers. Their customers are demanding to know that a company is doing everything they can possibly do to reduce their waste and to think about the life-cycle impact of their products.

So these are all basic, self-interested kind of motivations that can be appealed to. We need to get them the information so that they can make the right choices. Make sure the consumers are informed. The TRI is obviously a powerful tool to do that. And to advance the science of life-cycle analysis and designed to the environment so we can really make progress in this area of just understanding the self-interest of the firm.

And then the third element is where do we go with economics into the Agency. Again, there are many more, but these are the three that I think are particularly important. It flows from the first two, once you have an understanding so that you can set priorities and basically gauge whether the regulation is worth it in terms of overall social and economic costs and benefits.

And second, look at what self-interest and motivated firms will do. You need to work on building a market. You need to look at working on the entire marketplace and seeing how we can advance the most environmentally sound behavior through the marketplace.

And Mark and his team and Martha and others have really been pushing the envelope with EDF and others on point/nonpoint source trading. I certainly won't get into that. I know you've had a lot of discussion about it. But I do want to mention how important Bill and I think this is. Market-based approaches are by no means the province of the Clean Air Act at all.

There is a lot of skepticism on whether those work. Whether you can trust accounting systems that will grow up around trading systems. But we believe that they can work. We're learning. Certainly no one would have said five years ago that the Chicago Board and Trade, with the EPA's delicate deed, would set a market in smog futures, but that has happened.

And certainly in Southern California, people would have been doubtful that you could set up a marketplace involving more than 2,000 firms trading in very complex kinds of pollution in an airshed, but we find that program in California is by no means over the hump, but it's a growing force and we can learn from that.

And I think some of the lessons—certainly not all—can help us. I know that our team has identified, I guess over 800 possible candidates for point/nonpoint source trading activities. We've been involved in the Cherry Creek project in Colorado and Tarp Pamlico in North Carolina. There are some opportunities to use what we've learned, to engage the agricultural community, a lot more in California and elsewhere, and we're committed to work on that. And certainly point/nonpoint kind of pretreatment trading is very much a possibility.

Again, the thrust here is simply that once we have developed some sophistication about how to measure and how to value things, our horizons just open up dramatically in terms of what we can do, in terms of using the marketplace not as a replacement for traditional regulations. There will always be a need for that, but as a supplement to expand all the tools we have to work with.

I just mentioned two other areas that don't neatly fit into my three-point construct I just went through, but certainly are important. I know you talked about one is the world market—and there is always debate about whether strong environmental regulations create jobs or have some marketplace benefit.

The export market is so substantial and so robust that we have to be sure that we are aware of it, we capitalize on it, and to the extent appropriate after we've made sure we have met environmental goals, make sure that those markets are as available to our people as possible.

Certainly in the area of harmonization we want to be ahead of the curve. Basic trade policy is going to change forever after the GATT agreement and what's going to be going on in GATT that will lead to harmonization; we can be leading thinkers as the world comes more together on how we can make sure environments can is an important factor in trade but are not an unfair trade barrier.

So again, through the economics and the science of value economics, number one. Number two, we can find ways to appeal to the self-interest of firms by understanding what makes them tick, and wiring ourselves to work, capitalizing on that as long as we can. And third, use what we've learned in those two areas to build marketplaces for reducing pollution. Obviously we have to have data. We have to have

reliable information that we can count on. But I don't think there is any doubt that the environment will be protected more quickly and more effectively if we can harness that kind of information.

Again, my personal view is that the only way to achieve this is for us to really address what we've been doing in watersheds, and understanding of watersheds—more impact activities around watersheds to give us a chance to really focus on nonpoint sources and how they relate to point sources and so forth in developing strategy.

I'm sorry I didn't get to hear Dave Gibbons talk about trading as a major regulatory program for agriculture. Certainly where you stand does depend on where you sit. But, anyway, all those ideas are worth looking at. So my point is that we all have to invest in this new way of thinking and acting. Substantively, in terms of our professional discipline, in terms of our money for research, and politically, because any change is threatening, we have to be able to stand up and say this is the way we have to go, and make sure that it happens. So that's what is critically important.

I was at a conference with Paul Pourtney in Colorado a couple of months ago. Dick Celeste, the governor of Ohio, told a story. He was a very young politician running for his first statewide office and he was out in rural Ohio. He was driving very quickly from one event to the next and he got to a fork in the road, and sign said Smithville this way six miles, and then going in the other direction it said, Smithville this way six miles.

He was totally confused. And there was an old guy standing nearby and he said, "Excuse me, I'm Dick Celeste, I'm running for governor. By the way, this sign says that Smithville is both ways at the fork in the road. Does it make any difference which one I take?" And the old guy just looked at him, "Not to me it don't."

I think the fact that we in the environmental field and the economics field have not only spoken plain English, but the fact that a lot of people may not care as much about these issues in terms of approaches as they should. I think if we work on translating this into plain English and engaging the public on these choices, economics will have a major role and be a lot more important in the future of environmental programs.

Shortly after I started at EPA, I talked about the Joel Barker film that a lot of you had seen. He talked about the Swiss watch industry. It's a true story. Up until the sixties, the Swiss watch industry had about 70% share of the world's market for wristwatches, and everything was going great. They were employing thousands of people. And then, within eight years, the market share dropped from almost 70% down to about 12% of the world market for wristwatches. And the reason for that is the quartz movement. Most of us have quartz watches now. What I had never known before was that quartz movement was invented in the laboratories at the Swiss watch industry. The scientists in the Swiss watch industry went to the senior leadership to demonstrate the idea. They said it was ridiculous. It doesn't have the springs and the jewels that has made us so successful all these years. The rest is history. Now the Japanese and a few others picked up on it and as I said, it's an important lesson.

