CAN WATER POLLUTION POLICY BE EFFICIENT?

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Introduction

In 1972 Congress established the Federal Water Pollution Control Act in which the Environmental Protection Agency was given responsibility to "restore and maintain the chemical, physical, and biological integrity of the nation's waters." Two national goals of "swimmable and fishable" in 1983 and "zero-discharge" in 1985 were set forth.

The 1972 law set up a national permit system for direct regulation of discharges from industrial and municipal sources, making it illegal to discharge wastes from point sources without a permit. The permit states discharge limitations for specific pollutants, establishes schedules for upgrading controls, and requires monitoring and periodic reports. As of February 1980 a total of 58,907 permits had been issued (15,395 municipal dischargers and 43,512 nonmunicipal dischargers).

Municipal dischargers were required to achieve a level of secondary treatment by 1977 and all other dischargers (mostly industrial) were required to use the "best practical control technology currently available" (BPT) by the same date. By 1983 municipal plants were to achieve BPT and industrial dischargers were to achieve "best available technology economically achievable" (BAT) in order to progress to the national goal of eliminating discharges of all pollutants. Note that the emphasis is on emissions from point sources. EPA was given no specific authority to regulate pollution from nonpoint sources.

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As of 1980, EPA reported that the industrial dischargers had a compliance rate of 80 percent. By contrast, municipal dischargers have been slow to comply despite being eligible for construction grants, with a compliance rate of 40 percent with the 1977 requirements. In February 1980, EPA estimated that 63 percent of major municipal treatment facilities were not yet in compliance with the original July 1977 deadline. By the end of 1979, EPA had obligated $24.4 billion in construction grant appropriations (75 percent of construction costs) to municipalities for sewage treatment plants. Construction had begun on 6,623 projects but only 1,552 were in operation. EPA inspections of operating municipal sewage plants reveal that less than one half perform satisfactorily because of operation and maintenance problems. Apparently, EPA is in a poor bargaining position with reluctant municipalities to require compliance because of lack of effective sanctions.

In the last decade some success in the control of water pollution has been achieved. A few areas have seen some dramatic improvements. Many industrial point sources of pollution are now under control, but municipal sources remain a serious problem. Moreover, more than half of all pollutants are coming from nonpoint sources that are currently uncontrolled. The most important nonpoint sources are urban storm runoff and runoff from agricultural activities. Also, toxic pollutants in surface and ground water are a major concern. For example, even though salmon are returning to the mouth of the Hudson River after a 75-year absence, they should not be eaten because of high PCB (polychlorinated biphenyls) contamination. Also, many states are finding synthetic organic compounds in wells of public water systems.

With the adoption of a program based almost exclusively on direct governmental controls, with almost no reliance on economic tests for efficiency, and with no reliance on private property and market-type approaches, no one should expect a favorable outcome. Congress has established a complex and cumbersome program of detailed regulation with a set of goals that fail to include economic scrutiny of benefits and costs. Most observers conclude that water pollution control programs in the United States are expensive, largely ineffective, and wasteful. This is ironic because the rationale for public intervention in the control of water pollution is to combat the inefficiency caused by unregulated use of water resources.

This paper will assess three instruments for management of water pollution: Direct regulation, effluent charges, and tradable permits and the role each can play in achieving efficient water pollution control. We will look at the failure to estimate benefits stemming from present policies and possibilities for more reliance upon market mechanisms and property rights in efficient water pollution policies. Finally, we will focus on the need to adopt policies that deal with management of nonpoint sources, groundwater protection, and the control of toxics. These areas tend to be neglected in a policy aimed largely at controlling point sources of conventional pollutants in surface waters by direct discharge regulation.

Defining Pollution

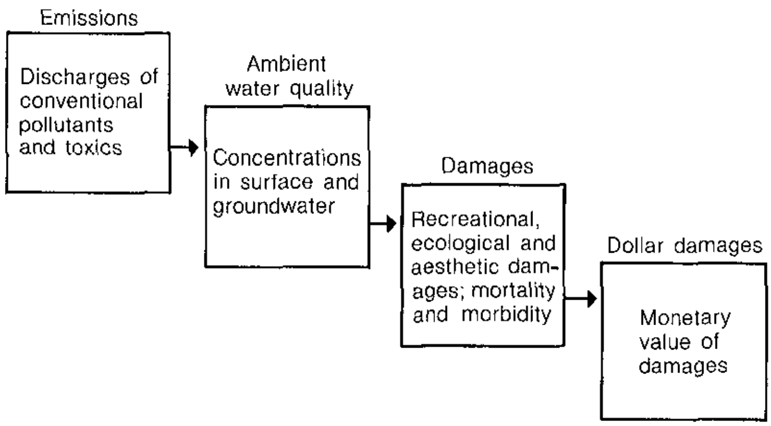
Pollution can be defined as damage to the services provided by the environment caused by the disposal of residuals from production or consumption activities. The discharge of residuals includes heat, noise, and damage to aesthetics as well as the discharge of solids, liquids, or gaseous materials. We will be concerned with the pollution caused by the actions of man although it is clear that the actions of nature also cause the emission of materials into the environment that can reduce its services. Air pollution from volcanic action is well-established. Likewise, natural oil seeps can cause damage to aquatic food chains.

The cost (or damage) of pollution is the value of environmental services foregone by the disposal of residuals. The damage to the environment is both a function of the volume of discharge in relation to the assimilative capacity of the environment and the location of the use of that environment (primarily by the location of receptor activities). In other words, if there is little stress on the assimilative capacity or if there are few activities harmed, the damage will be small.

Four Steps in Estimating Pollution Damages

Four steps are required to go from estimates of water pollution discharges to dollar estimates of damages. Each step involves information gaps and measurement error, and the level of ignorance increases with each step. As can be seen from Figure 1, pollutants like conventional biochemical oxygen demanding substances (BOD) or toxic pollutants such as asbestos, benzene, or mercury are first shown as emissions. We then progress to ambient water quality in streams, lakes, or underground waters. Changes in ambient quality produce damaging effects on humans, plants, wildlife, and property. Step three involves identifying an adverse effect and attributing it to the change in ambient quality; i.e., specifying the dose-response function. In step four the researcher attempts to put a dollar value on the damages sustained from water pollution or, conversely, on damages averted by pollution abatement.

FIGURE 1
STEPS IN ESTIMATING POLLUTION DAMAGES



Steps one and two involve the assembling of data on emissions and on ambient quality from both point and nonpoint sources for various surface waters and for ground water. The problems associated with water quality data are immense — the sparsity of data, nonrepresentative monitoring sites, and limited detection capability for some pollutants make for poor data quality. There is also a lack of coordination across programs. A federal task force found more than 100 water monitoring programs managed by 20 federal agencies, which spent approximately $275 million in 1978 (CEQ 1980). State and local monitoring were not studied.

Surface waters are visible and tend to be better monitored. Less visible ground waters finally are receiving attention because of contamination from toxic organic and inorganic chemicals. Because ground water is widely used for drinking water, infiltration of toxic chemical pollutants may be posing health risks. Only recently has EPA instituted a statistically designed monitoring survey for ground water.

Nonpoint sources of water pollution are ones where there is no obvious outfall or pipe for discharge. Nonpoint sources are diffuse, difficult to identify and to control. The most important nonpoint sources are runoff from agricultural operations, urban storm runoff, runoff from mining and forestry activities, and from individual septic systems. The General Accounting Office has found that more than one half of all water pollution is from nonpoint sources (GAO 1977). Yet the Clean Water legislation and economic literature devote little attention to this problem. More control of emissions from point sources may do little to improve ambient quality where nonpoint pollution is serious.

Using U.S. Geological Survey (USGS) data and EPA water quality definitions, the Council on Environmental Quality (CEQ 1980) analyzed six pollution indicators in rivers and streams. The pollution indicators were for fecal coliform bacteria, total phosphorus, dissolved oxygen, total cadmium, total lead, and total mercury. The results showed little or no change in ambient water quality from 1975 through 1979. This has been interpreted as "good news" since population and gross national product increased during the period. However, it appears that EPA criteria for swimming and preservation of aquatic life were frequently violated by the indicators.

In step three it is fair to say that the range of uncertainty about dose-response functions is large. There is considerable debate about the existence of thresholds and factors of safety. Responses vary greatly among individuals, property, and plant and animal species. Long-term and short-term exposures cannot be equated. Also, epidemiological studies are scarce.

With regard to damages caused by low ambient quality, the usual practice is to employ thresholds developed by EPA for water quality and to assume that violations of these thresholds cause damages. However, the extent or quantitative measure of the damages resulting from violations of thresholds and standards is not known. That is to say, *reliable measures of total damages stemming from water pollution by region or by watershed do not exist.* Furthermore the thresholds developed by EPA are not universally accepted. In its study of water quality conditions for surface water, CEQ used annual median concentrations for 1975 to 1979. Although annual median concentrations may be useful to pick up violation rates for thresholds, such data do not say very much, if anything, about the actual extent of damages. The thresholds themselves appear to be related, for the most part, to the preservation of aquatic life. Yet data on damages to aquatic life resulting from these threshold violations in the field do not exist.

Step four involves putting dollar values on damages sustained from water pollution or, conversely, on damages averted by pollution abatement. As one might expect from the discussion of damage estimates in step three above, *there exist no credible estimates of the overall benefits being conferred by the federal water pollution control program.* In this context, Mills (1978, p. 128) has stated: "It is incredible that an expensive national program has been undertaken with almost no analysis of the benefits it will confer on society."

It is generally believed that the major source of benefits from water pollution control will be from enhanced water-based recreation (swimming, boating, and fishing) and aesthetics. A report prepared for EPA in 1976 using 1973 dollars, but estimating benefits of water pollution control upon hypothetical conditions expected to prevail with use of best available technology and zero discharge in 1985, found that annual benefits would be $10.1 billion a year from eliminating all water pollution. More than 60 percent of all estimated benefits were from recreation. Ackerman et al. (1974) examined proposed recreational benefits from cleaning up the Delaware River and found them to be trivial in comparison with the costs. Freeman (1979) points out that there is a substantial body of research on estimating demands for outdoor recreation, but little work has been done on the role of water quality in influencing the demand for recreation. Because of insufficient evidence no one has attempted to estimate the health benefits from the elimination of possible chemical contamination in drinking water.

A complete economic analysis would require a comparison of the benefits with the estimated costs of control. No such study has been made. We cannot even find an estimate of the total costs of water pollution control to date. CEQ (1980, p. 394) estimates that annual costs for "incremental" (the increase in spending because of new regulations) federal water pollution abatement were $12.7 billion for 1979 alone. The cumulative estimate for 1979-1988 was given as $169.7 billion for federal programs and $250 billion for all federal, state, and local regulation.

As far as we can tell, these future cost estimates are largely for control of point emissions with virtually no attempt to cost out control of nonpoint emissions. There are two aspects of the omission that need to be stressed. First, costs for control of nonpoint emissions are likely to be high. Second, unless we control nonpoint emissions, the incremental benefits of increased control of point emissions may not be very large.

Already, we have seen that the control programs on point emissions through 1979 have not improved water quality as conventionally measured. Regional improvements in some areas are evident, but on a national level, the best we can conclude is that surface water quality has not deteriorated in the face of growth in population and GNP in the period 1975 to 1979; in other words, national water quality is virtually unchanged. One must be skeptical that a continuation of present programs of expenditure and control for point emissions will lead to dramatic improvements by 1983, 1985 or 1988. It now appears that the EPA's report (1976) on benefits to be forthcoming in 1985 from zero-discharge was based upon conditions not likely to be reached in 1985 or perhaps ever. More importantly, it is not at all clear what is meant by zero-discharge considering the magnitude of nonpoint problems. Given the large expenditures involved in pollution control, there is a good case for benefit estimates. Why is there so much reluctance to get on with the task?

Causes of the Pollution Problem

A key assumption in our discussion of damages from water pollution is that social welfare is to be judged by individual needs and wants. This value judgment is central to our examination of the role of private markets and government in providing the water quality demanded by society. Acceptable water quality is not now adequately provided for by private markets. It is an example of a good for which people may not be able to judge what is in their best interest because they may have little information on the effects of water pollution.

Government should provide better information about the level of water quality and about the effects of water pollution so that individuals and firms can better make their own decisions. Ignorance on the part of individuals is usually a poor rationale for collective action. In fact, lack of knowledge about levels of ambient water quality and about dose-response functions is also an obstacle to efficient public decision-making as well as individual choice. We wish we could guarantee that public institutions will make fewer mistakes and have better information than market institutions. This pervasive ignorance may be as much of a problem as the question of market failure.

If there are no markets for clean water or if markets for water resources do not function properly, the resulting prices do not convey correct signals about water quality demand and supply. In general, the water pollution problem is one of economic inefficiency stemming from market failure. There are two relevant sources of market failure, which provide the basic rationale for public policy either to strengthen or to replace markets to determine optimal water quality. However, these sources of market failure may create problems for collective decision-making as well.

The first is the lack of well-defined property rights. Water resources tend to be mobile, and the size of the unit for vesting property rights tends to be very large. This is particularly true for large bodies of water and for river basins crossing state lines. For some purposes, control of a major river system is indivisible. It was argued earlier (Milliman 1959) that state water law could go much further in treating water rights as private property so that water use could be allocated through the market mechanism. Although the reasoning developed at that time applied mainly to the use of water for irrigation, it is clear that water rights could be developed for water-borne waste disposal from point sources and for many aspects of water quality. In fact, where it has been possible to specify water rights through the law of appropriation in some western states, limited markets in water rights have developed that deal at least in part with water quality problems stemming from waste disposal.

The worst water pollution problems in the United States are found in eastern states where development of market mechanisms for water resources has been virtually nonexistent. The major limitations of the water-law approach involve sources of nonpoint pollution, e.g., urban and agricultural runoff and for instream uses where access cannot be controlled. However, as noted above, public policies for pollution control using nonmarket approaches are ineffective on nonpoint pollution problems. If we can develop government regulations for the discharge of emissions of pollutants from point sources, we can develop property-rights and market-type solutions for point sources. All aspects of water resource use do not have to remain inflicted with the common property syndrome.

The second source of market failure stems from water quality as an environmental amenity. Some aspects of water quality, once supplied, are equally available to all. Since users cannot be excluded for nonpayment, there is no obvious way that private producers operating through markets could produce and sell clean water. As a result, the market system will tend to underproduce clean water.

This public good aspect of water quality offers no incentives to consumers either. This is the "free rider" problem. Individuals receive a certain level of water quality regardless of what they contribute. The dilemma is how to get people to reveal their preferences for clean water and yet accept responsibility for sharing the costs.

It is not clear just how important the public good aspect really is. Certainly the problem of excludability is much greater in dealing with air pollution than it is with regard to many rivers, lakes, and underground waters that have fairly well-defined flows and locations. This means that ways to control access and segregate uses could be devised for many kinds of "mobile" water resources. Water quality for swimming, boating, and fishing could have some aspects of exclusion and therefore allow market-type mechanisms, to some extent, to determine preferences. Users could be asked to help bear costs and to allocate water quality resources for recreational uses, particularly if waste discharges also had to compete for emission rights. Preserving the aesthetics of a lake or river basin may be the strongest argument for the public good feature. It is possible that aesthetics will be much less of a problem once the question of how much to invest in water-based recreation is decided.

We do not want to push these ideas too far at this point because we want to go into more detail below. It is clear that there are all sorts of problems in dealing with market-like solutions for determining the "optimal" level of water quality. Can property rights be defined with sufficient precision in enough cases to create markets? Can a large number of downstream consumers negotiate effectively with upstream polluters? How should pollution rights be vested? Will the market solutions approximate competitive outcomes? It is clear, however, that once the goal of efficiency is established, the search for clean water strategies will change considerably. The important problem, at this point, is not market versus nonmarket strategies but goals: Do we want clean water at any price or do we want water pollution policies that are socially efficient and subject to careful studies of benefits and costs?