I think what the water program and you here have come upon is the quartz movement of environmental protection, but it won't necessarily sell to our leadership unless you go back and sell it and make sure they don't pass it by and miss the opportunity. It's really the future of environmental protection that will help once and for all solve this economy/environment dialectic we have going.

So, again, I thank the team here at EPA for putting this conference together. I thank you all for coming, and we look forward to working with you. Thanks very much.

Closing Remarks

Martha Prothro
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(transcribed from audio tape)

LaJuana is very busy trying to accomplish some of the few remaining very high priorities for the rest of this year; she wasn't able to join us now. She has asked me to say a couple of things.

I wanted to share with you the story about who an economist really is, what economists do. An economist can look at the rumpled sheet and tell us whether it was done for love or money. I couldn't help thinking about this during the last panel, because Bob Adler was clearly saying they do it for love, and a lot of other people related it to the money.

But it occurred to me that really most of our panelists throughout this conference have kind of accepted the idea that we do it for love. But how we do it has something to do with money. And one of the good things that came out of this conference was that it kind of leads you inexorably—an economist can make you do this; I know, I've got some on my staff—it kind of leads you to well, wait a minute now, are you really attacking the real problem? Or is there a problem out there that's bigger than the one you are dealing with and you're not facing it?

And I think that is one of the reasons we ended up today talking so much about nonpoint sources. And I can tell that was something that all of you were sort of captured by too, because I could tell by your questions that were sent up to the speakers, that you're all wondering, not just should we, but how are we going to do this?

It's so clear, now that we've all talked about it, that that's something that we need to deal with. It's true that the Office of Water hasn't done enough in the past in terms of economic analysis in allowing a consideration of cost/benefit and that sort of thing to drive our program. We used to be much more focused on it than we have been recently. And I think that this conference has really shown a lot of us how important it will be for the future, for us to stick to this and to rigorously analyze what we're doing in our programs and what our options for the future are.

One of the things that LaJuana did want me to pass on, and I'm sorry that Dave Gibbons isn't here, because I told her what he said today. She admitted that she asked him to be provocative, which he certainly was. But she also was a little surprised by what he said, after all these years that she has dealt with him. She was glad he got out of his rut about not doing anything with nonpoint sources. So I guess we all feel like he implied that EPA didn't want to do anything about nonpoint sources. We think we have been doing things with nonpoint sources, that we've come a long way and that we have a lot further to go. But I wanted to reassure everyone that we are on that track.

We were talking at the table about whether or not a coalition of industry and industry consultants, plus environmental groups might actually lead to a regulatory program for nonpoint sources in the re-authorization of the Clean Water Act. And my personal view is that's not going to be enough.

That a firm still occupies a special status in our society and to have a regulatory program, that's sort of treating agriculture as another SIC-code is unlikely for our program. But I think we are

moving in slowly and inexorably, as I say, into the nonpoint source area. All states now have provisions in nonpoint source programs that allow them to issue orders to farmers who are causing water quality problems and they are required to clean up those problems.

This is not a permit program. It is not an effluent guidelines program. But it's something that we've got out there and most of the agricultural folks that we talk to support this kind of an approach. Now we haven't fully implemented it. We haven't given a tool to the state's that meets localities' needs to really make this work. But I know certain family history that, under the right circumstances, even farmers can support some kind of regulation.

My father's family comes from Arkansas, actually a little town in Arkansas named Prothro Junction. And I always have to point out to people that it was named Prothro Junction not because we were the most distinguished family, but because we were the most numerous family.

But I think the key thing the farmer cares about is not having to do paperwork and making sure that whatever it was they are required to do, reflected their own values. And in this case, they had blue laws and farmers weren't allowed to plow on Sundays. My grandfather, who had a third-grade education, was the justice of the peace, and he sent many a farmer to jail for a day or two, all for plowing on Sunday, because the other farmers would ride by and they would see these guys out there plowing, and they would go and make a citizen's arrest and bring them to the justice of the peace.

Sometimes they'd pay a fine and, if they didn't have any money, they might spend the night locked up in the back shed or something. But that was something—we would probably never do anything like today, but in those days, that reflected their values. They supported that. The community was together on it.

I think we have the farmers on our side as far as valuing clean water, and can we find a way to do it without the paperwork, I don't know. That's a real challenge for EPA.

Everything is economics, I think. That is, I don't know how else to sum up this meeting. Everything kind of leads us to the question of what our values are as well, not just the price, but the values. But I like the fact that economists now tell us that things go in cycles so that we don't feel like we're running around in circles. I'd rather go around in a cycle than around in a circle.

Well, I want to thank all of our speakers, many of whom have left, unfortunately. I certainly enjoyed and benefitted greatly from the conference and I hope that you have too. I think we ought to do this type of thing more often and I would like to stay in touch with the people we've met here. We've got a lot of insight, a lot of valuable information. And we want to hear from you as well. I hope you'll look at the proceedings and send us your ideas and stay in touch on these issues.

And again, I want to recognize Mark Luttner who has really been a key person in organizing this. Thanks, Mark, from all of us for a fine conference.

Appendix

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