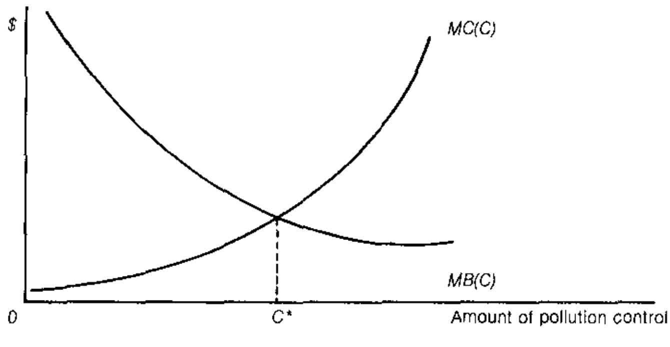
The Efficient Level of Pollution Control

To some people the notion that there is an optimal level of pollution control and therefore an optimal level of pollution is very disturbing. Indeed, the federal legislation states: "It is the national goal that the discharge of pollutants into the navigable waters be eliminated in 1985." Holders of this point of view believe that any amount of pollution is undesirable and that it should be eliminated despite enormous social costs.

It is our view that the discharge of residuals is a legitimate economic activity, which is socially undesirable only when the damages exceed the cost of control. Moreover, the label of "pollution" covers a multitude of discharge activities, some of which are far more serious than others. It is nonsense to contemplate the immediate elimination of all forms of pollution. Deadly toxic discharges are a very different matter from discharges of degradable organic wastes into waters having large amounts of dissolved oxygen. Finally, the control of pollution involves the use of scarce resources and opportunity costs. Although pollution control may prevent damages, there can be too much pollution control as well as too little. How far do we go?

Society's willingness to pay for a cleaner environment can be illustrated by a marginal benefit *(MB)* function. The *MB* function shows the marginal damages averted by additional pollution control. Figure 2 shows the relationship between the *MB* function and the marginal costs *(MC)* of pollution control for environmental quality. The socially efficient level of pollution controls is the value C^* where the marginal benefits of control equal the marginal costs of control, or $MB(C^*) = MC(C^*)$.

FIGURE 2
THE OPTIMAL LEVEL OF POLLUTION CONTROL



It can be shown that C^* is the level of control that is socially efficient. If the level of control were to the right of C^* the increase in control costs would exceed the increase in benefits of improved environmental quality. To the left of C* the level of control would be too small. It can also be shown that at C* the sum of the residual damages plus the treatment costs will be minimized. Note that this reasoning usually implies that some residual pollution remains at C*.

This logic is widely accepted by economists, but has not been adopted as a matter of public policy. If the goals of public policy for water pollution control refuse to recognize that there is an optimum level of control involving comparisons of *MB* and *MC*, then we will make little progress. It will not be useful to argue the merits of market and private property approaches to pollution control versus collective and centralized decision-making unless there is a commitment to this logic.

How one applies the logic will probably continue to be controversial. How to estimate the *MB* and *MC* curves will remain a very difficult task for which there may never be precise answers. As we saw in the discussion of the four steps to estimate pollution damages, much of the information needed to compute *MB* curves is lacking. We know too little about dose-response functions. The presence of nonpoint sources of pollution makes the prediction of concentrations and the level of control costs difficult. The randomness and dynamic nature of the real world will cause the functions to shift. Finally, the distribution of benefits and costs of pollution control policy will always be a source of public debate. Nevertheless, the existence of a theory of the optimum level of pollution control is central to policy formation and implementation.

Efficiency Without Optimality

Ideally, then, pollution control measures should be pursued up to the point where the *MB* of control equals *MC* of control. But what do we suggest when we have little information on the shape and position of the *MB* function? Rather than do nothing or futilely ban all pollution, it has been proposed that achievement of predetermined ambient standards be used as the benefit function of environmental policy. For example, where the policy-maker is unable to develop an *MB* function for recreational fishing, the environmental agency might set a minimum standard of 5 milligrams per liter of dissolved oxygen to be maintained in a stream subjected to the discharge of BOD wastes. This standard would preserve fish life. In such cases Baumol and Oates (1975) have argued for the second-best approach of efficiency without optimality. The standard would be taken *provisionally* as given and the efficiency goal would be to minimize the cost of achieving that goal. Pollution control strategies would then be judged by their relative efficiency in achieving the standard.

There is much to be said for efficiency without optimality when the information required for an optimal solution does not exist. As we shall see below, the price system and market mechanisms can be employed to achieve environmental standards in a least-cost manner. Of course, once the minimum cost of achieving a standard is known, we will then be able to infer the minimum benefit the standard must have in order to justify its continuation. Acceptance of standards or environmental targets should not be used as an excuse not to implement step three and attempt to quantify damages in physical terms.

Alternative Pollution Control Strategies

We have argued that the goal of environmental policy should be to correct for market failure and improve efficiency in the allocation of environmental resources. We have suggested that the *MB* of control should be equated with the *MC* of control; short of that, the least-cost achievement of predetermined standards is the second-best goal. We have expressed concern that current environmental policy appears to have goals that are unrelated to either optimality or efficiency. In this section we shall analyze various pollution control strategies, with the primary basis for judgment their relative efficiency. The present policies for water pollution control not only have goals that pay little heed to efficiency, but also employ strategies or instruments that are not efficient. We will suggest that the market mechanism and property rights can play a greater role in policy for water pollution when efficiency in resource use is desired. The strategies, however, have limited applicability for curbing nonpoint pollution in an efficient manner, and implicitly assume that the pollution problem to be solved is one of control of point emissions.

Direct Regulation

The management strategy that is the backbone of current U.S. water policy is the use of the police power of the government to regulate either the output of residuals directly or to regulate the inputs used in production. Input regulation requires firms to adopt certain kinds of equipment or treatment processes, such as secondary treatment of municipal wastes. Output standards tell a discharger how much emission is allowed at each source. Here the firm is allowed to determine the method for reducing emissions as long as the target is reached.

The economic literature is virtually unanimous in its criticism of the regulatory approach to water pollution control. The major criticism of direct regulation is that the information requirements to attain efficiency are not likely to be met. To determine the optimal input and output standards, the regulators would need to know the *MB* and *MC* functions of each discharger. If this information were known, regulation could be used to establish C^* for each of the dischargers and to set the optimal amount of ambient quality consistent with equality of marginal damages averted and marginal costs of control. With many dischargers and many receptors, going through the four steps to determine damages and then comparing incremental damages with a myriad of control cost functions is mind-boggling.

As actually practiced, the strategy of direct regulation is a more manageable task. First, some predetermined ambient quality standards are selected so that information on *MB* functions is not required. If efficiency without optimality were the second-best goal, the regulation strategy would attempt to set discharge regulations for each discharger so as to minimize the total cost of achieving the ambient quality target. Even in this second-best case, the information requirements for efficiency are formidable. It is not realistic to assume that regulators possess the necessary cost information on treatment of residuals for each of the dischargers under their jurisdiction in order to minimize control costs.

In the absence of such cost information, the regulators adopt shortcuts that often come out of tough bargaining sessions between regulators and dischargers. At issue is the cost and availability of control methods to be used in meeting discharge permits. In most cases, the bargaining process results in detailed and comprehensive regulation when the range of control techniques is large. However, the end result is usually some form of uniform cutback or uniform percentage abatement of emissions from previous levels. Regulators are under great pressures to treat different dischargers in the same region equitably. This means that "fairness" requires uniform percentage abatement.

Uniform percentage abatement is known to be wasteful; it fails to minimize total treatment costs. Since costs of pollution control vary greatly among sources, a policy of uniform percentage treatment is bound to be more costly than a policy which would equalize treatment costs at the margin among dischargers. Kneese and Bower (1968) found in a study of the Delaware estuary that a policy of uniform effluent charges would achieve given quality objectives at about half the cost of uniform percentage emission regulation.

Mills (1978) has also shown that under direct regulation, dischargers pay nothing for their quotas. The direct discharge policy prevents a discharger from discharging more than its quota (or treating a uniform percentage). If firms were subject to effluent charges on emissions, there would be no "free" quotas. They would have to either treat or pay a charge on *all* emissions. As a result, their costs of production would be higher and output less. By contrast, firms subject to direct regulation have lower costs, resulting in overproduction.

Buchanan and Tullock (1975) have shown that even with perfect information a system of direct regulation cannot be efficient because an incentive would remain for new firms to enter the industry. Without controls on entry and output the number of firms would grow, producing an inefficient output. The agency would also have to regulate where the firms may locate in a region in order to deal with interactions on ambient quality and on damages among emitters and receptors.

Kneese and Bower (1968) have also pointed out that direct regulation, in comparison with effluent charges, offers no incentive to the discharger to do more than meet standards. Charges have the advantage of placing continuous pressure on the discharger to improve his waste treatment processes. They also argue that effluent charges yield revenues so that the administration costs come more from the consumers and the firms involved than from general taxpayers. As we shall see below, this may generate political opposition from firms and agencies unwilling to bear the costs of effluent charges, particularly municipal discharges.

There are two instances where direct regulations can be defended. First, as Baumol and Oates (1975) have argued, effluent charges and tradable permits suffer from a serious liability as a means of pollution control because the number of permits or the effluent charge may be very difficult to change on short notice. During emergency periods when water levels are excessively low, emission levels suitable for normal periods may be inefficient or even intolerable. Some meteorological conditions are not easily foreseeable. For such "crisis" conditions, a temporary program of direct regulation of discharges may be justified.

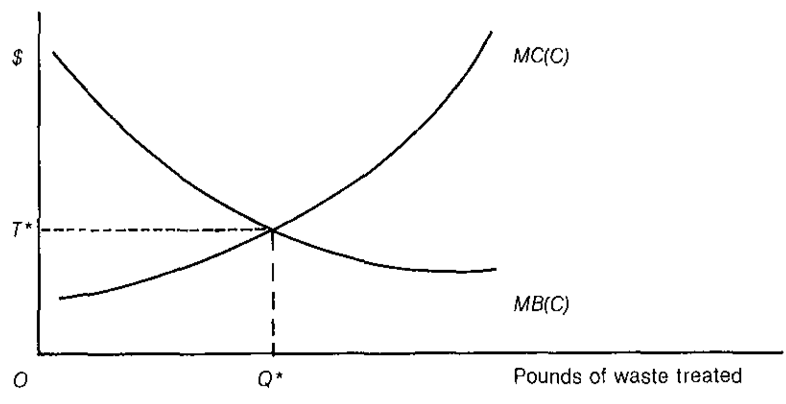
Second, Dorfman (1977) has argued that the correct effluent charge may be found only after some experimentation, and the risk of having dangerous concentrations of effluent may not be worth taking. In such cases direct regulation, despite the failure to minimize costs of treatment among dischargers, may avoid a more serious risk of dangerously high emission levels.

Effluent Charges

Most economists advocate effluent charges as the primary strategy for water pollution control. Stemming from the work of Pigou, taxes have long been advocated to correct for divergencies between marginal private costs and the marginal costs of pollution imposed upon third parties. In recent years, a strong case for effluent charges has been presented by Kneese and Bower (1968) and by Baumol and Oates (1975).

The difficulties of setting up an optimal set of effluent charges are essentially the same ones that face a regulator in establishing an optimal set of direct discharge regulations. In a world of perfect information the regulator would know the *MB* or marginal damage functions connected with each source of emissions. The regulator would also know the *MC* functions of all of the treatment options available to each discharger. The proper effluent charges on discharger A at location B would be T^* as shown in Figure 3 and the optimal amount of abatement would be Q^*. However, the regulator must

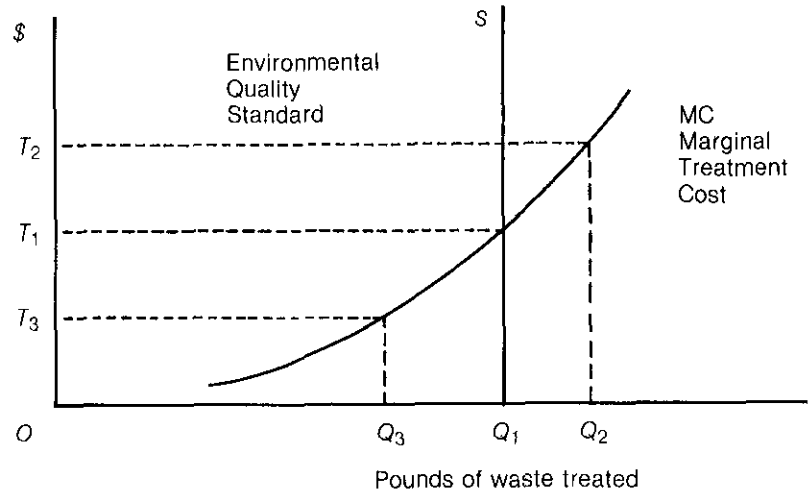
FIGURE 3
OPTIMAL EFFLUENT CHARGE



also have an accurate understanding of the effects of discharges at other locations and also the effects that effluent charges will have on other polluters. It is apparent that the degree of knowledge required to administer a system of optimal charges is completely unrealistic. As a consequence, *all* of the effluent charge schemes proposed are second-best approaches, which attempt to achieve some predetermined standards at the least cost, i.e., efficiency without optimality.

Figure 4 illustrates a "practical" scheme. The vertical S curve representing a predetermined environmental quality standard replaces the MB function from the preceding diagram. We assume that a discharge of Q_1 will meet some standard of environmental quality, e.g., dissolved oxygen of 5 milligrams per liter.

FIGURE 4
EFFLUENT CHARGES AND ENVIRONMENTAL QUALITY STANDARD



The correct effluent charge is T_1 which is equal to the marginal costs of treatment at the intersection with the environmental quality standard.

Assume, however, that the regulator does not know the position of the MC function and therefore has to guess at what level to set effluent charges in order to achieve the environmental quality standard. If the effluent charge is mistakenly set at T_2 because it is believed that treatment costs are higher than they turn out to be, the quality of waste treated will be Q_2 and the environmental standard will be exceeded. By contrast, if the effluent charge is set too low, say at T_3, because it is believed that marginal treatment costs are lower than they are, the level of treatment will be Q_3. Then environmental standards will not be achieved. It is hoped that through an iterative process, with changing effluent charges affecting the amount of treatment, we will converge at T_1 and Q_1.

It should be noted that the effluent charge approach achieves the least-cost combination for reaching the standard. As effluent charges are raised, a discharger will tend to cut back on emissions (treat waste) until the marginal cost of treatment is equal to the charge. Note, however, that all dischargers in the area are subject to the same tax. Therefore, the marginal cost of treatment will be equalized across all dischargers. This insures that total costs of treatment are minimized because any change in this pattern would involve either an increase in emissions or an increase in costs of treatment.

Effluent charges appear to be very attractive. They require relatively little knowledge about marginal costs of treatment for different kinds of firms and discharges. Also, they lead automatically to the least-cost pattern of achieving a given environmental standard. Compared with the drawbacks of direct regulation, these are major accomplishments.

There are, however, some problems with the effluent charge scheme. First, assume that the standard of environmental quality to be achieved is an important threshold. For example, assume that most fish will die if the level of DO falls below 5 milligrams per liter. If the tax is set too low, the environmental standard will not be achieved and the costs of being wrong may be very high.

Second, the system of iteration may impose substantial compliance costs upon dischargers. Often the investment costs in pollution abatement measures will be high. If the discharger perceives that the level of effluent charges is temporary, the firm will be reluctant to invest. This might lead to a destabilizing effect as opposed to a convergent process. If polluters are reluctant to invest in treatment because they think effluent charges will change greatly they may pay the charges and do little treatment. The control agency, in response, raises the charges. And instead of investing in treatment, the discharger might move from the region, even though the firm would have operated efficiently if the initial charge were close to the equilibrium rate.

Third, when firms enter or leave the region, the control agency will have to raise or lower the tax to reach the environmental standards. This may induce a new search process and create some instability. The agency is also perplexed about how much to raise or lower the effluent charge, so considerable instability can exist during periods of growth or decline in a region.

A fourth problem with the effluent charge strategy is how to set the "correct" zones or regions to which the charge will apply. In fairness, the problem of zonal definition is endemic to all strategies that depart from an individual policy for each point source of emissions. Ideally, of course, it would be desirable to have a separate schedule of effluent charges for each discharger. It is clear that the administrative burdens of such a system would be unreasonable. Therefore, the use of zones would allow common effluent charges and environmental standards to be specified within a given zone and different charges in other zones to secure the standard where costs of treatment differed. The problem of zonal definition arises where there is no natural clustering of dischargers. If dischargers in Zone A have an effluent charge of 10 cents per pound of BOD discharged and those in Zone B are charged 15 cents, it is clear that questions may arise as to where to draw the boundaries and how to treat firms located near boundaries equitably. Ackerman et al. (1974, p. 274) found this question of zonal definition to be a major problem in the case of the Delaware River Basin Commission. In order to reduce the pressures upon the commission, zonal differentials were made very small. Even so, the amount of "pushing and shoving" was considerable. However, a common environmental standard and effluent charge on point discharges all along a stream would reduce most of the efficiency gains that would come from relating discharge standards to ambient quality and to the use of the stream for different purposes in different sections. We will argue below that the pressures for uniformity of treatment across zones may be less intense under a system of tradable permits.

Finally, a system of effluent charges may run into political opposition from dischargers who rightly see that they either have to treat or pay "taxes" on all discharges. There will be no free rides, as with permits. Costs to firms will be higher than under direct controls (an advantage of the system) so it will be in the interests of dischargers to oppose effluent charges. In addition, special political pressures on the regulatory agency could come from municipalities that argue that they should be treated differently from firms because the effluent charge would put a financial burden on them. There is no analytical argument for giving cities special treatment.

In fact, subsidies to cities would create incentives for industries to join municipal systems. Perhaps the lesson to remember is that in presenting logical solutions to problems one cannot neglect political factors.

A system of effluent charges implies that the property rights in the water system have been vested in the water users. This means that if the standards to be achieved are based upon the preservation of aquatic life, such activities as boating, swimming, and fishing, as well as aesthetic appreciation and the preservation of the ecology of the water resource, have a vested right. The regulatory agency or the state acts as an agent for such uses, and it sells rights to discharge waste depending upon the assimilative capacity of the water resource and the standard chosen. The effluent charge minimizes the cost of achieving the standard, with the revenues realized as a kind of economic rent earned by society from use of the assimilative capacity of the water. Kneese and Bower (1968) suggest that the revenues can be used to cover the costs of administration of the program and to finance large-scale regional facilities (taking advantage of economies of scale) to improve water quality and lower treatment costs for all. Baumol and Oates (1975, p. 196) show that the dischargers will suffer a welfare loss, even though the community gains, from the imposition of charges to correct externalities unless they share in the tax revenues. It would seem that political opposition to effluent charges could be reduced if provisions are made to share revenues.

It has often been pointed out that the logic of effluent charges can be reversed to justify the payment of subsidies to dischargers by the users of the environmental services (the public). In this case the property rights would be vested in the dischargers. The state would then act as the agent for the public and "buy" reductions in waste discharges to improve water quality. Theoretically, it can be shown that the subsidy and the effluent charge can achieve equivalent results on the equilibrium position of individual firms in terms of the reduction of emissions and minimizing costs of control. However, as Baumol and Oates (1975) have shown, the subsidy approach encourages the entry of firms (while the effluent charge approach encourages their exit) so that the industry output is greater, and this may offset reduction in emissions by individual firms from subsidies.

Krutilla and Fisher (1975) point out that the initial vesting of property rights in the public will change the distribution of wealth. And with such a change, preferences for environmental services over other goods and services may shift. As a result, the optimal amounts of environmental quality and waste disposal may change, which could affect the optimal effluent charge or subsidy. This is contrary to the position taken in Coase (1960). The outcome of the bargaining is not independent of the initial vesting of property rights.

Tradable Permits

In contrast to the large amount of economic literature on effluent charges, there is very little on tradable permits. Some of the important references are Dales (1968), Montgomery (1972), Ackerman et al. (1974), Roberts and Spence (1976), Ackerman (1977), Tietenberg (1980), Lewis (1981), and Halm and Noll (1981). The theoretical case for tradable permits is quite strong; they appear to offer substantial advantages over effluent charges. It remains to be seen, however, how applicable this strategy is.

Recently, EPA has developed three limited versions of the tradable permits concept, which are being applied experimentally to air pollution at various places in the country. They are:

1. *Bubbles:* Plants are allowed to reduce controls on air emissions in a portion of the facility where abatement costs are high, in exchange for an increase in control in the same plant where abatement costs are lower. Multiplant bubbles have recently been suggested.
2. *Offsets:* In a given air shed a firm may increase emissions if it pays for a reduction in emissions from some other source in the same region.
3. *Banks:* A discharger that exceeds its emission standard may get credit for some fraction of the excess reduction in emissions in an "emission bank." Credits could then be sold to other firms seeking emission permits. Rules for trades are now being worked out.

Although these new options do not yet have well-established procedures governing transactions, they do show a new concern by EPA to minimize the costs of attaining standards and also an appreciation of how market-like approaches can offer incentives to dischargers. Their long-term status is unclear. It also remains to be seen whether the permit transactions move closer to trades of property rights. We do not know if EPA is taking similar approaches to water pollution.

Under the tradable permit system, the regulatory agency would determine the maximum total discharge of a pollutant to be emitted in a given region. Permits to discharge some fraction of this total would be printed and auctioned off or distributed in some fashion among dischargers. From then on, the allocation of emissions among dischargers would be determined by the market. Firms could buy permits in the original auction or purchase them from other firms or individuals. The government agency would have to monitor emissions to see that they were conforming with the discharge permits. Nothing would prevent individuals or groups who value clean water from buying permits and holding them idle.

The policy issues to be decided in the regulatory agency would be: (1) the environmental standard for ambient water quality; (2) the relation of total emissions to ambient quality; (3) the size of the region and whether to allow exchange of permits across zones; (4) the length of life of the permit; (5) how to issue the permits and then maintain a market for them; and (6) whether to change the ambient quality standards and number of permits as conditions warrant. Each of these policy issues involve a certain amount of "arbitrariness" and soul-searching. There are no obvious answers in a world of imperfect information.

It can be noted at the outset that the market here is not a true market in that the number of permits would be fixed in relation to some predetermined environmental target. Thus, the market only works on one side, that of rationing a fixed supply among a group of demanders. There is no feedback from the users about water quality achieved and their willingness to pay on the supply of rights, which is predetermined. A rise in the price of tradable permits signals only that permits are more in demand, but presumably it does not affect the amount supplied. This is clearly another case of efficiency without optimality. Each firm would buy or sell permits until the price of permits equaled the marginal costs of control. Since all firms would face the same permit price, marginal costs would be equated across the region and the total costs of abatement would be minimized. In a multiperiod situation the long-run marginal costs of control would be revealed by the equilibrium price of tradable permits.

The tradable permit scheme does not require knowledge of the marginal costs of treatment on the part of the agency nor does it require an iterative search for the correct effluent charge. Instead, the market makes the necessary calculations in the course of reaching an equilibrium price for permits. Thus, there is less chance of making an error on an important threshold. With effluent charges, the search for the correct charge may result in too little treatment and thus prove to be a costly mistake. Also, in the case of economic growth in the region, the regulatory agency does not have to guess how high to raise the effluent charge. New firms would have to buy up rights from existing firms, thus allocating pollution rights economically while still preserving environmental quality. Market adjustments in the price of pollution permits would be more flexible than administration of effluent charges in accommodating either growth or decline in a region. Currently all dischargers are required to have (nonmarketable) permits, so it may be easier to move to a system of tradable permits than establish a system of effluent charges.

Despite the advantages of a system of tradable permits, a number of difficult questions must be answered before we can be certain that efficiency can be achieved. Thus far we have assumed that there will be a large number of buyers and sellers of permits and that there will be a competitive long-run equilibrium price that will minimize abatement costs and yet distribute emissions among sources at various locations to meet certain ambient water quality standards. This is a tall order, which may be difficult to achieve in given watersheds. What are some of the implementation problems for a scheme of tradable permits? Will its application be restricted?

The basic questions go back to whether a competitive market can be constructed and how complex the technical relationships are between emissions (from point sources) and ambient quality. With regard to technical relationships, what pollutants and zonal definitions are to be used, and how do emissions interact to determine ambient quality? The effect of emissions on ambient quality is a function of location and geography, timing of discharges, the location of other emitters, and stochastic elements due to weather and other factors. It helps, of course, if the relationship between emissions and ambient quality is approximately linear. It also helps if emissions of key pollutants can be modeled as if they were independent or additive to other key pollutants. Over how large a region should the permit holder be allowed to locate? If the level of ambient water quality is very sensitive to the location of an emitter (not just to the amount of emissions), changes in the location of permits and emissions, with no change in total emissions, may produce significantly different levels of ambient quality. Clearly, a great deal of water quality modeling would be needed to simulate various locational patterns of emissions and the outcomes of different zonal boundaries and temporal patterns. We do not want to make too much of these technical problems because most of them exist under any kind of pollution control scheme. Nevertheless, the significance of possible changes in the spatial distribution of emissions needs to be carefully worked before emission permits can be made fully tradable for a given zone or geographical area.

On the economic side, the requirements are that the market be reasonably competitive. If it is not, it is possible that the efficiency losses from monopoly power either in the sale or purchase of permits will erode much of the efficiency gains of the system. It is also possible that a "thin" market may not generate prices for permits that are sufficiently close to the long-run equilibrium price to encourage either the proper amount of investment in permanent pollution control facilities or the proper number of firms in the area. In theory, a competitive regime of property rights in pollution permits can be shown to have the desirable equilibrium properties. The possibilities of noncompetitive markets and their properties need to be examined before one can fully endorse a scheme of tradable permits. Notice that the zonal definitions in terms of maintaining ambient quality standards may have to be qualified in terms of the requirements of a competitive market. The size and configuration of emission permit regions also will affect the number and size of potential market participants and the equilibrium solution.

With regard to equity, a primary question is the initial distribution of permits. At one extreme is the assumption that the property rights belong to the state and that the best solution is to simply auction off the permits to the highest bidders and let the process begin. This would mean that emitters would pay economic "rent" for permits plus abatement costs. An alternative would be to base the distribution of permits on the pattern of emissions that existed in preregulatory days. Another version of this policy is to make all existing discharge permits tradable. If the relative amount of the emissions were approximately equal across sources and if the number of emitters were large, the chances of achieving prices in the short run that would be close to long-run equilibrium prices would be good. Therefore, rational, long-term investment planning and cost minimizing would be fairly assured. However, if there were one or two large sources of emissions and a group of small emitters, there might be a problem in getting the market started fast enough to give the right signals to firms making location and abatement investment decisions.

Halm and Noll (1981), in investigating a potential market for tradable permits in sulfur oxide emissions in the Los Angeles airshed, identified 30 emitters of consequence. However, one firm had approximately 30 percent of all emissions. The problem they were concerned with was how to organize a permit market with a single large source and yet to try to approximate a competitive outcome. One outcome they investigated was to allocate only a fraction of the permits on a historical basis, say 80 percent, and then let the agency auction off the remainder. Thus, it would be possible under some schemes of permit distribution to place all firms in the position of being buyers, which would nullify some of the market power of the largest firm. Such a scheme would help preserve some equity by giving existing emitters some automatic property rights. This policy might go part way in appeasing municipal dischargers, who might demand special treatment if the auction method were used to vest all initial permits.

Ackerman et al. (1974, p. 275) feel that the tendency to minimize effluent charges across zones by regulatory authorities would be lessened with tradable permits. With a fixed number of rights in each zone, firms located on zonal boundaries could participate in both markets. When it is economical, such firms could buy a permit in an adjacent zone and pipe their wastes to the next zone. The calculation of the "correct" price is done by the market, and the option to pipe wastes to a neighboring zone reduces pressures for plant relocation.

Implementation problems include the length of life of the permit and how to change the number of permits as pollution policies change. The regulatory agency must be careful not to generate uncertain expectations regarding the decision to invest in permits and long-lived capital facilities. When information is imperfect, particularly when first starting a tradable permit scheme, it might be wise to issue permits with varying maturities as Ackerman et al. (1974, p. 268) have suggested. The arguments for moving toward a permanent vesting of rights are very strong. As the benefits of achieving predetermined environmental targets are better understood, the question of whether to change the number of permits can be faced with more information. Most of the monitoring and enforcement problems appear tractable compared with alternative strategies.

Obstacles to Efficient Policy

There are a number of obstacles to the establishment of an effective and efficient water pollution abatement policy. Perhaps foremost is the basic indifference about efficiency in a clean-water program. Unless there is some kind of headline-catching scandal, the fact that billions of dollars are being spent for pollution control facilities without documentation of possible benefits will continue to elicit little public outcry. In addition, there is a widespread notion that water pollution is simply wrong and that it is the role of government to exercise its police power to eliminate all pollution rather than to weigh the benefits and costs of alternative abatement policies. How else can we explain the fact that basic economic analysis has played almost no part in the formulation of water pollution policy? There has been an almost exclusive reliance on detailed federal regulation and judicial enforcement despite repeated criticisms of the inability of the bureaucracy to cope with complex environmental problems. The excellent, well-written critique by Kneese and Schultze (1975) of air and water pollution policies has received little attention by the Congress and the electorate.

Lack of Benefit Estimation

A second major barrier to the achievement of efficiency may stem from the first, but it needs special emphasis. In the discussion of the four steps to measure pollution damages, it was pointed out that measures of damages should be viewed as the benefits from abatement. Without measuring benefits, efficiency cannot be ascertained. Although measures of damages, particularly step four involving dollar valuations, cannot be done easily, we have to go as far as we can. Benefit-cost analysis should not be considered a simple decision rule, but a way to systematically organize information to help make choices about pollution damages and the resources involved in pollution control.

The theory of what and how to measure benefits of water pollution abatement is well understood (Freeman 1979). Currently, we do not have good approximations of the damages caused by pollution in various river basins and major lakes. Empirical estimates of the benefits of water pollution control policy are badly needed. As Freeman suggested (p. 265): "It would be penny-wise and pound-foolish not to plan to allocate 1 or 2 percent of the total funds to be spent on pollution control toward measuring and evaluating what we have bought with that massive expenditure."

Nonpoint Pollution

Nonpoint pollution is perhaps the major challenge facing the cleanup of the nation's water supplies. As earlier pointed out, more than half of all pollutants entering surface waters come from nonpoint sources. It is believed that nonpoint pollution also seriously affects ground water, although systematic data on ground water quality is not available. In contrast to the limited progress that has been made in cleaning up point discharges, progress with nonpoint sources is almost negligible. The most important nonpoint sources of pollution are agriculture, urban runoff, forestry and mining, and individual wastewater disposal (septic) systems.

Agriculture

According to CEQ (1979, 1980) water pollution from agriculture affects 68 percent of all river basins in the United States, with most of the pollution the result of fertilizers, pesticides, pathogens, organic materials, and sediment. Half of the sediment entering surface waters stems from soil erosion from farming, about 3.8 billion tons annually. According to the GAO (1977), soil erosion into streams is 25 percent worse than in 1934 despite conservation efforts. It is believed that 7.5 million tons of phosphorus and 600,000 tons of nitrogen enter surface waters annually. Most agricultural runoff is difficult to manage and can seriously upset ecological balances.

Urban Stormwater

Pollution from urban runoff, a more serious problem than previously recognized, contains heavy metals (lead, zinc, and copper) as well as high concentrations of coliform bacteria, BOD, asbestos, suspended solids, and oil and grease. CEQ (1980) reports that a study of Washington, D.C., found that street runoff contained 104 times as much suspended solids as the effluent from a secondary treatment sewage plant. The lead concentration was 1,015 times greater. Most of the older cities in the U.S. have combined sewer and stormwater collection systems that are a major source of water pollution. The amount of raw sewage and wastes dumped into receiving surface waters during rainstorms may offset sewage treatment in dry weather. Chicago's problems with raw sewage backing up into residences, flooding streets, and pouring into surface waters are well known. The city's tunnel and reservoir plan (TARP) to deal with this problem may turn into one of the most expensive public works projects ever, $11 billion at last estimate. The GAO has recommended that EPA reconsider TARP.

Other Nonpoint Pollution Sources

Septic systems are causing water quality problems in 43 percent of the U.S. river basins. Coal mining leads to sulfuric acid pollution in nearby surface and ground water. Forestry can cause soil erosion and landslides. Runoff from municipal and industrial waste disposal sites is now believed to pollute drinking water sources. One of the chemicals most frequently found in treated as well as untreated drinking water is trichloroethylene (TCE), a widely used solvent and degreaser, which causes cancer in mice.

The dangers of nonpoint toxic runoff has come to light only in the past five years. Yet the seriousness of organic waste pollution has been long established. For example, EPA estimates of total suspended solids and organic waste discharges for the U.S. for 1973 are shown in Table 1. The striking fact about Table 1 is how much the TSS wastes (96 percent) and BOD wastes (82 percent) are dominated by nonpoint sources. Yet EPA for years has granted permits for point discharges of such wastes and supervised a very expensive cleanup process. Of course, national totals can be deceiving. For one thing, nonpoint discharges may be more diffused than point emissions. But from 1975 to 1979 there was little improvement in dissolved oxygen in many surface waters despite the large expenditures and heavy regulation to reduce BOD pollution. If nonpoint sources of pollution are a relatively large part of the problem, how can we expect water pollution control policy aimed at point sources to be effective and efficient?

TABLE 1

EPA ESTIMATES OF U.S. DISCHARGES OF TOTAL SUSPENDED SOLIDS AND ORGANIC WASTE, 1973
(billion pounds)

	TSS		BOD	
Municipal sources	5.9	(0.15%)	5.6	(10.2%)
Industrial sources	117.9	(3.10%)	4.3	(7.8%)
Nonpoint sources	3,698.0	(96.75%)	45.0	(82.0%)
Total	3,821.8		54.9	

SOURCE: Council on Environmental Quality, Seventh Annual Report, 1976, p. 257.

To be fair, the Clean Water Act of 1977 gives EPA no specific authority to regulate pollution from nonpoint sources. EPA is awkwardly trying to deal with nonpoint problems through a Water Quality Management Program known as the "208" plans. The 1972 legislation was largely silent on nonpoint problems. Under 208 plans, states or regional planning agencies must propose "solutions" to regional water quality problems from point and nonpoint sources for both surface and ground waters. This is a tall order. Plus, the plans are not binding on anyone and have been widely criticized for their lack of specificity. The fact is, there are very few obvious solutions for the control of nonpoint runoff. Everyone talks about the need for "comprehensive" and "rational integrated solutions to complex regional water quality problems," but there needs to be more than comprehensive plans and vague references to land management techniques (known as BMPs, or Best Management Practice, in EPA jargon).

Under remedies for nonpoint pollution, CEQ (1980, p. 135) lists only two BMPs — "practices such as soil tilling that minimizes soil erosion in rural areas and street sweeping that minimizes total suspended solids in urban runoff." Funds are being spent by EPA under a Nationwide Urban Runoff Program and a Rural Clean Water Program (with the U.S. Department of Agriculture) to come up with nonpoint solutions. Thus far, the results are far from encouraging.

Economists writing on water pollution have not been able to offer much help either. Direct regulation of sources by licenses, effluent charges, and tradable permits are relatively well examined in the literature, but these techniques apply to point pollution. The common law concept of liability for damages for nonpoint pollution is difficult, if not impossible, to apply when hundreds of nonpoint polluters and parties sustaining uncertain damages are involved. The fact is that the policies applicable to point source pollution appear to have little value for nonpoint pollution problems. It also appears that most economic theorists are unaware of the magnitude of the nonpoint problem.

Kneese and Bower (1968) and Davis (1968) have made a case for regional river basin management of water quality. They believe that such agencies could influence land use decisions to reduce nonpoint pollution. They also advocate instream treatment measures, as opposed to exclusive emphasis on end-of-the-pipe treatment, which may be effective for nonpoint problems. Short of such broad-brush suggestions, we are lift to particularized measures for slowing runoff, such as settling ponds for urban stormwaters or putting up barriers to inflows, like swales around urban lakes or dikes on irrigation drainage canals. It is possible that such practices may have payoffs that are higher than expensive treatment facilities for point emissions. We will never know, however, until we begin to weigh benefits and costs of all of the various abatement alternatives.

Conclusion

This paper examined various pollution abatement strategies as a basis for an efficient water pollution control policy. Particular attention was paid to the present policy of direct regulation and to two untried market approaches, *effluent charges* and *tradable permits*. There is a need for an efficient water policy based upon a *weighing of benefits and costs*. But the question is whether an efficient water pollution policy can really be achieved.

The evidence is fairly clear that the present policy of detailed direct regulation of discharges is expensive, wasteful, and ineffective. Economic concepts have not been employed in the goals being sought or in the instruments being used. No credible estimates of benefits and costs of current programs exist despite the expenditures of billions of dollars. Much more worrisome is that even though these conditions are relatively well known by economists, there is little public concern for efficiency and little effort to change the thrust of water pollution policy by the electorate or by Congress.

Other obstacles to efficient policy are noted. One is the failure to estimate physical damages from pollution in a systematic fashion and the failure to at least attempt to place monetary values on damages averted by pollution abatement. This means that benefits of environmental improvement from water quality are in the realm of conjecture.

Another obstacle stems from the failure to deal with the serious problem of nonpoint pollution. Efforts to deal with water pollution by controlling only point sources cannot succeed. Current U.S. policy as well as the economic literature fail to recognize this problem.

With regard to point pollution, both effluent charges and tradable permits have significant advantages over direct regulation. The use of administered markets can do much to reduce regulatory controls and to allow for more initiative by individual decision-makers to achieve least-cost solutions. In addition, the integration of water law with these market-type solutions promises to strengthen the role of private property and market allocation. The need for public policy in water pollution has arisen because private markets are not working well. Instead of attempting to make markets and the price system work more effectively, Congress has adopted a policy of direct regulation. Effective and efficient water pollution control policy requires a commitment to make greater use of markets and the price system as instruments of social policy. Even more basic, however, is a commitment to a goal of efficiency in environmental policy itself. The obstacles to such a commitment appear formidable.

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WHO CARES ABOUT EFFICIENCY?

Terry L. Anderson

The answer to the question in the title of Professor Milliman's paper is yes, water pollution policy *could* and *should* be efficient. But this misses the crucial question: Can we reasonably expect that water pollution policy will be efficient?

After briefly addressing Professor Milliman's major points, I would like to consider the likelihood of achieving efficient policy. I then will discuss the institutional constraints that lead to my conclusion.

Milliman's theme is an old one in natural resource economics. Students in any undergraduate resource economics class are made keenly aware of the fact that there is an optimal level of pollution. Furthermore, they understand that from the menu of policy alternatives available for achieving this optimal level, some policies have lower costs (are more efficient) than others. Milliman, however, asks why the efficiency principles have not had more of an impact on pollution policy. This is the second paper I have seen recently that asks why policy-makers have not responded to the economic sermon and searched out the efficient marginal conditions. What I find hard to believe is that economists would ever expect policy-makers to have efficiency as their goal. After all, government officials are utility maximizers who have no proprietary interests in pursuing environmental efficiency for the "public interest." Instead, they will be subject to intense special interest pressures that will cause them to diverge from the pursuit of socially efficient pollution control.

It is well known that government officials increase their utility by expanding their sphere of influence. Hence, it is no mystery why bureaucrats have favored direct pollution control over market alter-

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natives. As Professor Milliman points out, direct regulation requires considerably more information and hence a larger bureaucracy. The extent of discretionary power inherent in pollution regulation has been aptly summarized by Steven Williams:

> At every stage of the [regulation] procedure, we see government agencies exercising enormous discretion: the EPA sets standards for new plants in every subcategory of every industry; state agencies set standards for all plants to make them conform to the SIP [state implementation plans]; and state agencies decide whether or not to issue the necessary permits for a new plant in non-attainment or PSD [preservation of significant deterioration] areas. This vast discretion has three dangerous facets: it is an occasion for influence-peddling, it breeds unfairness, and it erodes the rule of law.[1]

Even in the cases where the politician or bureaucrat is in the business of establishing and enforcing private property rights, it is likely that inefficiency will result. For example, when private property rights are assigned in ways that encourage rent dissipation, privatizing the commons may not improve resource usage.[2] In the extreme case, "rent seekers" could dissipate the entire gain from privatization. Whether this will happen depends upon the incentives of those who are designing and implementing the property rights system. When the definition and enforcement of rights is in the hands of the utility-maximizing bureaucrat, the issue will be whether the bureaucrat gains from the process. The Milliman paper suggests that a simple auction be used to facilitate the initial assignment of pollution permits. This, of course, would eliminate rent-seeking initially. But if the proceeds from such an auction do not remain in the discretionary domain of the bureaucratic agency, it is unlikely that this form of allocation will be chosen. The result is that utility-maximizing bureaucrats opt for actions by potential claimants that will generate utility for the bureaucrats.

Finally we turn to the question of whether there is any way of structuring political institutions to encourage efficiency. My suggestions, though by no means novel, should be contrasted with

[1] Steven F. Williams, "Pollution Control: Taxes Versus Regulation," Original paper 23, International Institute for Economic Research, August 1979, pp. 9-10. For more detailed discussion of this type of rent seeking, see Mike Maloney and Bruce Yandle, "Building Markets for Tradeable Water Pollution Rights," forthcoming in Terry L. Anderson, ed., *Water Use in the West: Scarce Resource Allocation, Property Rights and the Environment* (Cambridge, Mass.: Ballinger Publishing Co.).

[2] Terry L. Anderson and Peter J. Hill, "Establishing Property Rights in Energy: Efficient vs. Inefficient Processes," *Cato Journal* 1 (Spring 1981): 87-105.

those of Professor Milliman and other economists who have tried to convince politicians that efficiency should be their goal. Convincing people that they should take actions not in their self-interest is fruitless; rather, institutional constraints that link self-interest with efficiency or which preclude inefficiency must be considered.

My first suggestion is that more attention be paid to constitutional constraints on political action. It is possible that at this higher level rules can be devised that promote economic efficiency. The first 50 years of the republic suggest that it is possible to discourage rent seeking by depriving government of economic empowerments.[3]

The second possibility for increasing the likelihood of efficient policy is to have policy formulated in a less centralized governmental arena where costs and benefits fall more directly on constituents. At this point the efficiency of common law comes to mind. Furthermore, evidence suggests that efficient solutions are more likely when there is competition among governments.[4] As long as the decision-making unit faces some of the costs of promoting inefficiency, there is greater hope for efficient policy. While this decentralization may not be possible for all water pollution control programs, it at least suggests that policy formulated closer to those who stand to gain and lose will be scrutinized more carefully for efficiency.

Lastly, the work of Adam Smith makes it clear that efficiency will only be generated by institutions that guide self-interested individuals in the direction of what is socially beneficial. His "invisible hand" is really a system of private property rights that links authority and responsibility. An attempt to educate molders of public opinion on this doctrine may help promote economic freedom and efficiency.

[3]For a more detailed discussion of the role of the Constitution, see Terry L. Anderson and Peter J. Hill, *The Birth of a Transfer Society* (Stanford, Calif.: Hoover Institution Press, 1980).

[4]See Terry L. Anderson and Peter J. Hill, "An American Experiment in Anarcho-Capitalism: The *Not* So Wild Wild West," *Journal of Libertarian Studies* 3 (Spring 1979): 9-29.

ETHICS AND THE MARKETPLACE

P.J. Hill

Professor Milliman's paper is a thoughtful discussion of the past problems in and the future prospects for achieving allocative efficiency in water pollution policy. He presents a cogent argument for extending the use of private property and the market where possible and where not feasible, replicating its results with pollution charges and/or tradable permits. However, one of the more disturbing aspects of the paper is his recognition that there is little public interest in doing so. This is the basic issue I wish to discuss.

There is a general antipathy to prices, markets, and private property on the part of policymakers and the public. Moral and ethical considerations weigh heavily, and if people are not convinced of the morality of markets, efficiency considerations will seem of little importance in determining policy. Below I list some of the common ethical objections to private property and markets and my response, using where possible the context of the water pollution issues raised by Professor Milliman.

Objection 1

The market, through its emphasis on competition, promotes greed and strife.

Response

This view of markets is surely incorrect, though it is a widely held belief. As long as scarcity exists — when there is just not enough to go around to satisfy all existing desires — competition will exist. The market system is not the cause of people acting in their own self-interest; it is simply an attempt to channel that self-interest in socially productive ways. The institution of private property in-

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sures that when people impose costs on others or generate benefits for others, they must take cognizance of those costs and benefits. In fact, the attempt to apply property rights to the solution of pollution problems is precisely that, an attempt to keep people from imposing costs on others without their consent.

A market that is built around a system of well-defined and enforced property rights encourages social coordination. Such a market pinpoints potential areas of cooperation among individuals. It encourages individuals to look for ways of satisfying other people. Transferable property rights means resource owners will be rewarded only if they satisfy consumers' preferences.

In contrast to the cooperation that is encouraged by the market system, alternative institutions are much more likely to promote confrontation and strife. In the case of water pollution, nonmarket-oriented policies result in either/or solutions: Either the polluter wins the right to continue imposing costs upon other people without their consent or the recipient wins the right to have the pollution reduced with no attention to marginal benefits and costs.

Objection 2

The market system only acknowledges present desires. It doesn't allow future generations, who might have a high demand for clean water, to buy in.

Response

Again, this view of markets is almost completely divorced from the way they actually work. Private property rights allow people ("speculators") who believe that future generations will want to preserve a resource to withhold that resource from present consumption and, if they are correct, to be rewarded for their actions. Hence, those wishing to consume it now must bid it away from *all* of the potential claimants who believe it will be more valuable in the future. Since there is a wide diversity of opinions about the future value of resources, present users must be willing to out-bid even the most optimistic of those that are speculating on future value. While it may be true that under any set of institutions, the present generation will, out of altruism, consider the desires of future generations, it is surely the case that if people are rewarded for their efforts to preserve, they will do so more often.

Objection 3

The institution of private property leads to an unequal distribution of wealth and power. In the context of water pollution, if a pollution tax or tradable permits are instituted, the wealthy will find it easiest to acquire the right to pollute.

Response

History speaks eloquently on this issue. By far the most effective defense against some people having undue power over others has been the institution of private property. Political power is always somewhat concentrated, even in a democracy. One man-one vote, while pleasing rhetoric, does not explain the mechanics and incentive structure of most collective decision-making. When more and more of the decisions about the use of resources are carried out through the coercive power of the state, those who have political clout find they also have substantial economic clout. Even though power is not equally distributed in the marketplace, it seems to be even more unevenly distributed in the political arena. The fear that market solutions to the pollution problem would lead to greater concentrations of power in the hands of a few individuals seems to be largely unfounded. It is when decisions about the use of resources are politicized that certain individuals gain undue power over others.

It is a fallacy that pollution charges or tradable permits would allow the wealthy to pollute unduly. The purpose of such policies is to force people to bear the costs of their actions. Therefore, if the charges or permits are appropriately instituted, the willingness of some to continue polluting simply means that resources are moving to their highest valued use. A tax on pollution is not a license to pollute, it is simply an attempt to approximate the market by giving the right to use resources to people only if they have paid for them. Again, it is important to remember that a system of property rights means that individuals can only take actions that impact upon other individuals if they take into account the consequences of those actions.

Objection 4

Markets maximize the wrong goals; they give us not what we really need but instead only what we are willing to pay for. This is well illustrated by a recent comment by Senator George Mitchell (D-Maine), who in commenting on some changes in the Clean Air Act said, "If economics are taken into account at standard setting, then ambient standards no longer set acceptable levels but instead levels that we can afford."

Response

A system of property rights and the consequent market that develops from those rights will not necessarily yield results that are congruent with some predetermined set of "socially appropriate goals." These institutions are simply allowing people to express their preferences about the goals that they feel are important, rather than allowing the ends towards which they strive to be determined by others in the society. What the critics of markets are often saying is that people have the wrong goals, and that they would be most happy to have the coercive power of the state at their disposal to see that the correct ones are met. It is true, as Senator Mitchell fears, that a market order will only provide those things that people are willing to pay for. However, this would seem to be an advantage rather than a disadvantage.

Markets also allow a much greater diversity in goals than alternative systems. People who feel strongly about issues, but are not in a majority, are much more likely to find their desires met under a private property, market system than under an order of collective decision-making. The all-or-nothing aspects of collective decision-making mean that people who fail to convince the majority that they are correct end up dissatisfied. In contrast, in markets you only have to convince another property owner to exchange with you. Markets also allow people who feel very strongly about some things to represent those feelings in an efficient and low-transaction-cost manner. If some individuals feel, for instance, that the majority of the population is making wrong decisions about the allocation of resources over time, they can bet against the system; they have a way of expressing their differing viewpoints. In a world of uncertainty it would seem desirable to have a system that allows and encourages diversity.